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WINGTIP VORTEX DIAMETERS, TANGENTIAL SPEEDS AND HORIZONTAL TRANSPORT WITHIN THE FIRST 100 FEET ABOVE THE GROUND

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ABSTRACT

The research supported in this study was part of a joint government and industry accelerated evaluation of the operational impact of wake turbulence produced by large jet aircraft. Data were collected through low altitude aircraft flybys of instrumented towers by Boeing 727 and 707 aircraft, a Douglas DC9, and a Convair 880.

Aircraft induced air circulations were measured by hot film anemometry. Smoke visualized vortex circulations were filmed by FAA personnel to supplement the vortex measurements. The fundamental purpose of this data set is the provision of a quantitative estimate of vortex characteristics for FAA follow-on studies. These studies would attempt to relate these characteristics to the characteristics of the particular test aircraft, its flight configuration, and other relevant aerodynamic parameters.

The tower measurements and calculated vortex characteristics are shown in a number of data tables and graphical depictions. The vortex characteristics presented are vortex size, basic shape, tangential speed versus radial distance, core diameter, age, speed of horizontal transport, separation of vortex pair centers, and supplemental measurements of atmospheric wind speeds and temperatures.

A smaller vertical spacing of tower sensors, on the order of one foot, is necessary to better measure and better quantitize the vortex core characteristics and the radial distribution of tangential speeds. Sequential tower measurements of the energy of circulation for the same vortex, combined with the appropriate micrometeorological measurements are needed to evaluate and quantitize vortex decay in the atmosphere.

I. Introduction

During May and June of 1970 a follow-on testing series was conducted at the National Aviation Facilities Experimental Center (NAFEC), New Jersey. The Air Resources Laboratories Field Research Office, Idaho Falls, was again requested to provide for the recording of air flow data and some atmospheric parameters, process the project raw data, and where possible, determine vortex characteristics such as core diameters, maximum tangential speeds, horizontal transport, and atmospheric properties affecting vortices.

An earlier three phase test series was conducted during February 1970 at Edwards Air Force Base, California, at Boeing, Seattle, and at the National Reactor Testing Station (NRTS), Idaho. The NAFEC test series was initiated to determine and compare the characteristics of vortex systems generated within the ground effect region to those vortex systems generated above and descending into the ground effects region.

The test measurement procedures were basically the same as the NRTS testing in February. Jet aircraft were flown by an instrumented 100 foot tower at selected combinations of lateral distances and heights above the ground. The tower was instrumented with hot film anemometers, temperature sensors, a slow response wind vane and propeller and colored smoke grenades for flow visualization. In conjunction with these measurements, FAA personnel used 16 mm color movie film to record the smoke indicated vortex circulations, and used double photo-theodolite tracking to provide aircraft positions with respect to the tower and the times of fly-by.

II. Background of Problem

Interim traffic control restrictions applying to both the Boeing 747 and Lockheed C-5A advanced technology transports, were announced by the

Federal Aviation Administration about nine hours before the 747 entered commercial service. The FAA action, which might be modified after additional testing of the aircraft, was based on an indication that the aircraft may produce greater wake turbulence, both in the air and on the ground, than do earlier jet transports.

In February 1970 the FAA, in cooperation with industry, the Department of Defense, the Department of Commerce, and other government agencies, conducted an accelerated evaluation of the operational impact of wake turbulence produced by large jet aircraft. The program was divided into three phases, all of which were conducted concurrently in three geographical areas. The first phase involved the Western Region (WE), the National Aeronautics and Space Administration, NASA, Flight Research Center, Edwards California, and the U. S. Air Force, Edwards Flight Test Center, California. These flight tests were conducted in the Edwards area. Primarily, the tests performed by the above groups were inflight penetrations of the vortices of the Lockheed C-5A by an instrumented Convair 990 at Edwards.

The second phase was conducted by the Boeing Company in the Seattle, Washington area. In these tests, the above mentioned Convair 990, a Boeing 737, and a North American F86 aircraft penetrated the vortex systems of the Boeing 747 and 707-300 series aircraft.

The objective of the third phase of this wake turbulence program was to conduct flight tests at the ARL-ESSA Test Grid Facility at the National Reactor Testing Station, Idaho. These flight tests were made to gather quantitative data on the vortex wake turbulence characteristics of large, medium, and small jet transport aircraft from a low-altitude tower fly-by

technique. This phase was reported in March 1970 Interim Report #1, Dickson and Start (1970).

These preliminary studies indicated that large jet transports may have certain operating characteristics which will require special handling. Of concern are indications that these aircraft may generate greater wake turbulence both on the ground and in the air.

On April 21, 1970 FAA Flight Standards requested that NAFEC investigate the deterioration of a vortex that is generated in ground effect. The request was precipitated by the Boeing Aircraft Company who reported that the strength of vortices generated in ground effect deteriorate very rapidly. Accordingly, closer aircraft separation criteria can be tolerated during takeoffs and landings. The tests described in this report were conducted at NAFEC jointly with NAFEC/ESSA-ARL Idaho Falls personnel and equipment during the period May-June 1970. ESSA-ARL recording equipment was used for the data acquisition. The resultant data tapes were compatible with (ESSA's) data processing equipment. All data was processed at Idaho Falls.

III. Instrumentation and Data Handling

The testing site for this series was at NAFEC, Atlantic City, New Jersey. The NAFEC complex includes several runways, similar to most international airports around the United States. A 100 foot instrumented tower was erected 125 feet from the edge (200 feet from the center) of runway 22/04. Wooded areas began approximately 1/4 mile to the northeast of the tower, 1/2 mile to the north and east of the tower, and a mile or more in the remaining directions. The runways and taxiways were located within a large area of mowed grass, typical of most airfields.

The 100 foot tower used for these tests was of a tapered, triangular cross-section, about five feet on a side at the base and two feet on a side at the top. The tower is shown in figure C-1A.

Fast response instrumentation for sensing the vortex induced airflows were mounted on ten foot, horizontal sliding booms. These booms were bolted to the tower at the 100 foot height level and at successive 10 foot lower intervals and could be telescoped parallel to runway 22/04. The acquisition of fast response instrumentation and its positioning on the tower were administered by personnel of FAA, NAFEC. The sensors[1] were quartz-coated, hot platinum film elements operated at constant temperature (400°F). These anemometers were mounted at the outer end of the telescoping booms in a clamp which could be rotated through a 180° horizontal sector. The hot film sensors were a single cylindrical rod about 1/2 inch long. The longitudinal axes of the rods were aligned parallel to the planned aircraft flight path and horizontal. The sensors were plug-in tips which were inserted in short tubular probe arms. A view of the installed hot film sensors is shown in figure C-1B. The output signals from these sensors were in the range of 4 to 14 volts.

Signal voltages from the hot film sensors were recorded on an Ampex (FR 1300) 14 track tape recorder. The tape recorder and periferial electronic equipment were supplied and operated by the Special Instrumentation Group, Idaho Nuclear Corporation, who were under contract to ESSA, as in the February NRTS study. The input voltages were recorded in the frequency modulation mode (FM). Output voltages from the hot film sensor electronic modules were conditioned for improved signal to noise ratio prior to

[1]A product of Thermo-Systems, Inc., St. Paul, Minnesota.

recording on tape. An opposing voltage (hereafter termed a bucking voltage) of approximately nine volts was used to displace the relative zero voltage of the electronics output. The relative output voltages from the hot film modules then spanned from -5 to +5 volts. This output voltage was attenuated by a factor of four through operational amplifiers. The final conditioned voltages transmitted to the tape recorder were now within the range limits of ±.125 (rms) volts for the recorder. The recovery of output voltage as from the hot film electronic modules is given by equation (1).

$$EHF = EB + (ATTN)(TZC) + (ZFCE(TSI) - ZFCE(FIELD)) + ATTN(ETR) \qquad (1)$$

where

EHF = hot film electronics module output voltage

EB = bucking voltage (about 9 volts)

TZC = tape recorder zero reference drift (volts)

ZFCE(TSI) = zero flow calibration voltage measured by manufacturer

ZFCE(FIELD) = zero flow calibration voltage measured in the field during testing

ETR = tape recorded voltage

ATTN = operational amplifier attentuation adjusted for deviations of Δfrequency/Δvoltage.

In practice, terms on the right side of equation (1) are grouped and simplified into the quantity tape voltage times the attenuation, plus a constant effective bucking voltage, and plus the difference between the manufacturer's and the field observer's value of the zero flow sensor voltage. Each testing day the hot film sensors were sheltered from the natural atmospheric air motions and the voltage output logged. Also, the

bucking voltages and attenuations applicable to each hot film sensor system were adjusted as needed and logged each day. Following each aircraft data run, the bucking voltages were recorded to constantly check for any voltage drift. The electronics systems were very stable and extremely little change occurred.

The recovered output voltages, EHF, were compensated for air temperature and density variations using an approximate correction factor based on a mean air temperature during the aircraft data pass[2]. The observed hot film system output voltages were multiplied by the following quantity, termed a cooling factor, K.

$$K = \left[\frac{TS - TC}{TS - TE}\right]^{1/2} \qquad (2)$$

where

TS = operating temperature of the sensor, 400°F

TC = air temperature at time of calibration, °F

TE = air temperature of environment during sampling, °F.

Atmospheric measurements were made with slow response instrumentation to provide a first indication of the state of the atmosphere. Temperatures were measured on the tower at 100 feet, 30 feet, and 10 feet above the height of the runway. The temperature was sensed by Honeywell nickel-A type resistance bulbs within Climet aspirated shields. The three temperatures were recorded on a six-point multiplexing type of strip chart recorder. The three sensors were carefully calibrated against one another, and the absolute temperatures and temperature differences are accurate to ±0.2F°.

[2]Operating and Service Manual, 1050 Series, Constant Temperature Anemometers and Related Accessories, Thermo-Systems, Inc., St. Paul, Minnesota, p 4-2.

Wind direction and speed were measured by a Bendix-Friez aerovane located at the 103 foot level of the tower (clamped to a short vertical mast mounted at the tower top). The wind directions and speeds were recorded as analog ink pen traces on a strip chart recorder. The Bendix-Friez aerovane system was calibrated in the ESSA low speed wind tunnel at Idaho Falls. A flow chart illustration of the data acquisition systems is given in figure C-[illegible].

The voltage versus airflow calibrations of the hot film sensor systems were performed by Thermo-Systems, Inc., at their facilities before shipment of the sensors to the field site location. Eighteen paired calibration point values were determined for each sensor, spanning airflows between zero and approximately 145 feet per second (fps). A plot of log voltage versus log airflow was a very good approximation of a straight line.

To be sure the calibrations would encompass all observed field data, one additional calibration point was extracted from the extrapolated log-log plots at 15 volts output from the hot film electronics. This extended the flow calibration range to at least 232 fps for all sensors, bounding all field observations.

A flow diagram of raw data extraction procedures is shown in figure C-[illegible] Four extraction procedures were performed by personnel scanning strip chart records of temperatures, wind speed and direction, and brush recorder traces of analog tape recorder voltages.

The only automated data extraction procedure, but most essential, was the analog to digital conversion of hot film voltages from five 14 channel analog tapes. The wind speeds were rounded to integer values in miles per hour. Wind directions were recorded to the nearest five degree value.

The analog tapes were digitized at a rate of one data point per 104 milliseconds (msec) with 208 msec filtering by a Honeywell DDP-124 analog to digital conversion system. The DDP-124 output was stored on digital magnetic tape for further processing. Since the extreme values may be obtained from analog records, the 104 msec digitizing rate was selected as the best rate. The FAA project director was briefed on this data extraction method and concurred on the approach. The digitized hot film voltages for individual sensors were merged or grouped according to data points acquired at the same instant during testing, as was the data from the February testing at the NRTS (Dickson and Start, 1970). During this same merge process, the hot film electronic module output voltages were converted to air flow speeds. The speed conversion process was a linear interpolation within a matrix of calibration voltages versus air flow.

During the second aircraft fly-by of the field experiment, May 27, the hot film anemometer at the 70 foot level on the tower developed an electrical short. For the remainder of the day this tower level had missing data. The electrical short could not be corrected or replaced prior to the completion of the field experiment. The hot film anemometer at the 100 foot level was interchanged with the anemometer from the 70 foot level during the remainder of the testing to avoid non-uniform sized height gaps between sensors.

