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COMPARISON OF SOLAR SYSTEM MEASURED DATA FOR VARIOUS SAMPLE RATES

Prepared by Wyle Laboratories, Solar Energy Systems Division, Huntsville, Ala.

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This work was done under the technical supervision of Charles N. Thomas, Marshall Space Flight Center.

16. ABSTRACT

This study compared the results of MSFC Solar House data for sample rates of 50, 100, 250, 300, and 600 seconds. The data considered for summer days were the heat incident on the collectors, the heat collected by the collectors, the heat used by the air conditioner generator, and the heat used by the auxiliary heater. For winter days, the heat incident, the heat collected and the heat used by the heat exchanger were computed. These data were compared for different weather days such as clear days, partly cloudy days, cloudy days, and very cloudy days. Also, data for the integration of all these weather days were compared. The percentage differences for these data, using 50 second sample rate as a base, are also presented.

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1.0 INTRODUCTION

The study reported on herein was to compare the results of MSFC Solar House data for sample rates of 50, 100, 250, 300 and 600 seconds. The data considered for summer days were the heat incident on the collectors (Q_{inc}), the heat collected by the collectors (Q_{col}), the heat used by the air conditioner generator (Q_{gen}) and the heat used by the auxiliary heater (Q_{aux}). For winter days, Q_{inc}, Q_{col} and the heat used by heat exchanger (Q_{hx}) were computed. These data were compared for different weather days such as clear days, partly cloudy days, cloudy days, and very cloudy days. Also, data for the integration of all these weather days were compared. The percentage differences for these data, using 50 second sample rate as a base, are also presented.

This study was initiated per the verbal request of Dr. William R. Humphries of MSFC EP-45.

2.0 DATA SAMPLING AND INTEGRATION

The "Local Climatological Data" issued by the National Oceanic and Atmospheric Administration Environmental Data Service, U.S. Department of Commerce, were used to choose separate weather days. Using twenty-four hour average sky cover in tenths as a base, 0 to 2 tenths sky cover is a clear day, 3 to 5 tenths sky cover is a partly cloudy day, 6 to 7 tenths is a cloudy day and

8 tenths sky cover and up is a very cloudy day. The instantaneous variables were computed based on the following equations:

$$Q_{inc} = 1300^{*} \ (Q03)$$

$$Q_{col} = 480^{**} \ (F01) \ [(T04)-(T03)]$$

$$Q_{gen} = 480 \ (F02) \ [(T08)-(T09)]$$

$$Q_{aux} = 480 \ (F03) \ [(T08)-(T13)]$$

$$Q_{hx} = 480 \ (F02) \ [(T07)-(T18)]$$

where:

Q_{inc} = The heat incident on the collectors (BTU/hr)

Q03 = Solar flux, 45° South with diffuse components (BTU/hr ft^2)

Q_{col} = Heat collected by the collectors (BTU/hr)

F01 = Collector pump flow rate (gpm)

T04 = Collector outlet manifold water temperature (°F)

T03 = Collector inlet manifold water temperature (°F)

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* The total area of the collector is 1300 ft^2

** $\frac{8 \text{ lb}}{1 \text{gal}} \times \frac{1 \text{ BTU}}{1 \text{ lb°F}} \times \frac{60 \text{ min}}{1 \text{ hr}} = 480 \frac{\text{BTU-min}}{\text{gal °F hr}}$

Q_{gen} = Heat used in the air condition generator (BTU/hr)

F02 = AC/Htr hot water flow rate (gpm)

T08 = A/C inlet water temperature (°F)

T09 = A/C outlet water temperature (°F)

Q_{aux} = Heat used by the auxiliary heater (BTU/hr)

F03 = AC/Htr exchanger loop flow (gpm)

T13 = A/C pump outlet water temperature (°F)

Q_{hx} = The heat used by the winter heat exchanger

T07 = Heater inlet water temperature (°F)

T18 = Heater outlet water temperature (°F)

The heat flux, flow rate and thermocouple readings were taken directly from the SEL data tapes recorded for the MSFC Solar House. Using trapezoidal rule, these instantaneous variables were then integrated over a 24-hour period. The subroutines used to integrate the data are included in the Appendix to this report.

Data was integrated and compared for both summer and winter days. For the summer days, data of one clear day and two days each for partly cloudy, cloudy and very cloudy days were integrated and the percentage differences, using 50 second sample

rate data as a base, were computed for sample rates of 100, 250, 300 and 600 seconds. The results of these computations are depicted in Tables I through IV. The percentage differences for sample items Q_{aux}, Q_{col}, Q_{gen} and Q_{inc} are also depicted in graph format in Figures 1 through 4.

In an effort to provide a more meaningful comparison of the data, the values of the sample items for each of the seven days were added together and percentage differences were computed for each sample rate. Since the sample data covers a seven-day period and includes all sky conditions, its integration could represent a long time integral result. Table V depicts the results of these computations. Tables VI through IX depict the sky conditions and outdoor dry bulb temperature for the seven sample days.

For the winter days, data of two weekends (from 4:00 pm Friday to 8:00 am Monday) for sample items Q_{col}, Q_{hx} and Q_{inc} were integrated and the percentage differences, using 50 second sample rate data as a base, were computed for the same sample rates as for summer days. The results of these computations are depicted in Tables X and XI. The same procedure as used with the summer day data was followed to obtain the long time integral results depicted in Table XII. Tables XIII and XIV depict the sky conditions and outdoor dry bulb temperature for the two weekend periods.

3.0 RESULTS

From Tables I through IV and Figures 1 through 4, it is clear that 100 second sample rate is almost as good as 50 second sample rate. The difference between them, for all sample items, Q_{aux}, Q_{col}, Q_{gen} and Q_{inc}, and all kinds of weather, are within 1%. On the daily basis, the percentage differences, using 50 second data as a base, for 250, 300 and 600 second sample rate are irregular with the exception of Q_{inc} which has the percentage difference increasing with increasing sample rate, as expected. The high percentage differences for Q_{aux} and Q_{gen} on cloudy days (Table III) are because of the relatively small amount of energy used compared with those other days and are smoothed out after adding up all weather days. As shown in Tables V and XII, the percentage differences of the long time integral data for all cases are with 5% which is satisfactory considering the accuracy of the measurements.

TABLE I. PERCENTAGE DIFFERENCE OF VARIOUS SAMPLE RATES, USING A 50 SECOND SAMPLE RATE AS THE BASE (CLEAR DAY)

SAMPLE DAY NO.	SAMPLE RATE (SEC)	SAMPLE ITEM				% DIFFERENCE			
		Q_{aux} (BTU)	Q_{col} (BTU)	Q_{gen} (BTU)	Q_{inc} (BTU)	Q_{aux}	Q_{col}	Q_{gen}	Q_{inc}
1*	50	56,353	329,017	144,365	,530,550	-	-	-	-
	100	56,353	328,285	144,245	1,527,260	0.0	0.2	0.08	0.2
	250	54,406	336,658	142,164	1,505,199	3.5	2.3	1.5	1.7
	300	50,323	345,225	138,989	1,496,731	10.7	4.9	3.7	2.2
	600	51,904	338,227	140,475	1,446,249	7.9	2.8	2.7	5.5

* See Table VI for Sky Cover Tenths and Temperature

TABLE II. PERCENTAGE DIFFERENCE OF VARIOUS SAMPLE RATES, USING A 50 SECOND SAMPLE RATE AS THE BASE (PARTLY CLOUDY DAY)

SAMPLE DAY NO.	SAMPLE RATE (SEC)	SAMPLE ITEM				% DIFFERENCE			
		Q_{aux} (BTU)	Q_{col} (BTU)	Q_{gen} (BTU)	Q_{inc} (BTU)	Q_{aux}	Q_{col}	Q_{gen}	Q_{inc}
	50	1,118,257	140,277	198,011	2,277,558	-	-	-	-
	100	1,118,462	140,277	198,011	2,277,398	0.02	0.0	0.0	0.008
2*	250	1,136,789	138,499	210,156	2,267,460	1.7	1.3	6.1	0.4
	300	1,125,457	157,185	199,149	2,252,682	0.6	12.1	0.6	1.1
	600	1,139,995	149,699	209,503	2,247,266	1.9	6.7	5.8	1.3
	50	132,961	486,458	250,130	2,248,825	-	-	-	-
	100	132,961	484,883	250,010	2,244,407	0.0	0.3	0.05	0.2
3*	250	143,738	466,336	256,773	2,246,289	8.1	4.1	2.6	0.1
	300	141,011	482,835	251,319	2,235,455	6.1	0.7	0.4	0.6
	600	138,795	465,795	248,439	2,225,273	4.4	4.2	0.7	1.1

* See Table VII for Sky Cover Tenths and Temperature

TABLE III. PERCENTAGE DIFFERENCE OF VARIOUS SAMPLE RATES, USING A 50 SECOND SAMPLE RATE AS THE BASE (CLOUDY DAY)

SAMPLE DAY NO.	SAMPLE RATE (SEC)	SAMPLE ITEM				% DIFFERENCE			
		Q_{aux} (BTU)	Q_{col} (BTU)	Q_{gen} (BTU)	Q_{inc} (BTU)	Q_{aux}	Q_{col}	Q_{gen}	Q_{inc}
4*	50	15,374	444,624	32,550	2,201,900	-	-	-	-
	100	15,374	444,624	32,550	2,201,905	0.0	0.0	0.0	0.0
	250	16,090	445,608	31,465	2,189,188	4.7	0.2	3.3	0.6
	300	12,564	469,461	30,562	2,187,193	18.3	5.5	6.1	0.7
	600	7,260	483,663	27,792	2,199,923	52.8	8.8	17.7	0.1
5*	50	13,730	332,994	33,437	2,132,907	-	-	-	-
	100	13,730	332,995	33,438	2,132,878	0.0	0.0	0.0	0.1
	250	18,813	343,994	44,411	2,122,112	37.0	3.3	32.8	0.5
	300	13,730	323,869	27,834	2,126,635	0.0	2.7	16.8	0.3
	600	8,840	366,695	21,832	2,101,449	35.6	10.1	34.7	1.5

* See Table VIII for Sky Cover Tenths and Temperature

TABLE IV. PERCENTAGE DIFFERENCE OF VARIOUS SAMPLE RATES, USING A 50 SECOND SAMPLE RATE AS THE BASE (VERY CLOUDY DAY)