For synchronization of FAA movie film data and tape recorded hot film voltages, a flashbulb was ignited at the time the aircraft wing was abeam of the tower, showing in the films. At the same instant, a voltage pulse was recorded on a channel in the analog tape recorder system, marking the voltage records at the same reference time. During the first two fly-bys,

727 passes 1 and 2, and during 707 pass 1, the voltage pulse was missing. For the 727 pass 28, the voltage pulse occurred 1.2 seconds before the tape recorder record of hot film voltages began. Finally, for 880 pass 38, the voltage pulse was between 10 and 15 seconds late. For all cases of abnormal timing voltage pulses, except for 880 pass 38, the age of the vortex was obtained from vortex smoke visualization films. The photographic angles of view were inadequate for resolving the age for the 880 fly-by.

V. Results

The results of this research are a number of data tables and graphical depictions of vortex size, basic shape, tangential speed versus radial distance from the vortex center, radius of maximum speed, age, rate of atmospheric transport, and supplemental atmospheric characteristics. While these tables and graphs quantitize many types of vortex characteristics, their more fundamental value is to provide the basis for additional FAA interpretations and analyses. The FAA follow-on studies would attempt to relate these vortex characteristics to the characteristics of the particular test aircraft, its flight configuration, and other relevant aerodynamic parameters. The data listed and plotted in the accompanying collection of tables and figures are all expressed in English units, feet, seconds, feet per second, pounds, Fahrenheit degrees, etc., for the convenience of the FAA. Since the FAA works with these types of units, the follow-on studies will be simplified by expressing the results of this study in the same units.

During the period May 27 through June 7, 1970 a total of 153 aircraft tower fly-bys were made. Of this total, 150 passes possessed tower data for analysis. Four aircraft were used in the tower fly-bys, a TWA 707, and three FAA aircraft, a 727, and a DC9 based in Oklahoma City, and a CV880 based at NAFEC. Data from eighty-five passes were collected for the CV880, from forty-two passes for the 727, and from twelve and eleven passes, respectively, for the DC9 and TWA 707.

Contour analyses of vortex plus atmospheric flow speeds are presented in figures [illegible] through [illegible]. The speed contour analyses are derived from the digitized hot film sensed air flows. The contours are presented in a time-vertical height set of reference coordinates. To preserve the concepts of equal area and equal length along the individual coordinate axes, the plotting scale for the time axis is adjusted. A scaled distance along the time axis (the product of the 100 foot atmospheric wind speed component normal to the aircraft track and unit time) is given a plot length which the same real distance would have, if scaled along the vertical height coordinate axis. Each contour plot is identified by a title listed along the top of the plot. Besides the aircraft identification, date, and time groups, the component of atmospheric wind speed normal to the aircraft flight track (denoted U) and the interval between contoured isotachs, are listed. All contour levels are for 10 feet per second or integer multiples of 10 fps. With time increasing from left to right, the first vortex will always possess clockwise tangential flow and the second vortex will possess counterclockwise flow. The atmospheric wind speed component will always be directed from right to left (large time to small time), along the direction of vortex transport. The heights and ages of the vortices when intercepted by a tower sensor are listed in Tables B-3 through B-[illegible].

In general, two characteristic regions are found above and below the vortices within which vortex-atmospheric flow interactions stand out. In one region the vortex flow adds to the atmospheric flow and produces a relative flow maxima; in the other region the vortex flow blocks the atmospheric flow and produces a minima. An indication of the horizontal separation of the centers of the vortex pairs may be obtained from the contour plots. Plots in which the radial gradient of vortex speed becomes relatively large, the contour analyses will not suitably illustrate to peak sensed vortex speeds. Tables [illegible] through [illegible] are the best source for obtaining these peak speeds.

The contoured patterns of speed deviate from symmetrical, smooth, ideally-shaped flow patterns. But this is not all bad. To a first approximation, the more chaotic the contour pattern, the more turbulent is the atmospheric flow; the less the vortex induced motions dominate the contour analysis, the less the organized energy of circulation (and hence the tendency for a more advanced stage of vortex decay) existing in the vortex. Additional discussion of the sources of irregular, somewhat-ragged plotted speed contours is contained in Appendix A.

Approximately thirty aircraft fly-by cases were not contoured, because there was a lack of flow speed data suitable for contouring. Two primary causes of ill-suited data were a failure of the sensors to intercept the vortex or an extremely slow transport of the vortex across the sensors. For selected cases and also those fly-bys which were not contoured, a two page plot was made of the speeds sensed by the array of hot film anemometers. These time-series plots of speeds for the various heights are presented in figures C-12[illegible] through C-21[illegible] The timing

synchronization voltage pulse is a vertical line which crosses the time axis. The heights of the sensor traces being plotted are given (in feet) by the larger sized numbers to the left of the vertical axes. The vertical axes are labeled for speeds of tens of feet per second. In instances where the flow speeds exceed 100 fps, the plotted speed trace is broken, discontinuously, and the speed value minus 100 fps is plotted in this modified manner until the real speed again decreases to less than 100 fps. Figure [illegible], for pass 8 of the 727 testing, illustrates this effect for data from the sensor located at the forty foot height. Again, as in the contoured speed analyses, the values of peak sensed speed should be obtained from tables B-[illegible] through B-[illegible]

In addition to the peak vortex plus atmospheric speeds listed in tables [illegible] through [illegible], other vortex characteristics are listed, (under the heading vortex core) along with aircraft flight identification data and atmospheric transport information. Under flight identification a ~~The~~ data column ~~in these tables~~ lists the month, day and year; the group 052770 represents May 27, 1970. The time column contains the hour, minute and second of when the plane was abeam of the tower. The group 063813 represents 0638 and 13 seconds, Eastern Daylight time. Vort No. in the table is one or two, depending whether the information describes a first or second vortex. The first vortex is always defined as the vortex generated by the wingtip which passed closest to the sensors.

The columns labeled V1, V2, and V3 represent the peak sensed of vortex core speeds. When V2 and V3 are given, they represent the speeds obtained when the sensor penetrated inside the vortex core, and when the sensor again passed through the point of maximum speed as it left the core. The speeds

are listed with units of feet per second. The column headed DIA contains the estimated core diameters, in feet, when they were calculated. A value of zero indicates no calculation was made. The age of the vortex, (in seconds), when intercepting the sensors is in the column next to the diameters.

A plot of these maximum speeds versus vortex core diameters is given in figure C-[illegible]. For large vortex speeds the core diameter remains small. As the speeds diminish towards 50 to 65 feet per second, the estimated diameter sizes are scattered over a large range. A scatter diagram plot of maximum vortex speeds versus ages is given by figure [illegible]. Considerable scatter exists in the data, particularly at slower speeds. The major value of this figure probably is the suggested boundary along the edge of the data points. This boundary of the observed data represents an estimate of the maximum vortex tangential speeds expected at a given vortex age, if all other conditions are held constant. It may well be that some appropriate normalizing of these speeds and ages will tend to collapse the data points toward some universal curve.

Three columns are given in tables [illegible] under the heading for atmospheric transport. All listed transport speeds are in units of feet per second. The last column, ATMO, lists the component of atmospheric wind speed along the perpendicular to the aircraft flight path. The speed listed in the next to last column, OBS, is the observed mean transport speed. This observed speed is derived from the lateral distance moved divided by the age of the vortex. Appendix A contains a discussion of possible sources of error in calculation of these observed speeds. The column labeled GEFS is the difference between the observed speed and the atmospheric wind speed component,

listed under column ATMO. The term GEFS is an estimate of the ground effect on transport speeds and contains all the sources of variability inherent in both the observed and measured atmospheric speeds. Scattergram plots of the atmospheric speed components versus the mean observed transport speeds are given in figures C-[illegible] and C-[illegible]. The first figure, C-[illegible], contains data for the first vortex. Data for the second vortex are plotted in figure C-[illegible]. From the figures estimates of the vortex transport speed associated with earliest arrivals of the first vortex for the given atmospheric speed component, and similarly estimates of the latest arrivals observed for the second vortex. Information of this type can be interpreted to give some guidance regarding vortex dwell time over runways and/or the likelihood of vortices being in a position to affect aircraft operations on a parallel runway.

For selected cases, in which a hot film sensor appeared to make a deep penetration into the core, approximately twenty values of speed were extracted from time versus speed records. The sequences of speed data contained the peak speed value and data points extracted at equal incremental steps in time outward from the peak.. An example showing the character of a hot film voltage versus time analog record is given in figure C-[illegible]. This trace is from the 40 foot sensor height during 727 pass 8. The upper trace shows the effects of both vortices intercepting the sensor. In the lower trace the time scale is expanded by a factor of ten. In the expanded plot each vertical line is separated in time from its neighbor by one tenth of a second.

The observed data were expressed as speeds versus radial distance, where distance was calculated as the core radius plus the mean observed

rate of vortex transport times the incremental time difference between when the data point was observed and when the peak speed was observed. To gain insight into the relationship between speed and vortex radial distance, the data were fitted by an equation of the form

$$V(R) = \frac{1}{aR^n} \tag{3}$$

where V(R) dentoes speed and R denotes radial distance. A least-squares calculation of the coefficient was obtained and a calculated speed generated for comparison with the observed speeds. Two first vortices from 727 data were used, 727 passes 8 and 9. The exponent n was given values of 1, 4/5, 3/4, 2/3, and 1/2. The best agreement with observed data was for n equal to 3/4. The mean value of the coefficient a for the 727 was 0.0070, and a range in value from .0067 to .0072 for these calculations. The coefficient a, as used in the equation above, is very nearly equal to the reciprocal of the peak sensed vortex speed. For other aircraft, the peak sensed speed at the edge of the vortex core differs considerably from the peak values for the 727 measurements. Values of observed vortex speed versus radial distance are listed in tables B-14 through B-17. The calculated coefficient a is listed for each vortex case. Note that each vortex provided two chances to determine a; one calculation for the rise above ambient conditions to the peak speed, and the other calculation during the descent back to ambient. Additional investigation of the relationship between speed and vortex radius are desired. Some additional normalizing of the data, perhaps something like the ratio of theoretical vortex strengths, may permit a better description of the radial distribution of speeds from a single

equation. Stated another way, the coefficient a and the exponent n are expected to be determined by other factors, many of which would be initial conditions.

A scatter diagram of calculated versus observed speeds is shown in figure C-22. The exponent n was 0.75 for these cases. The data for first vortices for cases from the 727 passes 8 and 9 and for the second vortex from the DC9 pass 10 were used. The largest deviations of the data points from a one to one relationship occur at the point of maximum speeds (at the core boundary). The actual data values plotted are listed in tables B-13 through B-14.

A plot of calculated speed versus radial distance is shown in figure C-23 for the 727. The exponent n was equal to 0.75 and the coefficient a was equal to 0.0070. The data points were generated for a vortex diameter of 1.6 feet and vortex ages between 7 and 13 seconds.

A listing of atmospheric temperatures for the three sensor heights on the tower and the atmospheric wind speed and direction are given in tables B-15 through B-25. The data are listed under a heading which identifies the aircraft pass, date, time, lateral displacement (in feet) of the aircraft nose from the tower (YPRIME), and the vertical height of the nose above the runway (ZPRIME), in feet. The wind direction and speed are given in degrees and miles per hour. The data group 31011 represents 310 degrees at 11 mph. An atmospheric index, discussed in Appendix A, is also listed.

VI. Conclusions

The FAA experimental design and the initially contracted ESSA support for the NAFEC testing series during May 1970 proposed the same type of hot wire/hot film anemometer information provided from the NRTS testing in

February, 1970. The NRTS information was a collection of time series plots of anemometer speeds. A post-NAFEC-testing revision of the contract requested that vortex characteristics, such as core diameters, be calculated if possible. In these instances, the information was desired beyond the original experimental design limits.

Core diameters were estimated for sixty-one vortices sampled during the May testing at NAFEC. Peak vortex flow speeds were calculated for over 100 vortices, along with the vortex ages at the moment of sampling. The mean speed of vortex horizontal transport and the atmospheric wind speed component normal to the vortex axis were calculated. Eulerian height versus horizontal distance contour analyses of airflow speeds were constructed from the tower mounted sensors to better visualize the spatial extent of vortex influences. The dependencies of vortex tangential speeds upon radial distances were examined for a few selected vortex measurements.