SAMPLE DAY NO.	SAMPLE RATE (SEC)	SAMPLE ITEM				% DIFFERENCE			
		Q_{aux} (BTU)	Q_{col} (BTU)	Q_{gen} (BTU)	Q_{inc} (BTU)	Q_{aux}	Q_{col}	Q_{gen}	Q_{inc}
6*	50	123,459	319,866	130,489	2,121,639	-	-	-	-
	100	123,359	319,264	130,195	2,118,537	0.1	0.2	0.2	0.2
	250	134,954	320,089	146,944	2,112,634	9.3	0.1	12.6	0.4
	300	127,711	327,619	132,797	2,107,244	3.4	2.4	1.8	0.7
	600	127,731	324,575	127,863	2,100,041	3.5	1.5	2.0	1.0
7*	50	144,713	160,190	203,043	1,175,540	-	-	-	-
	100	144,713	159,018	202,887	1,172,020	0.0	0.7	0.1	0.3
	250	146,835	159,726	203,313	1,160,023	1.5	0.3	0.1	1.3
	300	147,111	155,439	199,899	1,156,186	1.7	3.0	1.6	1.7
	600	129,023	171,803	195,719	1,144,324	10.8	7.3	3.6	2.7

* See Table IX for Sky Cover Tenths and Temperature

TABLE V. PERCENTAGE DIFFERENCE OF VARIOUS SAMPLE RATES, USING A 50 SECOND SAMPLE RATE AS THE BASE (SUMMATION OF SEVEN SAMPLE DAYS)

SAMPLE RATE (SEC)	SAMPLE ITEM				% DIFFERENCE			
	Q_{aux} (BTU)	Q_{col} (BTU)	Q_{gen} (BTU)	Q_{inc} (BTU)	Q_{aux}	Q_{col}	Q_{gen}	Q_{inc}
50	1,604,847	2,213,426	992,025	13,688,919	-	-	-	-
100	1,604,952	2,209,346	991,336	13,674,405	0.01	0.18	0.07	0.11
250	1,651,625	2,210,910	1,035,226	13,602,905	2.91	0.11	4.35	0.63
300	1,617,907	2,261,633	980,549	13,562,126	0.81	2.18	1.16	0.93
600	1,603,548	2,300,457	970,623	13,464,525	0.08	3.93	2.16	1.64

TABLE VI. SKY COVER AND DRY BULB TEMPERATURE FOR SAMPLE DAY NO. 1

SAMPLE NO.	DATE	TIME	SKY COVER (TENTHS)	DRY BULB TEMPERATURE (°F)
	6-22-75	1200	4	83
		1500	5	85
		1800	0	81
		2100	0	73
1		2400	0	72
	6-23-75	0300	0	69
		0600	0	71
		0900	0	79

TABLE VII. SKY COVER AND DRY BULB TEMPERATURE FOR SAMPLE DAYS NO. 2 AND 3

SAMPLE NO.	DATE	TIME	SKY COVER (TENTHS)	DRY BULB TEMPERATURE (°F)
2	7-13-76	1500	5	92
		1800	8	86
		2100	3	77
		2400	0	73
	7-14-76	0300	0	71
		0600	1	70
		0900	4	82
		1200	5	89
		1500	5	94
3	6-21-75	1200	3	85
		1500	3	87
		1800	3	83
		2100	3	76
		2400	4	74
	6-22-75	0300	3	72
		0600	3	73
		0900	1	80
		1200	4	83

TABLE VIII. SKY COVER AND DRY BULB TEMPERATURE FOR SAMPLE DAYS NO. 4 AND 5

SAMPLE NO.	DATE	TIME	SKY COVER (TENTHS)	DRY BULB TEMPERATURE (°F)
4	7-11-75	2400	0	64
	7-12-75	0300	0	61
		0600	4	63
		0900	5	74
		1200	6	78
		1500	3	81
		1800	6	73
		2100	0	66
		2400	0	63
5	7-12-75	2400	0	63
	7-13-75	0300	3	59
		0600	4	61
		0900	0	72
		1200	4	80
		1500	3	80
		1800	5	78
		2100	7	71
		2400	10	71

TABLE IX. SKY COVER AND DRY BULB TEMPERATURE FOR SAMPLE DAYS NO. 6 AND 7

SAMPLE NO.	DATE	TIME	SKY COVER (TENTHS)	DRY BULB TEMPERATURE (°F)
	7- 3-75	1500	9	85
		1800	5	84
		2100	8	78
		2400	9	73
6	7- 4-75	0300	8	72
		0600	5	71
		0900	2	81
		1200	8	86
		1500	10	87
	6-20-75	1500	6	87
		1800	9	84
		2100	8	80
		2400	10	71
7	6-21-75	0300	10	71
		0600	9	72
		0900	3	79
		1200	3	85

TABLE X. PERCENTAGE DIFFERENCE BETWEEN VARIOUS SAMPLE RATES AND A 50 SECOND SAMPLE RATE

(4:00 pm 2-7-75 through 8:00 am 2-10-75)