The peak measured vortex speeds are strongly affected by the sensor tower spacings and whether the sensor intercepts or misses the vortex core. Unless sensors are spaced much closer together than the ten feet which they were, the measurements of peak vortex speed cannot consistently be used as an index of either a) the strength of the vortex produced (the one extreme value measured for the aircraft type and configuration yields an estimate of this upper limit), or b) the state of decay of the vortex circulations (i.e., speed reduction from the expected peak generated value). For peak vortex speeds below about 65 fps, the vortices appear to possess a different character. The assumption of core solid rotation may be strongly violated in these instances and diameter estimates based on peak speeds below this value might then be poor. To avoid interpretation of

vortex-flow atmospheric-flow interactions or system noise as sensor penetrations of the vortex core, diameter calculations derived from a speed fluctuation less than the magnitude of the atmospheric wind speed should be rejected or interpreted with care.

From the information available for this test series, it is impractical to determine, with any confidence, the role of atmospheric conditions in determining the rate of vortex decay. The data measurements were not suited to this end. Any future attempts to determine a vortex rate of decay in relation to atmospheric characteristic should a) provide at least two or three sequential measurements of the energy of circulation for the same vortex, and b) include sufficient meteorological instrumentation to specify the detailed characteristics of the atmosphere, such as the three dimensional turbulence intensities, as well as the common types of meteorological measurements made at airports.

The radial distribution of vortex tangential speed was estimated for two carefully selected passes from the 727 data series. As a first approximation, tangential speed is proportional to radial distance to the -3/4 power. Very few cases were measured which were suited for this type of evaluation. A much smaller vertical spacing of sensors is required, on the order of one foot separation, to increase the likelihood of deep penetration of vortex cores by a sensor. Without considerably greater resolution in the vortex measurements, both the radial distribution of tangential speed and the decayed state of the vortices will be difficult to quantify.

VI. Acknowledgements

~~Since~~ This report is the combined effort by various personnel of the Air Resources Laboratories Field Research Office. Special recognition is given to Harold Boen, Computer Programmer. All ARL-FRO personnel at the NRTS have made contributions to this report, but special thanks are gratefully given to Mrs. Lydia Thorngren, who typed the original manuscript.

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APPENDIX A

THEORY AND DERIVATION OF EQUATIONS

Appendix A - Derivation of Equations and Definitions

Descriptions of vortex tangential speed, vortex radius at the point of maximum tangential speed, mean speed of vortex horizontal transport through the atmosphere and ground effect modifications, the relationship between tangential speed and vortex radius, and the characteristics of the atmosphere in which the vortex was imbedded, are some of the information desired. If it is postulated that spatial similarity exists within the vortex over short times (distances) so that sampling along a diagonal slice through a vortex (with respect to the vortex axis) is basically equivalent to sampling through a cross-section normal to the vortex axis, some useful definitions and simple equations may be formulated.

The following definitions are schematically shown in figure C-23. The aircraft passes by the tower sensors at some lateral separation, Y. The wingtips therefore pass by at Y ± (wingspan/2), defined as YP. The aircraft horizontal speed is called C. The atmospheric wind is a vector, VA, which generally is non-perpendicular to the flight path. Four possible trajectories by which a vortex element reaches the tower sensors are illustrated. One trajectory, SA, is parallel to the wind vector and is the longest expected path. The minimum length trajectory, SU, is along the perpendicular joining the tower sensors and the flight path. The actual trajectory, ST, and the straight-line approximated trajectory, STA, should begin on the wingtip track at a point between where SU and SA intersect the wingtip track. The actual vortex trajectory is expected to be curved because a time changing, surface boundary induced lateral movement (ground effect speed) is added to the atmospheric wind transport. The four solid dots on the trajectories denote the position of the vortex element (which

reaches the sensors) when the wingtip is abeam of the sensors, at time TE. When the atmospheric wind vector is normal to the flight path, all four points coincide.

The total lateral displacements of vortex elements intercepting the sensor are all equal to YP. The times at which each of the four elements were generated are different by the time increment required for the aircraft to fly from the point of vortex element generation to the point abeam of the sensors. At time T the vortex element intercepts the tower sensors. The approximate age of the vortex element, T-TE, differs from the true age of the vortex by some T', which is generally smaller than T".

The mean speed of vortex lateral transport is defined as the lateral distance of travel YP divided by the vortex age.

Thus,

$$VU = YP/(T-TE) \qquad \text{(A-1)}$$

$$VT = YP/(T-TE+T') \qquad \text{(A-2)}$$

$$VA = YP/(T-TE+T") \qquad \text{(A-3)}$$

where

VU = transport speed along trajectory SU

VT = " " " " ST

VA = " " " " SA

T' and T" = increments of time required for the aircraft to fly from the respective points of generation to abeam of the tower.

By knowing the wind direction and the aircraft heading, the angular departure, θ, of the wind vector from the normal to the flight path is calculated. From the right triangle in figure C-23,

$$\tan \theta = (C)(T")/YP$$

or

$$T'' = (YP)(TAN\theta)/C. \qquad (A\text{-}4)$$

T" represents an extimated upper limit of the error in vortex age defined by (T-TE). These errors versus θ are listed in table [illegible]. The values of T" are developed from the following approximate initial conditions.

$$C = 200 \text{ fps, and } 60 \text{ ft.} \leq YP \leq 350 \text{ ft.}$$

Two bracketing values of T" were calculated based on $0.25 \leq \frac{YP}{C} \leq 1.75$ seconds.

Since vortex age must be underestimated by T", the mean speed of vortex lateral transport must be overestimated. The maximum expected fractional overestimated of VT is obtained by dividing equation (A-1) by equation (A-3), or

$$\frac{VU}{VA} = \frac{T-TE+T''}{T-TE} = 1+\left(\frac{T''}{T-TE}\right) . \qquad (A\text{-}5)$$

Selected cases using actual data from some of the extreme situations are listed in table [illegible]. For wind directions within 65 degrees of the perpendicular to the aircraft track, the estimated transport speed should be in error by ten percent or less, and the age in error by 1/2 to 4 seconds, depending on the initial lateral distance between the sensors and the wingtip.

The ground effect modification of vortex horizontal transport may be approximated by the difference between VU defined in equation (A-1) and the wind speed component along the normal to the flight path. This yields

$$GEFS = [YP/(T-TE)] - VA(\cos\theta) \qquad (A\text{-}6)$$

where

GEFS = ground effect speed (fps).

If a vortex were to impinge, exactly centered, upon a hot film sensor, a plot of vortex tangential speed versus time or distance would possess these general features. The tangential speed would increase to a peak value, V1, then drop more rapidly to zero at the vortex center, V2, rise to a second peak value, V3, and then decrease to the initial conditions. The vortex center region between the two peaks is termed the vortex core or vortex tube. In practice, the observed speeds do not decrease to zero during a sensed vortex passage, but may decrease somewhat from the peak speeds. A speed versus time plot of the vortex induced flow will look like a peak with a dimple in it. An illustration of this effect is shown in figure .

Figure shows the path of a sensor through the vortex core which would generate a time series plot of vortex tangential speeds like the sequence in figure If the sensor had passed through the core center, the core diameter could be calculated as the product

$$\text{Diameter} = (\Delta T)(VT).$$

When the sensor fails to pass through the core center, this may yield poor estimates of the diameter.

Within the vortex core, theory postulates solid rotation; the angular velocity is a constant and the following relationships may be stated.

$$V1/R1 = V2/R2 = V3/R3 = W = \text{constant}$$

where,

omega = Ω

V = tangential speed

R = radial distance

W = angular speed.

From figure C- , along the dashed path of the sensor,

$$(\text{chord length}/2)^2 = R1^2 - R2^2 = R3^2 - R2^2$$

Since R1 = R3 and R2 = R1 V2/V1 = R3V2/V3

$$R1^2 = \frac{[(VT)(\ T)]^2}{4[1-V2^2/V1^2]}$$

and (A-7)

$$R3^2 = \frac{[(VT)(\Delta T)]^2}{4[1-V2^2/V3^2]}$$

Defining equation A-7 in terms of a diameter, D, and calling V2 by VMIN and the greater of V1 or V3 by VMAX,

$$D^2 = \frac{[(VT)(\Delta T)]^2}{[1 - VMIN^2/VMAX^2]} \qquad \text{(A-8)}$$

Equation A-8 was used to estimate vortex diameters for speed vs time traces containing a dimpled peak.

A theoretical relationship between vortex tangential speed and radial distance outward from the vortex center has been suggested (Morris, et al.) and VonMises (1945) in which the tangential speed is inversely proportional to the radial distance. To assess the radial extent of the vortices and the adequacy of the theoretical model above, a few measurements through vortices were carefully selected. Through curve fitting of the actual data, the relationship between tangential speed and radius can be examined. A hyperbolic relationship of the form

$$Y = \frac{1}{a(x)^n} \qquad \text{(A-9)}$$

was used. Applying the method of least squares, the equation for the

coefficient a becomes

$$a = \frac{\sum_{i=1}^{N} \frac{1}{X_i^n}}{\sum_{i=1}^{N} Y_i} \qquad \text{(A-10)}$$

where

X_i = values of radial distance

Y_i = values of tangential speed

N = number of paired (x,y) data points.

Other functions were considered for possible curve fitting, the reciprocals of exponential functions and logarithms, but their shape characteristics didn't appear as promising for fitting of the observed data as did the hyperbolic form. Also, the exponent n was varied to induce slight curve shape modifications. Improved data fitting resulted when the atmospheric wind speed was subtracted from the measured airflows.

While data for the vortex study were being collected, some characteristics of the atmosphere in which the vortices were imbedded were also documented. Temperatures were measured at 10, 30, and 100 feet above the ground using tower mounted sensors. The wind speed and direction at the 103 foot height were also measured. The vertical temperature lapse rates were calculated for the three different height combinations of temperatures. The calculated lapse rates were expressed as an equivalent number of F^o per 1000 feet. A non-dimensional atmospheric index, containing both temperature and wind speed information was formulated

$$AI = \frac{g}{\bar{T}_{30}} \frac{(\Delta T)(100)}{\bar{U}^2} \qquad \text{(A-11)}$$

where

AI = atmospheric index (non-dimensional)

g = acceleration of gravity (Fps/sec)

$\bar{T}_{30}$ = mean air temperature at 30 ft above ground (^{o}K)

ΔT = incremental temperature difference (K^{o})

$\bar{U}^2$ = mean 103 ft level speed squared

Note that the value 100 represents a height increment and has the units of feet.

This index, while lacking a known physical meaning, was calculated and included for possible screening by FAA personnel during their examination and interpretation of the vortex characteristics.

The contour analyses of the hot film anemometer flows in a height-time set of coordinate axes required special considerations. The first main consideration stems from the desire to examine the mean deviations or perturbations in the data and not the mean values. To examine the perturbations, the best possible sampling resolution is needed along both coordinate axes. This resolution was lacking along the height axis because the vortex core size was small compared to the vertical spacing of sensors. The influence of the vortices easily spanned the ten foot anemometer spacing, so that the larger scale vortex effects were better measured.

To compensate for the coarse data resolution along the vertical axis, the speed data were interpolated to a less coarse mesh of data points in the vertical direction. This interpolation was examined for two different distance weighting techniques. The simplest distance weighting technique was a linear one in which the speed values at the points of interpolation were

defined by

$$S(Z) = S(Z1) + (S(Z2) - S(Z1))\frac{[(Z - Z1)]}{[(Z2 - Z1)]} \qquad \text{(A-12)}$$

where

$S(Z)$ = interpolated speed at point Z between measurements made at heights Z1 and Z2.

$S(ZJ)$ = speed measured at height ZJ, where J = 1,2,... .

The second weighting technique substituted the ~~[illegible]~~ squares of distances for the square bracketed terms in equation (A-12). The ratios of the squares of distances resulted in the more satisfactory interpolation technique. The weighting by ratios of distances to the first power resulted in depicted contoured data, which were initially circular, in patterns that were systematically elongated along the vertical direction. An example of this relative elongation is shown in figure [illegible]. The identical data is shown for squared distance weighting in figure [illegible]. In both figures the maximum tangential speed, VM, was 150 fps, the outermost limit of the vortex influence was at a radius, R, of 20 feet, and the height of the vortex center, YS, was 40 feet.

In a contour analysis it is customary to smooth large data variations from the data set before analysis. For the wingtip vortex problem, however an examination of the perturbations is desired and the data cannot be pre-smoothed without degrading some of the information. To reduce some irregularity and raggedness of the speed contours, the coordinate positions of the points describing the contour line were smoothed. A simple set of rules were selected which determined how or if a contour should be smoothed. One of three smoothing choices was used, not to smooth, smooth with a five point running average, or "smooth" with a spline interpolation method. If

a contour contained less than six coordinate points it was not smoothed. If the contour were for a speed less than 40 fps and contained more than 20 coordinate points, a five point running average along the contour was used. Note that smoothing by the five point running average technique would tend to slightly shrink the area contained within a closed contour. If the contoured speeds were 40 fps or greater and the individual contours contained six or more coordinate position points, the spline interpolation method was used. The spline interpolation method does not smooth in a sense because the original data points are not altered. They normally would be altered in the five point running average smoothing. The spline method instead generates additional points between the initial position points of the contour. These additional points are added so that shorter, straight-line segments joining the enlarged set of coordinate position points have the following properties. The resultant contour curve, composed of many short line segments, approximates a function passing through the original data points. The function passes through the data in a manner which allows the second derivative of the function to remain continuous. A simple illustration of this method would be the drawing of an ellipse through the six points at the corners of a hexagon. Note that the curve generating function has a tendency to shape the contours into a circular pattern and to slightly enlarge the area contained within the contour.

The rules for contouring modifications were selected according to guidelines by which

1) vortex cores tended to be shaped toward circular
2) outer regions of the vortex influence were more smoothed where radial gradients of speed would be less subject to distortion.

3) inner regions were less smoothed and contours shape adjustments were made toward circular symmetry, especially for regions of large tangential speed.

Had suitable vertical resolution been available from more closely spaced sensors, this need for smoothing could have been eliminated or greatly reduced.

Two additional illustrations are included to point out the major effects upon contoured data and peak sensed vortex speeds when the vortex measurements are not derived from vortices in which a sensor penetrates the vortex core. In figure [illegible] the modeled, circular vortices are contoured and illustrated for vortex centers at one and five feet away from the nearest sensor. One obvious result of a sensor failing to penetrate the core is the rapidly diminished peak sensed speed. The vortex center midway between sensors, at 45 feet, seriously underestimates the vortex plus atmospheric flow (166.1 fps). The contoured vortex appears to become overly shortened along the vertical coordinate axis at greater distances between the sensor and the vortex center. This effect is acceptable because it most distorts those vortex measurements which are of least value. Note that contoured vortex centers (really pseudo-centers) will always be centered at a level of a hot film sensor because the interpolation routine will never generate a speed greater than the maximum sensed air flow.

APPENDIX B

TABLES

727 DATA

ACFT Pass#	1st Vortex HGT (ft.)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)	ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (sec)
1	40	16.3	30	54.2	23	30	12.1	-	-
2	30	15.4	80	54.7	24	40	11.5	40	58.3
3	30	8.6	30	38.9	25	40	9.4	-	-
4	30	6.1	50	31.0	26	40	13.8	40	45.2
5	30	10.7	50	46.2	27	40	12.2	-	-
6	40	10.6	10	38.0	28	30	9.6	80	40.0
7	40	8.3	20	31.0	29	20	8.0	20	63.5
8	40	7.7	40	25.9	30	30	13.8	60	41.7
9	40	12.6	40	24.1	31	30	13.1	10	51.4
10	40	10.5	60	26.8	32	30	13.5	-	-
11	40	9.5	10	31.9	33	30	20.6	-	-
12	50	5.7	50	14.1	34	40	11.5	20	40.2
13	30	13.7	50	58.3	35	50	12.3	20	29.8
14	60	8.1	10	21.1	36	40	13.5	50	22.8
15	50	7.7	30	15.8	37	50	16.3	50	34.2
16	50	5.1	40	10.7	38	30	14.6	-	-
17	60	2.7	50	5.4	39	60	4.1	20	11.5
18	-	-	-	-	40	40	19.4	40	22.6
19	40	12.1	-	-	41	90	10.0	80	20.9
20	30	12.7	50	61.3	42	40	25.1	-	-
21	30	8.9	30	46.9	43	50	39.5	-	-
22	30	7.3	-	-					

Sec

707 DATA

ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)
1	30	37.1	-	-
2	30	7.7	40	16.7
3	30	6.7	20	19.2
4	20	6.1	80	26.1
5	40	12.1	50	62.0
6	40	12.5	-	-
7	40	14.9	50	62.3
8	40	12.9	60	54.5
9	30	10.9	-	-
10	30	11.6	50	46.2
11	40	11.5	60	55.7

DC9 DATA

ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)
1	40	8.3	50	15.4
2	50	21.6	30	27.5
3	40	7.9	30	13.6
4	40	8.2	30	13.8
5	40	11.2	40	16.0
6	50	8.5	-	-
7	80	8.4	60	11.8
8	50	14.6	-	-
9	40	9.8	40	14.6
10	70	9.4	50	12.9
11	30	9.9	—	—
12	20	6.6	—	—

880 DATA

ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)	ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)
1	-	-	-	-	26	40	14.8	-	-
2	-	-	-	-	27	40	18.5	20	46.0
3	-	-	-	-	28	50	24.4	-	-
4	-	-	-	-	29	50	30.1	-	-
5	-	-	-	-	30	-	-	-	-
6	50	14.0	-	-	31	50	40.5	-	-
7	30	12.9	-	-	32	-	-	-	-
8	10	7.9	-	-	33	40	28.9	-	-
9	50	16.8	-	-	34	40	19.8	-	-
10	40	19.0	-	-	35	50	21.7	-	-
11	-	-	-	-	36	40	17.3	70	35.6
12	30	9.9			37	50	16.0	-	-
13	30	14.5	-	-	38	40	12/17	-	-
14	50	18.6	60	24.1	39	50	16.0	-	-
15	10	17.2	50	24.5	40	50	16.4	40	28.8
16	60	15.7	50	18.8	41	60	22.7	-	-
17	30	8.5	40	16.6	42	50	20.0	-	-
18	50	8.4	50	14.5	43	50	17	-	-
19	50	9.2	40	14.1	44	50	14.7	-	-
20	40	9.5	30	16.4	45	40	8.4	-	-
21	40	17.3	-	-	46	40	11.5	-	-
22	50	15.2	40	30.8	47	30	11.4	-	-
23	60	12.1	30	17.1	48	40	14.9	-	-
24	90	10.	90	18.5	49	70	21.0	-	-
25	90	7.1	50	12.0	50	30	11.9	-	-

880 DATA

ACFT Pass#	1st Vortex HGT (ft)	1st Vortex AGE (Sec)	2nd Vortex HGT (ft)	2nd Vortex AGE (Sec)
51	40	13.7	-	-
52	30	12.3	-	-
53	30	6.0	40	17.7
54	40	17.9	-	-
55	50	6.8	30	11.0
56	40	6.6	40	13.4
57	40	14.1	-	-
58	20	31	-	-
59	30	16.4	-	-
60	30	17.0	50	37.6
61	60	21.	-	-
62	40	14.	-	-
63	40	7.8	-	-
64	30	7.8	-	-
65	40	16.	-	-
66	50	10.9	40	25.6
67	50	11.0	40	18.4
68	40	11.8	30	27.5
69	50	7.2	50	12.5
70	40	8.8	40	14.4
71	30	12.2	-	-
72	30	8.6	50	47.5
73	30	10.9	-	-
74	40	12.6	-	-
75	40	13.1	-	-
76	-	-	-	-
77	70	40.	-	-
78	-	-	-	-
79	70	39.	-	-
80	-	-	-	-
81	-	-	-	-
82	-	-	-	-
83	-	-	-	-
84	40	16.1	-	-
85	30	17.2	-	-
86	30	17.	-	-
87	40	17.3	-	-

FLIGHT IDENTIFICATION					VORTEX CORE						ATMO. TRANSPORT		
ACFT TYPE	PASS NO.	HGT FT	DATE	TIME	VORT NO.	V1 FPS	V2 FPS	V3 FPS	DIA FT	AGE SEC	GEFS FPS	OBS FPS	ATMO FPS
727	1	40	052770	063813	1	74.4	0.0	0.0	0.0	12.1	-1.3	14.8	16.1
727	2	30	052770	064836	1	64.5	0.0	0.0	0.0	10.2	-1.5	14.6	16.1
727	3	30	052770	065732	1	76.7	52.4	86.9	13.9	8.6	-2.4	15.2	17.6
727	4	30	052770	070611	1	117.0	32.2	105.1	0.6	6.1	1.6	17.7	16.1
727	4	50	052770	070611	2	44.1	0.0	0.0	0.0	31.0	-9.2	7.0	16.1
727	5	30	052770	072040	1	108.6	37.3	79.7	3.7	10.7	2.1	16.7	14.7
727	6	40	052770	072922	1	139.2	120.8	139.2	1.5	10.6	0.0	14.6	14.6
727	6	10	052770	072922	2	36.1	0.0	0.0	0.0	38.0	-7.7	6.9	14.6
727	7	40	052770	073849	1	108.6	48.8	92.7	2.3	8.3	-2.4	14.9	17.3
727	7	20	052770	073849	2	0.0	0.0	0.0	0.0	31.0	-9.8	7.5	17.3
727	8	40	052770	074608	1	129.9	36.3	174.6	1.7	7.7	-3.0	12.6	15.6
727	8	40	052770	074608	2	61.3	0.0	0.0	0.0	25.9	-7.7	7.9	15.6
727	9	40	052770	075844	1	175.5	58.1	133.5	1.5	12.6	-1.1	14.5	15.6
727	9	40	052770	075844	2	46.4	0.0	0.0	0.0	24.1	-3.5	12.1	15.6
727	10	40	052770	080609	1	65.5	0.0	0.0	0.0	10.5	-1.0	14.9	15.9
727	10	60	052770	080609	2	40.2	0.0	0.0	0.0	26.8	-6.0	9.9	15.9
727	11	40	052770	081347	1	100.5	0.0	0.0	0.0	9.5	-2.8	12.7	15.6
727	12	50	052770	082751	1	64.1	0.0	0.0	0.0	5.7	-2.8	15.6	18.4
727	12	50	052770	082751	2	35.8	0.0	0.0	0.0	14.1	-4.4	14.0	18.4
727	13	30	052770	083459	1	76.9	0.0	0.0	0.0	13.7	-4.9	13.0	17.9
727	14	60	052770	102225	1	172.8	48.4	108.1	1.7	8.1	5.6	20.9	15.2
727	14	10	052770	102225	2	36.0	0.0	0.0	0.0	21.1	-2.1	13.1	15.2
727	15	50	052770	103227	1	101.8	0.0	0.0	0.0	7.7	-3.2	18.8	22.1
727	15	30	052770	103227	2	45.4	14.8	57.8	1.2	15.8	-6.0	16.0	22.1
727	16	50	052770	105550	1	147.8	84.5	205.1	0.6	5.1	-1.1	23.7	24.8
727	16	40	052770	105550	2	100.4	0.0	0.0	0.0	10.7	-3.4	21.4	24.8
727	17	50	052770	110339	1	130.7	30.8	98.1	2.5	2.7	7.2	35.6	28.3
727	17	50	052770	110339	2	105.7	0.0	0.0	0.0	5.4	9.4	37.8	28.3
707	1	40	052770	101720	1	34.8	5.9	34.8	19.3	7.3	2.7	21.7	19.1
707	2	40	052770	102933	2	37.7	26.4	40.7	8.4	16.7	-2.0	17.3	19.3
707	2	40	052770	102933	1	49.9	8.1	41.0	5.2	7.7	1.3	20.6	19.3
707	3	30	052770	104025	1	52.3	0.0	0.0	0.0	6.7	3.0	24.6	21.6
707	3	20	052770	104025	2	37.6	0.0	0.0	0.0	19.2	-6.2	15.4	21.6
707	4	30	052770	105145	1	53.2	30.5	43.6	20.6	6.1	9.1	28.1	19.1