SAMPLE RATE (SEC)	SAMPLE ITEM			% DIFFERENCE		
	Q_{col} (BTU)	Q_{hx} (BTU)	Q_{inc} (BTU)	Q_{col}	Q_{hx}	Q_{inc}
50	633,066	618,265	3,276,967	-	-	-
100	633,067	617,110	3,272,475	0.0	0.2	0.1
250	638,125	607,396	3,276,946	0.8	1.8	0.0006
300	657,512	624,395	3,264,623	3.9	1.0	0.4
600	714,788	679,844	3,255,414	12.9	9.9	0.6

TABLE XI. PERCENTAGE DIFFERENCE BETWEEN VARIOUS SAMPLE RATES AND A 50 SECOND SAMPLE RATE

(4:00 pm 2-27-76 through 8:00 am 3-1-76)

SAMPLE RATE (SEC)	SAMPLE ITEM			% DIFFERENCE		
	Q_{col} (BTU)	Q_{hx} (BTU)	Q_{inc} (BTU)	Q_{col}	Q_{hx}	Q_{inc}
50	787,252	436,706	5,283,433	-	-	-
100	786,900	436,706	5,280,161	0.04	0.0	0.06
250	781,313	447,665	5,286,168	0.7	2.5	0.05
300	774,186	412,784	5,260,773	1.7	5.5	0.4
600	741,336	398,000	5,261,099	5.8	8.9	0.4

TABLE XII. PERCENTAGE DIFFERENCE FOR VARIOUS SAMPLE RATES USING 50 SECOND SAMPLE RATE DATA AS A BASE

(128 Hours Integral Results)

SAMPLE RATE (SEC)	SAMPLE ITEM			% DIFFERENCE		
	Q_{col} (BTU)	Q_{hx} (BTU)	Q_{inc} (BTU)	Q_{col}	Q_{hx}	Q_{inc}
50	1,420,318	1,054,971	8,560,400	-	-	-
100	1,419,967	1,053,816	8,552,636	0.02	0.1	0.1
250	1,419,438	1,055,061	8,563,114	0.06	0.01	0.03
300	1,431,698	1,037,179	8,525,396	0.8	1.7	0.4
600	1,456,124	1,077,844	8,516,513	2.5	2.2	0.5

TABLE XIII. SKY COVER AND DRY BULB TEMPERATURE FOR WEEKEND NO. 1

DATE	TIME	DRY BULB TEMPERATURE (°F)	SKY COVER (TENTHS)
2-7-75	1500	35	1
	1800	31	1
	2100	30	0
2-8-75	0000	24	0
	0300	24	0
	0600	22	0
	0900	30	0
	1200	43	8
	1500	47	10
	1800	43	10
	2100	41	8
2-9-75	0000	40	10
	0300	43	10
	0600	41	10
	0900	36	10
	1200	30	10
	1500	31	10
	1800	29	0
	2100	27	0
2-10-75	0000	23	0
	0300	20	0
	0600	22	0
	0900	32	4

TABLE XIV. SKY COVER AND DRY BULB TEMPERATURE FOR WEEKEND NO. 2

DATE	TIME	DRY BULB TEMPERATURE (°F)	SKY COVER (TENTHS)
2-27-76	1500	70	1
	1800	64	1
	2100	50	0
2-28-76	0000	44	0
	0300	41	0
	0600	38	0
	0900	53	3
	1200	70	8
	1500	70	10
	1800	65	10
	2100	56	4
2-29-76	0000	48	3
	0300	50	3
	0600	45	0
	0900	59	1
	1200	69	10
	1500	71	10
	1800	62	10
	2100	58	7
3- 1-76	0000	54	6
	0300	49	0
	0600	47	7
	0900	62	6