FLIGHT IDENTIFICATION					VORTEX CORE						ATMO. TRANSPORT		
ACFT TYPE	PASS NO.	HGT FT	DATE	TIME	VORT NO.	V1 FPS	V2 FPS	V3 FPS	DIA FT	AGE SEC	GEFS FPS	OBS FPS	ATMO FPS
707	5	40	052870	065442	1	43.3	0.0	0.0	0.0	12.1	5.9	15.3	9.4
707	6	50	052870	070054	1	55.2	8.6	33.7	27.5	12.5	4.1	13.6	9.4
707	7	50	052870	070634	1	39.0	6.1	47.6	7.3	14.9	3.0	11.4	8.5
707	7	50	052870	070634	2	31.0	13.5	27.7	3.8	62.3	-3.6	4.8	8.5
707	8	50	052870	071243	1	34.4	10.2	38.1	11.6	12.9	2.9	12.4	9.4
707	8	60	052870	071243	2	32.7	6.6	23.7	15.8	54.5	-4.1	5.3	9.4
707	9	30	052870	071824	1	43.8	0.0	0.0	0.0	10.9	6.4	14.9	8.5
707	10	40	052870	085849	1	29.8	8.7	36.4	10.1	11.6	4.6	13.8	9.3
707	11	50	052870	090636	1	20.0	8.6	30.0	6.2	11.5	3.8	13.9	10.1
707	11	60	052870	090636	2	23.5	16.1	34.8	2.1	55.7	-4.9	5.2	10.1
727	19	40	052870	060647	1	55.2	0.0	0.0	0.0	12.1	-0.4	12.8	13.2
727	20	30	052870	061221	1	41.7	0.0	0.0	0.0	12.7	0.3	13.5	13.2
727	21	30	052870	061809	1	68.9	0.0	0.0	0.0	8.9	1.5	13.7	12.3
727	22	30	052870	062342	1	115.7	17.6	115.7	1.2	7.3	0.2	12.5	12.3
727	23	30	052870	063015	1	62.8	0.0	0.0	0.0	12.1	2.8	14.1	11.3
727	24	40	052870	063554	1	41.6	0.0	0.0	0.0	11.5	3.1	13.5	10.4
727	25	40	052870	064146	1	118.9	32.0	81.2	1.0	9.4	3.2	12.7	9.4
727	26	40	052870	082923	1	134.7	68.4	109.4	1.8	13.8	5.8	13.1	7.3
727	27	40	052870	083506	1	86.3	0.0	0.0	0.0	12.2	4.7	12.8	8.1
727	28	30	052870	084123	1	143.7	17.0	103.4	0.5	9.6	5.6	13.6	8.1
727	29	30	052870	084659	1	56.8	9.3	54.7	1.2	8.0	5.9	11.9	6.0
727	30	40	052870	090121	1	50.0	13.2	39.1	4.0	13.8	4.1	12.5	8.4
727	30	60	052870	090121	2	28.5	0.0	0.0	0.0	41.7	-1.7	6.7	8.4
727	31	30	052870	090936	1	50.7	29.8	64.9	1.2	13.1	3.0	11.8	8.8
727	32	30	052870	091706	1	79.0	60.6	79.0	2.0	13.5	3.7	9.9	6.2
727	33	30	052870	092414	1	62.8	0.0	0.0	0.0	20.6	-0.9	4.7	5.6
727	34	40	052870	093125	1	33.2	6.9	43.5	6.4	11.5	6.1	12.7	6.6
727	35	50	052870	093714	1	56.5	33.5	49.2	2.3	12.3	0.9	11.0	10.1
727	35	20	052870	093714	2	40.1	0.0	0.0	0.0	29.8	-2.0	8.2	10.1
727	36	40	052870	094324	1	160.3	110.5	143.2	0.4	13.5	-0.4	13.8	14.2
727	36	50	052870	094324	2	35.5	8.5	35.9	4.6	22.8	-1.3	12.9	14.2
727	37	50	052870	094847	1	49.8	17.2	30.6	3.8	16.3	5.0	10.1	5.0
727	38	30	052870	095525	1	86.9	39.4	75.7	1.3	14.6	-3.4	9.0	12.4
727	39	60	052870	100439	1	54.7	9.0	55.4	2.7	4.1	5.5	20.7	15.2
727	39	20	052870	100439	2	73.9	0.0	0.0	0.0	11.5	1.5	16.8	15.2
727	40	40	052870	113735	1	39.0	0.0	0.0	0.0	19.4	0.1	8.4	8.3
727	41	90	052870	114318	1	42.8	0.0	0.0	0.0	10.0	6.9	15.8	8.9
727	41	80	052870	114318	2	92.4	0.0	0.0	0.0	20.9	3.8	12.7	8.9
727	42	40	052870	114914	1	34.2	0.0	0.0	0.0	25.1	3.8	5.0	1.2
727	43	60	052870	115514	1	39.8	0.0	0.0	0.0	39.5	2.5	2.5	0.0

FLIGHT IDENTIFICATION					VORTEX CORE						ATMO. TRANSPORT		
ACFT TYPE	PASS NO.	HGT FT	DATE	TIME	VORT NO.	V1 FPS	V2 FPS	V3 FPS	DIA FT	AGE SEC	GEFS FPS	OBS FPS	ATMO FPS
DC9	1	40	060370	0648	1	166.7	90.9	124.9	0.0	8.3	0.0	0.0	17.6
DC9	1	50	060370	0648	2	69.3	0.0	0.0	0.0	15.4	0.0	0.0	17.6
DC9	2	50	060370	065223	1	34.7	0.0	0.0	0.0	21.6	0.0	0.0	17.5
DC9	2	30	060370	065223	2	40.2	0.0	0.0	0.0	27.5	0.0	0.0	17.5
DC9	3	50	060370	065715	1	43.8	0.0	0.0	0.0	7.9	0.4	16.5	16.1
DC9	3	30	060370	065715	2	44.7	0.0	0.0	0.0	13.6	0.4	16.4	16.1
DC9	4	40	060370	070424	1	52.0	0.0	0.0	0.0	8.2	1.1	17.2	16.1
DC9	4	30	060370	070424	2	46.0	0.0	0.0	0.0	13.8	0.9	17.0	16.1
DC9	5	40	060370	071001	1	0.0	0.0	0.0	0.0	11.2	-5.0	14.0	19.0
DC9	5	40	060370	071001	2	33.8	0.0	0.0	0.0	16.0	-3.4	15.6	19.0
DC9	6	50	060370	071449	1	0.0	0.0	0.0	0.0	8.5	1.2	20.2	19.0
DC9	7	80	060370	071859	1	37.7	0.0	0.0	0.0	8.4	-1.8	18.6	20.5
DC9	7	60	060370	071859	2	77.6	0.0	0.0	0.0	11.8	0.7	21.2	20.5
DC9	8	50	060370	072253	1	34.8	0.0	0.0	0.0	14.6	2.3	21.3	19.0
DC9	9	40	060370	072732	1	36.8	21.1	68.0	9.9	9.8	1.7	20.4	18.8
DC9	9	40	060370	072732	2	43.1	19.3	32.4	5.6	14.6	1.3	20.1	18.8
DC9	10	70	060370	073227	1	62.4	41.3	51.5	1.6	9.4	0.2	20.5	20.2
DC9	10	50	060370	073227	2	73.0	36.4	69.4	1.3	12.9	1.9	22.1	20.2
DC9	11	30	060370	073801	1	47.2	0.0	0.0	0.0	13.0	-2.5	16.3	18.8
DC9	12	20	060370	074242	1	95.2	75.4	84.5	1.4	6.6	5.0	26.7	21.7
DC9	12	10	060370	074242	2	39.9	32.6	41.4	0.7	18.6	-7.2	14.5	21.7
880	6	50	060270	080100	1	38.7	0.0	0.0	0.0	14.0	-0.5	11.3	11.8
880	7	40	060270	081113	1	41.2	0.0	0.0	0.0	12.9	-3.5	9.1	12.6
880	9	50	060270	083027	1	36.6	0.0	0.0	0.0	16.8	-4.0	7.0	11.0
880	12	30	060270	084902	1	37.5	8.5	38.7	14.4	9.9	-1.4	12.7	14.1
880	14	60	060270	090656	1	42.8	23.7	40.5	2.2	18.6	-4.8	6.2	11.0
880	15	50	060270	091328	1	50.1	13.9	43.2	6.1	17.2	-3.6	7.4	11.0
880	16	50	060270	091925	1	37.7	0.0	0.0	0.0	15.7	-3.3	8.4	11.7
880	17	30	060370	091824	1	42.3	0.0	0.0	0.0	8.5	-1.6	19.1	20.7
880	17	40	060370	091824	2	39.3	0.0	0.0	0.0	16.6	-3.7	17.0	20.7
880	18	50	060370	092854	1	42.3	0.0	0.0	0.0	8.4	-2.3	19.3	21.6
880	18	40	060370	092854	2	43.3	0.0	0.0	0.0	14.5	-2.1	19.4	21.6
880	19	50	060370	0935	1	52.0	0.0	0.0	0.0	9.2	0.0	0.0	26.0
880	20	10	060370	094111	1	48.1	0.0	0.0	0.0	9.5	-0.6	26.3	26.9
880	20	20	060370	094111	2	40.7	15.9	41.4	2.1	16.4	-4.4	22.6	26.9
880	21	40	060370	094701	1	53.6	0.0	0.0	0.0	17.3	-4.1	20.7	24.8
880	22	50	060370	0952	1	43.9	0.0	0.0	0.0	15.2	0.0	0.0	23.1
880	22	40	060370	0952	2	40.0	0.0	0.0	0.0	30.8	0.0	0.0	23.1
880	23	30	060370	100736	1	111.0	60.5	98.3	1.6	12.1	1.2	26.7	25.5
880	24	90	060370	100815	1	100.9	15.7	39.3	2.1	18.5	-8.8	17.2	26.0

FLIGHT IDENTIFICATION					VORTEX CORE						ATMO. TRANSPORT		
ACFT TYPE	PASS NO.	HGT FT	DATE	TIME	VORT NO.	V1 FPS	V2 FPS	V3 FPS	DIA FT	AGE SEC	GEFS FPS	OBS FPS	ATMO FPS
880	25	50	060470	065610	1	55.0	18.3	41.7	5.0	12.0	-8.1	6.1	14.2
880	26	30	060470	070447	1	33.2	9.7	29.2	5.2	14.8	-0.8	11.6	12.4
880	27	40	060470	071238	1	34.1	11.7	30.3	6.5	18.5	-2.9	9.5	12.4
880	28	50	060470	072056	1	35.0	0.0	0.0	0.0	24.4	-2.5	10.8	13.3
880	29	60	060470	073307	1	26.6	6.4	39.7	4.3	30.1	3.0	9.0	6.0
880	31	50	060470	075811	1	32.1	4.3	31.5	10.0	40.5	1.9	4.6	2.7
880	33	40	060470	081355	1	31.2	7.9	37.3	2.5	28.9	-0.5	4.6	5.0
880	34	40	060470	082219	1	37.6	0.0	0.0	0.0	19.8	1.9	4.9	3.0
880	36	40	060470	110105	1	30.5	8.2	32.4	12.7	17.3	3.1	14.0	10.9
880	36	70	060470	110105	2	40.1	0.0	0.0	0.0	35.6	-0.8	10.2	10.9
880	37	50	060470	110930	1	41.9	34.1	43.8	0.9	16.0	2.1	14.4	12.3
880	39	50	060470	112313	1	62.7	0.0	0.0	0.0	16.0	4.8	14.1	9.3
880	40	60	060470	113249	1	31.3	0.0	40.3	0.0	16.4	3.5	13.7	10.3
880	40	40	060470	113249	2	37.5	25.2	39.2	4.8	28.8	1.7	12.0	10.3
880	41	60	060470	114133	1	40.4	0.0	0.0	0.0	22.7	3.4	11.5	8.1
880	45	30	060570	081909	1	37.5	0.0	0.0	0.0	8.4	5.5	12.1	6.6
880	46	40	060570	083349	1	36.6	0.0	0.0	0.0	11.5	3.6	9.2	5.6
880	47	30	060570	083808	1	33.4	0.0	0.0	0.0	11.4	7.3	12.3	5.0
880	50	30	060570	085959	1	0.0	0.0	0.0	0.0	11.9	7.0	14.3	7.3
880	51	40	060570	090628	1	40.1	5.0	35.1	15.5	13.7	5.2	14.0	8.8
880	53	30	060570	091716	1	41.8	0.0	0.0	0.0	6.0	7.4	17.5	10.1