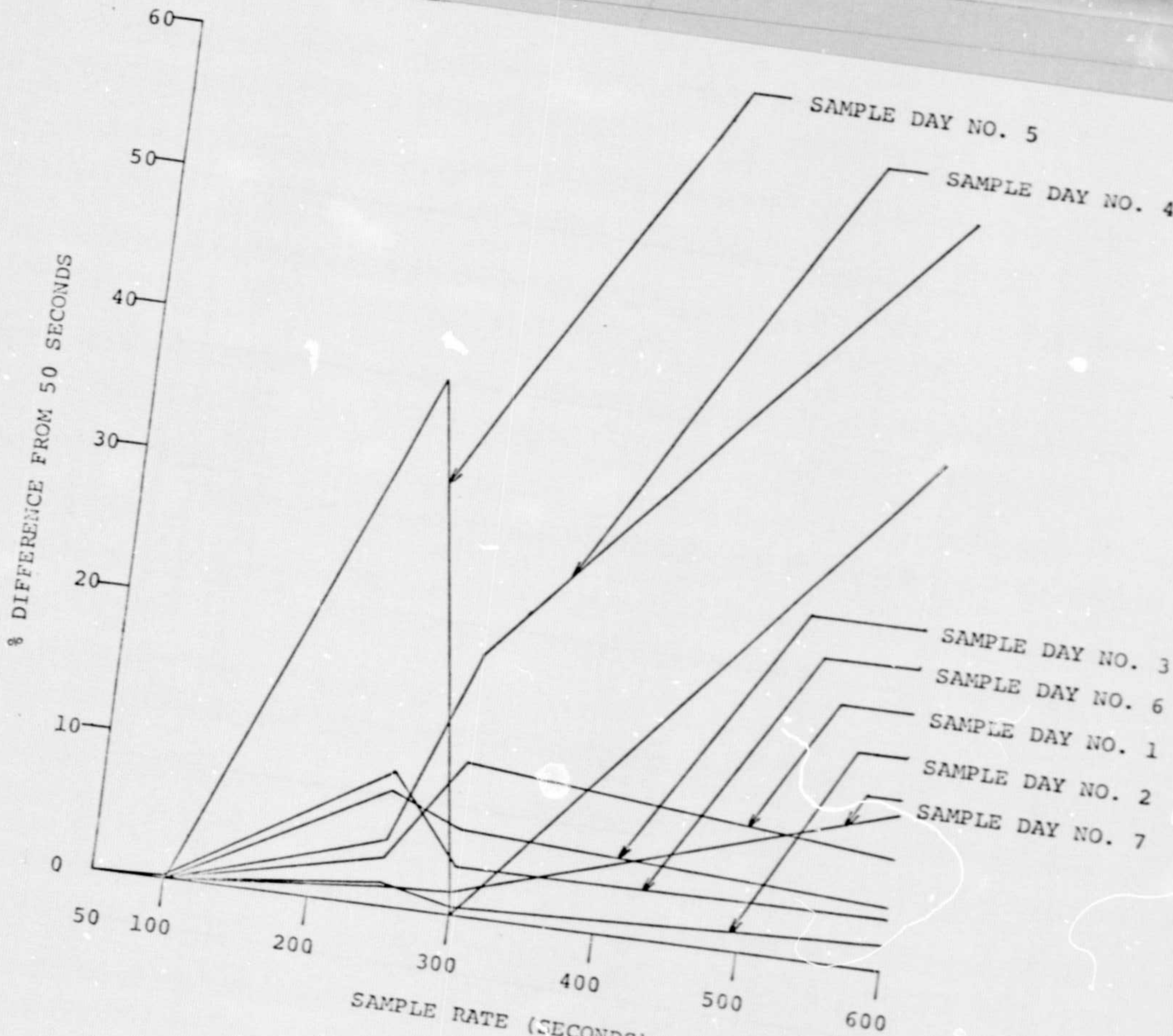

FIGURE 1. PERCENTAGE DIFFERENCES FOR Q_{aux} USING 50 SECOND SAMPLE RATE DATA AS A BASE

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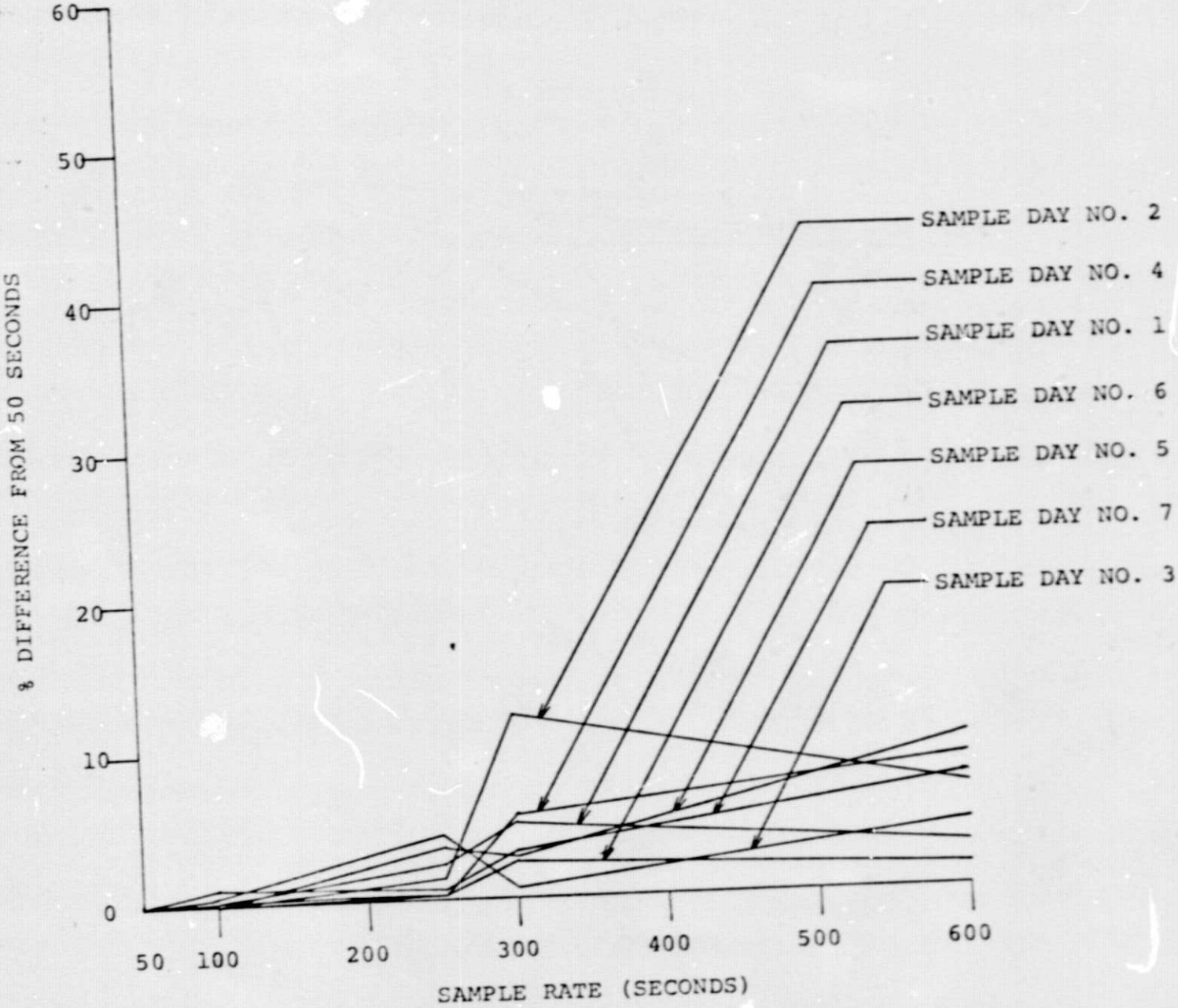

FIGURE 2. PERCENTAGE DIFFERENCES FOR Q_{col} USING 50 SECOND SAMPLE RATE DATA AS A BASE

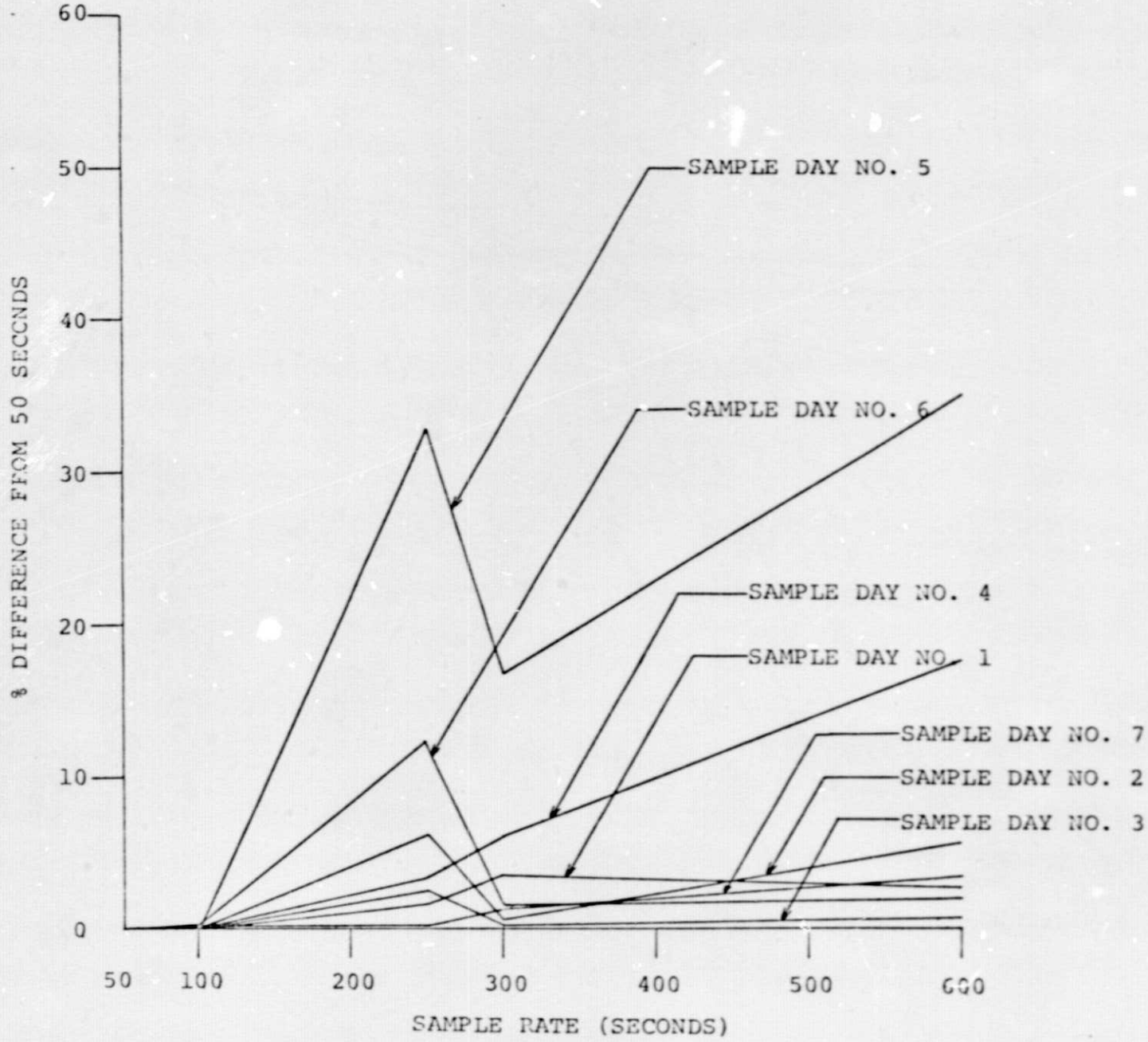

FIGURE 3. PERCENTAGE DIFFERENCES FOR Q_{gen} USING 50 SECOND SAMPLE RATE DATA AS A BASE

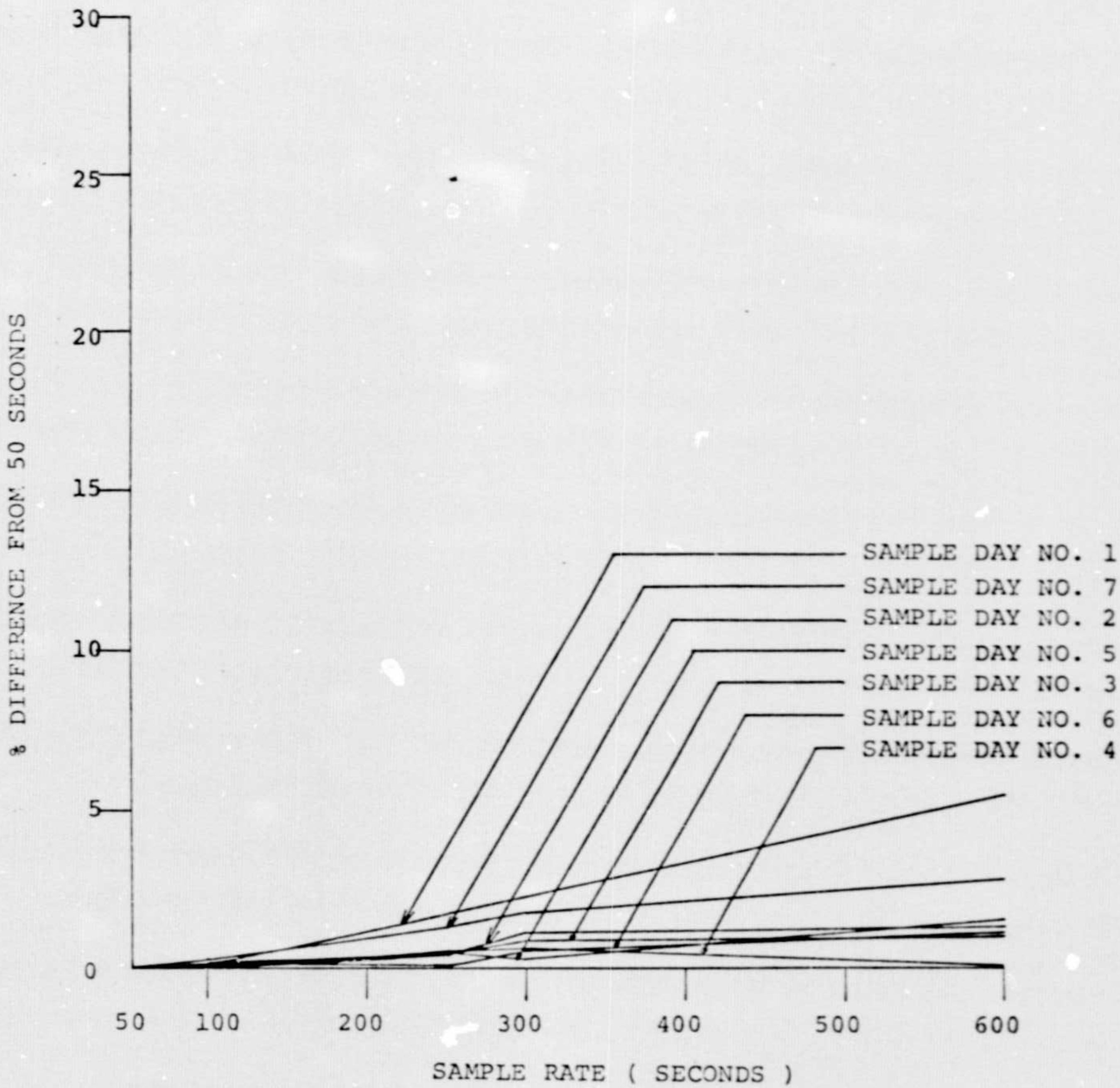

FIGURE 4. PERCENTAGE DIFFERENCES FOR Q_{inc} USING 50 SECOND SAMPLE RATE DATA AS A BASE

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APPENDIX

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00101     1•          SUBROUTINE PRT                                                    000000
00103     2•          COMMON/FIXED/NSCANS,AA(26),IFFP                                   000000
00104     3•          COMMON BUF(10,2000)                                               000000
00105     4•          DIMENSION ADARY(3)                                                000000
00106     5•          DATA ADARY/18H*020 HARD COPY CUT/                                 000000
00110     6•          IFFP=1                                                            000000
00111     7•          CALL GET(6HT-003 ,BUF(1,1))                                       000001
00112     8•          CALL GET(6HT-004 ,BUF(2,1))                                       000005
00113     9•          CALL GET(6HT-296 ,BUF(3,1))                                       000011
00114    10•          CALL GET( H -294 ,BUF(4,1))                                       000015
00115    11•          CALL GET(6HT-013 ,BUF(5,1))                                       000021
00116    12•          CALL GET(6HF-001 ,BUF(6,1))                                       000025
00117    13•          CALL GET(6HF-002 ,BUF(7,1))                                       000031
00120    14•          CALL GET(6HF-003 ,BUF(8,1))                                       000035
00121    15•          CALL GET(6HQ-003 ,BUF(9,1))                                       000041
00122    16•          PRINT 51                                                          000047
00124    17•          PRINT 35                                                          000051
00126    18•       35 FORMAT(8X,'T3',8X,'T4',8X,'T8',8X,'T9',8X,'T13',8X,'F1',8X,'F2',  000055
00126    19•         *8X,'F3',8X,'Q3',5X,'STEP')                                        000055