FLIGHT IDENTIFICATION					VORTEX CORE						ATMO. TRANSPORT		
ACFT TYPE	PASS NO.	HGT FT	DATE	TIME	VORT NO.	V1 FPS	V2 FPS	V3 FPS	DIA FT	AGE SEC	GEFS FPS	OBS FPS	ATMO FPS
880	54	40	060570	104636	1	37.8	0.0	0.0	0.0	17.4	0.0	0.0	9.9
880	55	30	060570	105353	1	46.1	0.0	0.0	0.0	6.8	0.0	0.0	16.9
880	56	40	060570	105819	1	54.5	42.8	50.6	0.0	6.6	0.0	0.0	8.4
880	56	40	060570	105819	2	45.9	0.0	0.0	0.0	13.4	0.0	0.0	8.4
880	60	30	060570	112707	1	37.0	0.0	0.0	0.0	17.0	0.0	0.0	5.5
880	63	30	060570	114630	1	36.4	0.0	0.0	0.0	7.8	0.0	0.0	6.5
880	64	30	060570	115059	1	36.0	0.0	0.0	0.0	7.8	0.0	0.0	4.9
880	66	50	060570	170905	1	36.7	0.0	0.0	0.0	10.9	0.0	0.0	10.4
880	67	50	060570	175709	1	37.3	0.0	0.0	0.0	11.0	0.0	0.0	10.9
880	68	40	060570	180228	1	38.6	0.0	0.0	0.0	11.8	0.0	0.0	10.9
880	68	30	060570	180228	2	33.6	0.0	0.0	0.0	27.5	0.0	0.0	10.9
880	69	50	060570	180750	1	42.0	0.0	0.0	0.0	7.2	0.0	0.0	12.6
880	69	50	060570	180750	2	39.0	0.0	0.0	0.0	12.5	0.0	0.0	12.6
880	70	50	060570	181226	1	31.8	10.3	34.5	0.0	8.8	0.0	0.0	11.0
880	72	30	060670	080039	1	36.1	0.0	0.0	0.0	8.6	3.2	12.0	8.8
880	73	30	060670	080520	1	36.1	0.0	0.0	0.0	10.9	1.9	11.8	9.9
880	75	30	060670	081335	1	35.4	0.0	0.0	0.0	13.1	3.3	14.4	11.0
880	87	40	060670	105921	1	33.9	18.1	27.9	0.8	17.3	3.8	7.5	3.7

Calculated and Observed Vortex Speeds

727 Pass #8 1st Vortex

Radial Distance (ft.)	1st Half Observed Speed*	1st Half Calculated Speed	2nd Half Observed Speed*	2nd Half Calculated Speed
0.9	129.7	155.2	171.9	168.4
2.1	85.7	78.7	86.4	85.4
3.4	71.6	55.4	67.4	60.1
4.6	55.2	43.7	56.4	47.4
5.9	41.6	36.5	49.2	39.6
7.2	39.1	31.5	40.2	34.2
8.4	36.6	27.9	34.0	30.3
9.7	31.3	25.2	30.3	27.3
10.9	28.5	23.0	27.4	24.9
12.2	23.2	21.1	24.3	22.9
13.5	19.9	19.6	21.6	21.3
14.7	18.6	18.4	19.0	19.9
16.0	15.6	17.3	16.9	18.7
17.2	12.5	16.3	14.8	17.7
18.5	10.3	15.5	12.8	16.8
19.8	9.0	14.7	10.3	16.0
21.0	7.8	14.1	8.4	15.3
22.3	6.6	13.5	6.9	14.6
23.5	5.5	12.9	5.7	14.0
24.8	4.4	12.4	4.6	13.5
	a = 0.0072		a = 0.0067	

*Less atmospheric flow

Calculated and Observed Vortex Speeds

727 Pass #9 1st Vortex

Radial Distance (ft.)	1st Half Observed Speed*	1st Half Calculated Speed	2nd Half Observed Speed*	2nd Half Calculated Speed
0.7	174.5	184.5	134.4	176.1
2.2	98.5	81.2	89.2	77.5
3.6	67.8	55.4	64.6	52.8
5.1	55.3	43.0	48.8	41.1
6.5	41.0	35.6	35.6	34.0
8.0	33.5	30.7	29.5	29.3
9.4	27.7	27.1	26.2	25.8
10.9	22.8	24.3	24.2	23.2
12.3	20.8	22.1	22.8	21.1
13.8	19.8	20.4	21.3	19.4
15.3	18.7	18.9	19.9	18.0
16.7	15.7	17.6	18.7	16.8
18.2	12.9	16.6	17.7	15.8
19.6	11.1	15.6	16.5	14.9
21.1	9.3	14.8	15.3	14.1
22.5	8.2	14.1	13.6	13.5
24.0	8.1	13.5	12.0	12.8
25.4	7.7	12.9	10.6	12.3
26.9	7.1	12.3	9.6	11.8
	a = 0.0069		a = 0.0072	

*Less atmospheric flow

Calculated and Observed Vortex Speeds

DC9 Pass #10 2nd Vortex

Radial Distance (ft.)	1st Half Observed Speed*	1st Half Calculated Speed	2nd Half Observed Speed*	2nd Half Calculated Speed
0.6	75.1	116.4	70.3	113.5
1.3	58.6	67.6	59.0	66.0
2.0	51.4	49.5	52.9	48.3
2.7	44.0	39.8	44.2	38.8
3.3	39.2	33.6	38.5	32.7
4.0	34.8	29.2	34.5	28.5
4.7	31.5	26.0	31.5	25.4
5.4	28.8	23.5	28.7	22.9
6.0	26.7	21.5	26.1	21.0
6.7	24.5	19.9	24.1	19.4
7.4	22.9	18.5	21.8	18.0
8.1	21.4	17.3	19.7	16.9
8.7	18.5	16.3	17.6	15.9
9.4	18.3	15.4	15.7	15.0
10.1	15.4	14.6	14.6	14.3
10.8	14.0	13.9	13.3	13.6
11.4	12.8	13.3	12.1	13.0
12.1	11.1	12.8	11.0	12.4
	a = 0.0121		a = 0.0124	

*Less atmospheric flow

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	1	52770	63813	233.	59.	31011	57.8	58.2	59.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	20.0	0.366E-01
30 - 100 FT	11.4	0.236E 00
10 - 100 FT	13.3	0.300E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	2	52770	64836	203.	46.	31011	58.0	58.1	58.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	5.0	0.915E-02
30 - 100 FT	5.7	0.118E 00
10 - 100 FT	5.6	0.125E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	3	52770	65732	185.	57.	31012	58.3	58.2	58.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-5.0	-0.767E-02
30 - 100 FT	8.6	0.149E 00
10 - 100 FT	5.6	0.105E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	4	52770	70611	162.	59.	31011	58.7	58.6	58.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-5.0	-0.906E-02
30 - 100 FT	4.3	0.882E-01
10 - 100 FT	2.2	0.497E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	5	52770	72040	233.	67.	31010	59.5	59.4	59.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-5.0	-0.108E-01
30 - 100 FT	0.0	0.0
10 - 100 FT	-1.1	-0.297E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	6	52770	72922	209.	73.	31510	60.4	60.2	60.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.213E-01
30 - 100 FT	-1.4	-0.347E-01
10 - 100 FT	-3.3	-0.880E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	7	52770	73849	178.	71.	32012	61.4	60.9	60.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.365E-01
30 - 100 FT	-1.4	-0.239E-01
10 - 100 FT	-6.7	-0.121E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	8	52770	74608	151.	71.	32511	62.1	61.7	61.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.343E-01
30 - 100 FT	-2.9	-0.561E-01
10 - 100 FT	-6.7	-0.142E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	9	52770	75844	237.	101.	32511	62.6	62.2	62.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.341E-01
30 - 100 FT	-2.9	-0.556E-01
10 - 100 FT	-6.7	-0.141E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	10	52770	80609	210.	92.	32011	62.9	62.5	62.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.339E-01
30 - 100 FT	-4.3	-0.831E-01
10 - 100 FT	-7.8	-0.164E 00

ERATURES
T 100FT
2 60.1

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	11	52770	81347	175.	78.	32511	63.5	62.9	62.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.505E-01
30 - 100 FT	-2.9	-0.550E-01
10 - 100 FT	-8.9	-0.185E 00

ERATURES
T 100FT
9 60.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	12	52770	82751	143.	91.	32513	64.1	63.5	63.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.358E-01
30 - 100 FT	-5.7	-0.781E-01
10 - 100 FT	-11.1	-0.165E 00

ERATURES
T 100FT
7 61.5

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	13	52770	83459	232.	75.	33013	64.2	63.4	63.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.477E-01
30 - 100 FT	-2.9	-0.391E-01
10 - 100 FT	-11.1	-0.164E 00

ERATURES
T 100FT
2 62.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	14	52770	102225	223.	99.	34012	68.1	67.0	66.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.727E-01
30 - 100 FT	-4.3	-0.651E-01
10 - 100 FT	-15.6	-0.255E 00

ERATURES
T 100FT
5 62.2

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	15	52770	103227	199.	102.	33016	68.4	67.2	66.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-60.0	-0.445E-01
30 - 100 FT	-10.0	-0.855E-01
10 - 100 FT	-21.1	-0.195E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	16	52770	105550	175.	92.	33018	68.6	67.8	67.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.233E-01
30 - 100 FT	-11.4	-0.766E-01
10 - 100 FT	-17.8	-0.129E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	17	52770	110339	150.	94.	32520	68.7	67.6	66.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.259E-01
30 - 100 FT	-10.0	-0.544E-01
10 - 100 FT	-20.0	-0.117E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	1	52770	101720	224.	39.	34015	68.0	66.9	66.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.466E-01
30 - 100 FT	-10.0	-0.977E-01
10 - 100 FT	-20.0	-0.211E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	2	52770	102933	224.	58.	33014	68.2	67.2	66.6

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.485E-01
30 - 100 FT	-8.6	-0.956E-01
10 - 100 FT	-17.8	-0.214E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	3	52770	104025	230.	50.	34017	68.5	67.7	66.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.261E-01
30 - 100 FT	-12.9	-0.968E-01
10 - 100 FT	-18.9	-0.154E 00

RATURES
100FT
67.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	4	52770	105145	237.	42.	34015	68.5	67.7	67.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.336E-01
30 - 100 FT	-10.0	-0.965E-01
10 - 100 FT	-16.7	-0.174E 00

RATURES
100FT
66.9

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	5	52870	65442	251.	41.	36010	48.5	48.5	48.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	0.0	0.0
30 - 100 FT	4.3	0.129E 00
10 - 100 FT	3.3	0.109E 00

ERATURES
100FT
66.2

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	6	52870	70054	235.	50.	36010	49.2	48.9	48.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.393E-01
30 - 100 FT	0.0	0.0
10 - 100 FT	-3.3	-0.108E 00

ERATURES
100FT
66.6

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	7	52870	70634	236.	74.	36009	49.5	49.2	49.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.483E-01
30 - 100 FT	1.4	0.524E-01
10 - 100 FT	-2.2	-0.884E-01

ERATURES
100FT
66.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	8	52870	71243	225.	68.	36010	49.9	49.6	49.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.388E-01
30 - 100 FT	2.9	0.841E-01
10 - 100 FT	-1.1	-0.355E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	9	52870	71924	228.	39.	36009	50.4	50.2	50.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.316E-01
30 - 100 FT	-2.9	-0.103E 00
10 - 100 FT	-4.4	-0.174E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	10	52870	85849	226.	59.	511	55.8	55.1	54.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.671E-01
30 - 100 FT	-4.3	-0.943E-01
10 - 100 FT	-11.1	-0.264E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
707	11	52870	90636	225.	56.	35009	56.1	55.5	55.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.854E-01
30 - 100 FT	-2.9	-0.931E-01
10 - 100 FT	-8.9	-0.314E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	19	52870	60647	209.	35.	36014	46.3	47.5	48.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	60.0	0.839E-01
30 - 100 FT	17.1	0.266E 00
10 - 100 FT	26.7	0.456E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	20	52870	61221	226.	39.	36014	46.8	47.5	48.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	35.0	0.487E-01
30 - 100 FT	14.3	0.222E 00
10 - 100 FT	18.9	0.322E 00

ACFT 727

ERATURES
T 100FT
2 50.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	21	52870	61809	176.	41.	36013	47.2	47.8	48.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	30.0	0.481E-01
30 - 100 FT	10.0	0.180E 00
10 - 100 FT	14.4	0.284E 00

ERATURES
T 100FT
1 54.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	22	52870	62342	145.	42.	36013	47.1	47.4	48.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	15.0	0.242E-01
30 - 100 FT	12.9	0.233E 00
10 - 100 FT	13.3	0.263E 00

ERATURES
T 100FT
5 55.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	23	52870	63015	225.	40.	36012	47.2	47.7	48.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	25.0	0.471E-01
30 - 100 FT	11.4	0.241E 00
10 - 100 FT	14.4	0.334E 00

ERATURES
T 100FT
5 48.7

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	24	52870	63554	209.	46.	36011	47.5	47.7	48.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	10.0	0.223E-01
30 - 100 FT	10.0	0.252E 00
10 - 100 FT	10.0	0.274E 00

ERATURES
T 100FT
5 48.5

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	25	52870	64146	173.	33.	36010	47.9	47.9	48.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	0.0	0.0
30 - 100 FT	5.7	0.174E 00
10 - 100 FT	4.4	0.147E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	26	52870	82923	235.	71.	1010	54.8	54.2	54.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.708E-01
30 - 100 FT	-2.9	-0.773E-01
10 - 100 FT	-8.9	-0.260E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	27	52870	83506	210.	49.	1011	55.4	54.4	54.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.968E-01
30 - 100 FT	-4.3	-0.955E-01
10 - 100 FT	-14.4	-0.347E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	28	52870	84123	185.	58.	1011	55.5	54.6	54.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.869E-01
30 - 100 FT	-4.3	-0.952E-01
10 - 100 FT	-13.3	-0.319E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	29	52870	84659	149.	54.	2012	55.7	55.0	54.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.565E-01
30 - 100 FT	-2.9	-0.529E-01
10 - 100 FT	-10.0	-0.200E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	30	52870	90121	227.	73.	510	55.9	55.2	54.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.810E-01
30 - 100 FT	-5.7	-0.152E 00
10 - 100 FT	-12.2	-0.351E 00

RATURES
100FT
54.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	31	52870	90936	209.	77.	1012	56.5	55.7	55.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.637E-01
30 - 100 FT	-5.7	-0.105E 00
10 - 100 FT	-13.3	-0.264E 00

ERATURES
100FT
54.1

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	32	52870	91706	188.	57.	1510	56.6	56.2	56.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.456E-01
30 - 100 FT	-2.9	-0.745E-01
10 - 100 FT	-6.7	-0.188E 00

ERATURES
100FT
54.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	33	52870	92414	150.	60.	1509	56.6	56.0	56.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.846E-01
30 - 100 FT	0.0	0.0
10 - 100 FT	-6.7	-0.233E 00

ERATURES
100FT
54.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	34	52870	93125	200.	94.	1009	56.5	56.2	56.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.423E-01
30 - 100 FT	-2.9	-0.920E-01
10 - 100 FT	-5.6	-0.194E 00

ERATURES
100FT
54.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	35	52870	93714	189.	92.	35009	57.2	56.3	56.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.126E 00
30 - 100 FT	-4.3	-0.138E 00
10 - 100 FT	-13.3	-0.463E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	36	52870	94324	240.	83.	32510	57.1	56.8	55.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.339E-01
30 - 100 FT	-12.9	-0.334E 00
10 - 100 FT	-13.3	-0.376E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	37	52870	94847	218.	105.	32010	57.5	57.1	56.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.449E-01
30 - 100 FT	-14.3	-0.369E 00
10 - 100 FT	-15.6	-0.436E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	38	52870	95525	186.	86.	35512	58.3	57.3	56.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.773E-01
30 - 100 FT	-5.7	-0.102E 00
10 - 100 FT	-15.6	-0.298E 00

ACFT 727

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	39	52870	100439	139.	86.	34012	58.5	57.2	56.6

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-65.0	-0.100E 00
30 - 100 FT	-8.6	-0.153E 00
10 - 100 FT	-21.1	-0.405E 00

ACFT DC9

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	40	52870	113735	217.	131.	35508	60.7	60.1	59.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.998E-01
30 - 100 FT	-5.7	-0.218E 00
10 - 100 FT	-11.1	-0.459E 00

ACFT DC9

RATURES
100FT
55.9

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	41	52870	114318	212.	124.	34007	61.3	60.3	60.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.216E 00
30 - 100 FT	-4.3	-0.213E 00
10 - 100 FT	-14.4	-0.773E 00

RATURES
100FT
56.1

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	42	52870	114914	179.	98.	3509	61.4	60.3	60.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.144E 00
30 - 100 FT	-4.3	-0.129E 00
10 - 100 FT	-15.6	-0.503E 00

RATURES
100FT
56.9

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
727	43	52870	115514	152.	110.	4013	61.6	60.7	60.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.560E-01
30 - 100 FT	-4.3	-0.613E-01
10 - 100 FT	-13.3	-0.206E 00

RATURES
100FT
56.6

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	1	60370	64800	0.	0.	22012	66.3	66.1	65.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.135E-01
30 - 100 FT	-2.9	-0.440E-01
10 - 100 FT	-4.4	-0.743E-01

RATURES
100FT
59.7

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	2	60370	65223	0.	0.	21512	66.4	66.2	66.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.135E-01
30 - 100 FT	-1.4	-0.219E-01
10 - 100 FT	-3.3	-0.556E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT	ACFT
DC9	3	60370	65715	177.	86.	21511	66.6	66.4	66.2	DC9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.160E-01
30 - 100 FT	-2.9	-0.521E-01
10 - 100 FT	-4.4	-0.880E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT	ACFT
DC9	4	60370	70424	188.	93.	22011	67.3	66.8	66.7	DC9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.396E-01
30 - 100 FT	-1.4	-0.259E-01
10 - 100 FT	-6.7	-0.131E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT	ACFT
DC9	5	60370	71001	203.	92.	22513	67.5	67.2	67.0	DC9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.169E-01
30 - 100 FT	-2.9	-0.369E-01
10 - 100 FT	-5.6	-0.778E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT	ACFT
DC9	6	60370	71449	218.	106.	22513	67.9	67.5	67.3	DC9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.225E-01
30 - 100 FT	-2.9	-0.367E-01
10 - 100 FT	-6.7	-0.929E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT	ACFT
DC9	7	60370	71859	203.	108.	22514	68.3	67.7	67.5	DC9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.289E-01
30 - 100 FT	-2.9	-0.315E-01
10 - 100 FT	-8.9	-0.106E 00

RATURES
100FT
66.2

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	8	60370	72253	357.	101.	22513	68.4	67.9	67.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.279E-01
30 - 100 FT	-2.9	-0.365E-01
10 - 100 FT	-7.8	-0.108E 00

RATURES
100FT
66.7

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	9	60370	72732	247.	89.	23013	68.6	68.2	67.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.222E-01
30 - 100 FT	-4.3	-0.545E-01
10 - 100 FT	-7.8	-0.107E 00

ERATURES
T 100FT
2 67.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	10	60370	73227	239.	127.	23014	69.4	68.6	68.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.380E-01
30 - 100 FT	-2.9	-0.311E-01
10 - 100 FT	-11.1	-0.131E 00

ERATURES
T 100FT
5 67.3

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	11	60370	73801	258.	35.	23013	69.8	69.4	69.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.219E-01
30 - 100 FT	-4.3	-0.536E-01
10 - 100 FT	-7.8	-0.105E 00

ERATURES
T 100FT
7 67.5

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
DC9	12	60370	74242	223.	33.	23015	70.5	69.9	69.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.244E-01
30 - 100 FT	-1.4	-0.133E-01
10 - 100 FT	-7.8	-0.784E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	1	60170	143332	240.	21.	20018	78.6	76.9	77.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-85.0	-0.434E-01
30 - 100 FT	2.9	0.168E-01
10 - 100 FT	-16.7	-0.105E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	2	60170	143921	234.	43.	20019	78.2	76.5	76.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-85.0	-0.391E-01
30 - 100 FT	4.3	0.227E-01
10 - 100 FT	-15.6	-0.885E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	3	60170	144607	162.	39.	20019	79.1	76.9	77.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	*****	-0.502E-01
30 - 100 FT	1.4	0.752E-02
10 - 100 FT	-23.3	-0.132E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	4	60170	150537	162.	111.	20020	78.4	76.6	76.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-90.0	-0.373E-01
30 - 100 FT	-2.9	-0.137E-01
10 - 100 FT	-22.2	-0.114E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	5	60270	75345	227.	44.	25016	71.4	70.5	70.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.319E-01
30 - 100 FT	-2.9	-0.232E-01
10 - 100 FT	-12.2	-0.107E 00

ERATURES
T 100FT
9 77.1

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	6	60270	80100	218.	50.	25514	71.7	71.4	71.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.138E-01
30 - 100 FT	-4.3	-0.449E-01
10 - 100 FT	-6.7	-0.758E-01

ERATURES
T 100FT
5 76.8

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	7	60270	81113	177.	40.	25515	72.4	71.4	71.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.397E-01
30 - 100 FT	-2.9	-0.261E-01
10 - 100 FT	-13.3	-0.131E 00

ERATURES
T 100FT
9 77.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	8	60270	81833	167.	28.	25515	73.2	72.2	71.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.393E-01
30 - 100 FT	-7.1	-0.645E-01
10 - 100 FT	-16.7	-0.163E 00

ERATURES
T 100FT
5 76.4

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	9	60270	83027	178.	58.	25015	73.5	72.7	72.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.313E-01
30 - 100 FT	-7.1	-0.641E-01
10 - 100 FT	-14.4	-0.140E 00

ERATURES
T 100FT
5 70.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	10	60270	83712	210.	58.	25514	73.6	73.2	73.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.179E-01
30 - 100 FT	-2.9	-0.292E-01
10 - 100 FT	-6.7	-0.738E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	11	60270	84307	233.	51.	25016	73.7	73.2	73.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.171E-01
30 - 100 FT	-2.9	-0.223E-01
10 - 100 FT	-7.8	-0.659E-01

ACFT 880

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	12	60270	84902	186.	50.	26015	73.9	73.3	73.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.233E-01
30 - 100 FT	-4.3	-0.381E-01
10 - 100 FT	-10.0	-0.963E-01

ACFT 880

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	13	60270	90041	180.	79.	25513	74.0	73.2	73.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.414E-01
30 - 100 FT	-1.4	-0.169E-01
10 - 100 FT	-10.0	-0.128E 00

ACFT 880

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	14	60270	90656	176.	67.	25015	74.5	73.6	73.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.347E-01
30 - 100 FT	-2.9	-0.253E-01
10 - 100 FT	-12.2	-0.117E 00

ACFT 880

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	15	60270	91328	187.	67.	25015	74.7	74.1	73.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.230E-01
30 - 100 FT	-2.9	-0.251E-01
10 - 100 FT	-8.9	-0.846E-01

ACFT 880

ERATURES
T 100FT
2 73.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	16	60270	91925	192.	69.	25016	74.9	74.2	74.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.236E-01
30 - 100 FT	-2.9	-0.220E-01
10 - 100 FT	-10.0	-0.835E-01

ERATURES
T 100FT
3 73.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	17	60370	91824	222.	82.	24015	74.4	73.6	73.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.309E-01
30 - 100 FT	-5.7	-0.506E-01
10 - 100 FT	-13.3	-0.128E 00

ERATURES
T 100FT
2 73.1

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	18	60370	92854	222.	116.	25017	75.3	74.2	73.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.327E-01
30 - 100 FT	-5.7	-0.391E-01
10 - 100 FT	-16.7	-0.123E 00

ERATURES
T 100FT
6 73.4

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	19	60370	93500	0.	0.	23018	75.1	74.0	73.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.293E-01
30 - 100 FT	-2.9	-0.175E-01
10 - 100 FT	-14.4	-0.953E-01

ERATURES
T 100FT
1 73.9

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	20	60370	94111	310.	86.	23519	75.4	74.0	73.6

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-70.0	-0.334E-01
30 - 100 FT	-5.7	-0.314E-01
10 - 100 FT	-20.0	-0.118E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	21	60370	94701	418.	95.	24018	75.0	73.7	73.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-65.0	-0.347E-01
30 - 100 FT	-4.3	-0.263E-01
10 - 100 FT	-17.8	-0.118E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	22	60370	95200	0.	0.	23016	75.6	74.5	74.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.368E-01
30 - 100 FT	-2.9	-0.219E-01
10 - 100 FT	-14.4	-0.120E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	23	60370	100236	383.	116.	23518	75.6	74.1	73.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-75.0	-0.398E-01
30 - 100 FT	-2.9	-0.174E-01
10 - 100 FT	-18.9	-0.124E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	24	60370	100815	379.	122.	23018	75.8	74.7	74.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.290E-01
30 - 100 FT	-8.6	-0.520E-01
10 - 100 FT	-18.9	-0.124E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	25	60470	65610	133.	118.	2510	63.6	63.3	63.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.304E-01
30 - 100 FT	-1.4	-0.330E-01
10 - 100 FT	-4.4	-0.112E 00