00127    20•          DO 30 K=1,NSCANS                                                  000055
00132    21•          PRINT 45,(BUF(I,K),I=1,9),K                                       000064
00141    22•       30 CONTINUE                                                          000104
00143    23•       45 FORMAT(1X,9F10.2,5X,I4)                                           000104
00149    24•          DO 50 I=1,NSCANS                                                  000104
00147    25•          D1=1.                                                             000104
00150    26•          D2=1.                                                             000105
00151    27•          D3=1.                                                             000106
00152    28•          D4=BUF(3,I)-BUF(5,I)                                              000107
00153    29•          D5=BUF(2,I)-BUF(1,I)                                              000112
00154    30•          D6=BUF(3,I)-BUF(4,I)                                              000115
00155    31•          IF(BUF(8,I).LT.1.0.OR.D4.LT.0.0)D1=0.                             000120
00157    32•          IF(BUF(6,I).LT.1.0.OR.D6.LT.0.0)D2=0.                             000134
00161    33•          IF(BUF(7,I).LT.1.0.OR.D6.LT.0.0)D3=0.                             000154
00163    34•          BUF(1,I)=480.*BUF(8,I)*D1*D4                                      000172
00164    35•          BUF(2,I)=480.*BUF(6,I)*D2*D5                                      000177
00165    36•          BUF(3,I)=480.*BUF(7,I)*D3*D6                                      000204
00166    37•          BUF(4,I)=1300.*BUF(9,I)                                           000211
00167    38•       50 CONTINUE                                                          000215
00171    39•          PRINT 51                                                          000215
00173    40•       51 FORMAT(1H1)                                                       000225
00174    41•          DO 53 I=1,NSCANS                                                  000225
00177    42•          PRINT 52,I,(BUF(K,I),K=1,4)                                       000225
00206    43•       53 CONTINUE                                                          000241
00210    44•       52 FORMAT(1X,I5,3X,4F12.2)                                           000241
00211    45•          CALL IDL  (4,ADARY)                                               000241
00212    46•          CALL INTR(  ,932)                                                 000245
00213    47•          CALL INTR(2,216)                                                  000251
00214    48•          CALL INTR(5,86)                                                   000255
00215    49•          CALL INTR(6,72)                                                   000261
00216    50•          CALL INTR(12,36)                                                  000265
00217    51•          CALL END JOB                                                      000271
00220    52•          RETURN                                                            000273
00221    53•          END                                                               000316

        END OF COMPILATION:        NO  DIAGNOSTICS.
```

```
      SUBROUTINE INTH(L,MM)
      COMMON /FIXED/NSCANS
      COMMON BUF(10,2000)
      DIMENSION T(2000)
      DIMENSION  TIM(432),PLOT(432),LABEL(12),TIME(12)
      DATA TIME/72H                              (HR)
     1                                                /
      DATA LABEL/72H
     $                                                /
      DT=50./3600.
      QA=0.
      QC=0.
      QG=0.
      QI=0.
      DO 20 K=5,8
      BUF(K,1)=0.
   20 CONTINUE
      KK=1
      T(1)=0.
      DO 10 I=2,NSCANS
      J=I-1
      II=J/L*L-J
      IF(II.NE.0)GO TO 10
      KK=KK+1
      QA=QA+(BUF(1,J)+BUF(1,I))*DT*.5*L
      QC=QC+(BUF(2,J)+BUF(2,I))*DT*.5*L
      QG=QG+(BUF(3,J)+BUF(3,I))*DT*.5*L
      QI=QI+(BUF(4,J)+BUF(4,I))*DT*.5*L
      BUF(5,KK)=QA
      BUF(6,KK)=QC
      BUF(7,KK)=QG
      BUF(8,KK)=QI
      T(KK)=(KK-1)*DT*L
   10 CONTINUE
      DX=L*DT*3600.
      PRINT 11,DX
   11 FORMAT(1H1,1X,'TIME STEP = 'F5.1,' SECONDS',//,4X,'TIME')
      DO 15 J=1,KK
      PRINT 12,T(J),(BUF(I,J),I=5,8)
   15 CONTINUE
   12 FORMAT(1X,F6.2,4F12.2)
      JM=-MM
      MJ=4
      DO 40 N=1,8
      DO 35 J=1,MJ
      DO 30 M=1,MM
      M3=(J-1)*MM+M
      TIM(M)=T(M3)
      PLOT(M)=BUF(N,M3)
   30 CONTINUE
      CALL QUIK3V(-1,1H.,TIME,LABEL,JM,TIM,PLOT)
   35 CONTINUE
   40 CONTINUE
```

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