RATURES
100FT
73.4

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	26	60470	70447	232.	104.	2009	63.5	63.3	63.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.250E-01
30 - 100 FT	-2.9	-0.816E-01
10 - 100 FT	-4.4	-0.138E 00

RATURES
100FT
74.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	27	60470	71238	236.	86.	2009	63.6	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.501E-01
30 - 100 FT	-2.9	-0.818E-01
10 - 100 FT	-6.7	-0.207E 00

RATURES
100FT
73.9

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	28	60470	72056	324.	97.	1510	63.5	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.305E-01
30 - 100 FT	-2.9	-0.662E-01
10 - 100 FT	-5.6	-0.140E 00

RATURES
100FT
74.1

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	29	60470	73307	331.	103.	505	63.3	63.1	62.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.814E-01
30 - 100 FT	-2.9	-0.265E 00
10 - 100 FT	-4.4	-0.448E 00

RATURES
100FT
63.2

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	30	60470	0	0.	0.	0	0.0	0.0	0.0

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	31	60470	75811	246.	114.	2507	63.4	63.1	62.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.622E-01
30 - 100 FT	-2.9	-0.135E 00
10 - 100 FT	-5.6	-0.286E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	32	60470	80637	243.	98.	2006	63.4	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-10.0	-0.564E-01
30 - 100 FT	-2.9	-0.184E 00
10 - 100 FT	-4.4	-0.311E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	33	60470	81355	192.	100.	506	63.5	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.846E-01
30 - 100 FT	-2.9	-0.184E 00
10 - 100 FT	-5.6	-0.388E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	34	60470	82219	158.	100.	2006	63.5	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.846E-01
30 - 100 FT	-2.9	-0.184E 00
10 - 100 FT	-5.6	-0.388E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	35	60470	83929	155.	370.	3507	63.6	63.2	63.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.828E-01
30 - 100 FT	-2.9	-0.135E 00
10 - 100 FT	-6.7	-0.342E 00

RATURES
100FT
62.9

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	36	60470	110105	302.	75.	7513	64.9	64.2	63.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.413E-01
30 - 100 FT	-5.7	-0.773E-01
10 - 100 FT	-12.2	-0.179E 00

ERATURES
100FT
63.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	37	60470	110930	290.	117.	8013	64.5	63.9	63.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.356E-01
30 - 100 FT	-7.1	-0.971E-01
10 - 100 FT	-12.2	-0.180E 00

ERATURES
T 100FT
2 63.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	38	60470	111622	295.	96.	7512	64.4	63.6	63.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.558E-01
30 - 100 FT	-4.3	-0.686E-01
10 - 100 FT	-12.2	-0.212E 00

ERATURES
T 100FT
2 63.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	39	60470	112313	285.	96.	7511	64.4	63.6	63.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.664E-01
30 - 100 FT	-2.9	-0.544E-01
10 - 100 FT	-11.1	-0.229E 00

ERATURES
T 100FT
2 63.0

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ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	40	60470	113249	285.	104.	7014	65.3	63.9	63.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-70.0	-0.711E-01
30 - 100 FT	-8.6	-0.101E 00
10 - 100 FT	-22.2	-0.281E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	41	60470	114133	321.	89.	6513	65.2	64.2	63.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.588E-01
30 - 100 FT	-5.7	-0.773E-01
10 - 100 FT	-15.6	-0.227E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	42	60570	80232	241.	55.	26005	64.4	63.7	63.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.281E 00
30 - 100 FT	-7.1	-0.659E 00
10 - 100 FT	-13.3	-0.133E 01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	43	60570	80907	215.	36.	26006	64.6	64.1	63.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.139E 00
30 - 100 FT	-8.6	-0.546E 00
10 - 100 FT	-12.2	-0.844E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	44	60570	81426	191.	43.	25008	64.8	64.3	63.8

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.778E-01
30 - 100 FT	-7.1	-0.255E 00
10 - 100 FT	-11.1	-0.430E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	45	60570	81909	162.	40.	26007	65.3	64.8	64.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.101E 00
30 - 100 FT	-7.1	-0.330E 00
10 - 100 FT	-11.1	-0.557E 00

ERATURES
T 100FT
2 63.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	46	60570	83349	166.	61.	24509	66.3	65.9	65.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.480E-01
30 - 100 FT	-8.6	-0.236E 00
10 - 100 FT	-11.1	-0.332E 00

ERATURES
T 100FT
7 63.2

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	47	60570	83808	200.	50.	24508	66.7	66.1	65.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.908E-01
30 - 100 FT	-8.6	-0.298E 00
10 - 100 FT	-13.3	-0.502E 00

ERATURES
T 100FT
1 63.5

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	48	60570	84214	221.	54.	25009	67.0	66.4	66.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.714E-01
30 - 100 FT	-5.7	-0.156E 00
10 - 100 FT	-11.1	-0.328E 00

ERATURES
T 100FT
3 63.8

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	49	60570	84659	246.	58.	24509	67.6	67.0	66.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-30.0	-0.708E-01
30 - 100 FT	-4.3	-0.116E 00
10 - 100 FT	-10.0	-0.293E 00

ERATURES
T 100FT
3 64.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	50	60570	85959	230.	68.	25010	69.3	68.6	68.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.653E-01
30 - 100 FT	-7.1	-0.153E 00
10 - 100 FT	-13.3	-0.309E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	51	60570	90628	252.	64.	25012	70.3	69.5	69.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.511E-01
30 - 100 FT	-5.7	-0.838E-01
10 - 100 FT	-13.3	-0.211E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	52	60570	91157	205.	76.	26012	70.5	70.0	69.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.318E-01
30 - 100 FT	-4.3	-0.623E-01
10 - 100 FT	-8.9	-0.140E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	53	60570	91716	165.	65.	25512	71.2	70.4	70.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.505E-01
30 - 100 FT	-5.7	-0.827E-01
10 - 100 FT	-13.3	-0.209E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	54	60570	104636	0.	0.	24516	76.0	74.8	74.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-60.0	-0.400E-01
30 - 100 FT	1.4	0.109E-01
10 - 100 FT	-12.2	-0.101E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	55	60570	105353	0.	0.	27015	76.2	75.3	75.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.340E-01
30 - 100 FT	-4.3	-0.371E-01
10 - 100 FT	-13.3	-0.125E 00

ATURES
100FT
69.1

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	56	60570	105819	0.	0.	25510	76.5	75.6	75.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.761E-01
30 - 100 FT	-2.9	-0.554E-01
10 - 100 FT	-12.2	-0.256E 00

RATURES
100FT
69.7

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	57	60570	110235	0.	0.	22510	77.3	76.0	76.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-65.0	-0.109E 00
30 - 100 FT	0.0	0.0
10 - 100 FT	-14.4	-0.300E 00

RATURES
100FT
70.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	58	60570	111818	0.	0.	24011	76.9	75.6	75.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-65.0	-0.906E-01
30 - 100 FT	4.3	0.684E-01
10 - 100 FT	-11.1	-0.191E 00

RATURES
100FT
74.9

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	59	60570	112236	0.	0.	24510	77.0	76.1	76.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.756E-01
30 - 100 FT	-1.4	-0.275E-01
10 - 100 FT	-11.1	-0.231E 00

RATURES
100FT
75.0

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	60	60570	112707	0.	0.	24011	77.6	76.5	76.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-55.0	-0.759E-01
30 - 100 FT	-4.3	-0.679E-01
10 - 100 FT	-15.6	-0.266E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	61	60570	113138	0.	0.	23014	77.3	76.4	76.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.384E-01
30 - 100 FT	-1.4	-0.140E-01
10 - 100 FT	-11.1	-0.117E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	62	60570	114211	0.	0.	24512	78.5	77.0	76.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-75.0	-0.861E-01
30 - 100 FT	-7.1	-0.945E-01
10 - 100 FT	-22.2	-0.317E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	63	60570	114630	0.	0.	24013	78.4	77.2	76.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-60.0	-0.587E-01
30 - 100 FT	-7.1	-0.803E-01
10 - 100 FT	-18.9	-0.229E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	64	60570	115059	0.	0.	23513	78.5	77.2	76.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-65.0	-0.635E-01
30 - 100 FT	-7.1	-0.803E-01
10 - 100 FT	-20.0	-0.243E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	65	60570	115531	0.	0.	22515	79.3	77.9	77.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-70.0	-0.509E-01
30 - 100 FT	-8.6	-0.718E-01
10 - 100 FT	-22.2	-0.201E 00

ATURES
100FT
76.3

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	66	60570	170905	0.	0.	18011	79.8	78.3	78.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-75.0	-0.101E 00
30 - 100 FT	0.0	0.0
10 - 100 FT	-16.7	-0.277E 00

.ATURES
100FT
76.5

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	67	60570	175709	0.	0.	18513	74.5	74.1	73.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.205E-01
30 - 100 FT	-5.7	-0.669E-01
10 - 100 FT	-8.9	-0.113E 00

ATURES
100FT
76.7

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	68	60570	180228	0.	0.	18513	74.5	74.1	73.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.205E-01
30 - 100 FT	-5.7	-0.669E-01
10 - 100 FT	-8.9	-0.113E 00

ATURES
100FT
76.7

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	69	60570	180750	0.	0.	18515	74.6	74.1	73.9

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.192E-01
30 - 100 FT	-2.9	-0.251E-01
10 - 100 FT	-7.8	-0.741E-01

ATURES
100FT
77.3

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	70	60570	181226	0.	0.	19015	75.5	75.1	75.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.152E-01
30 - 100 FT	1.4	0.124E-01
10 - 100 FT	-3.3	-0.313E-01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	71	60670	74855	186.	73.	28006	64.5	64.2	64.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-15.0	-0.833E-01
30 - 100 FT	-2.9	-0.181E 00
10 - 100 FT	-5.6	-0.382E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	72	60670	80039	163.	61.	31006	64.7	64.2	64.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.139E 00
30 - 100 FT	-1.4	-0.905E-01
10 - 100 FT	-6.7	-0.458E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	73	60670	80520	189.	55.	29507	64.7	64.3	64.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.814E-01
30 - 100 FT	-2.9	-0.133E 00
10 - 100 FT	-6.7	-0.336E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	74	60670	80932	213.	51.	29507	65.0	64.5	64.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.101E 00
30 - 100 FT	-4.3	-0.199E 00
10 - 100 FT	-8.9	-0.447E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	75	60670	81335	248.	51.	29008	65.4	64.7	64.4

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.108E 00
30 - 100 FT	-4.3	-0.152E 00
10 - 100 FT	-11.1	-0.426E 00

ATURES
100FT
64.0

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	77	60670	95824	406.	108.	21005	67.8	66.8	67.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.382E 00
30 - 100 FT	5.7	0.499E 00
10 - 100 FT	-6.7	-0.629E 00

ATURES
100FT
64.1

NDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	78	60670	100402	496.	110.	22006	68.3	67.3	67.5

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.263E 00
30 - 100 FT	2.9	0.172E 00
10 - 100 FT	-8.9	-0.579E 00

ATURES
100FT
64.1

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	79	60670	100908	485.	78.	23006	68.4	67.5	67.6

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.237E 00
30 - 100 FT	1.4	0.859E-01
10 - 100 FT	-8.9	-0.578E 00

ATURES
100FT
64.2

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	80	60670	101426	596.	83.	24006	68.5	67.7	68.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.210E 00
30 - 100 FT	4.3	0.257E 00
10 - 100 FT	-5.6	-0.360E 00

ATURES
100FT
64.4

INDEX

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	81	60670	102055	576.	88.	25506	69.2	68.2	68.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-50.0	-0.260E 00
30 - 100 FT	-2.9	-0.170E 00
10 - 100 FT	-13.3	-0.859E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	82	60670	102547	504.	83.	22506	69.4	68.5	68.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-45.0	-0.233E 00
30 - 100 FT	-4.3	-0.255E 00
10 - 100 FT	-13.3	-0.857E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	83	60670	103159	410.	89.	26005	70.0	69.2	69.0

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.296E 00
30 - 100 FT	-2.9	-0.242E 00
10 - 100 FT	-11.1	-0.102E 01

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	84	60670	104535	232.	70.	28507	70.4	69.9	69.3

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-25.0	-0.935E-01
30 - 100 FT	-8.6	-0.368E 00
10 - 100 FT	-12.2	-0.568E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	85	60670	104938	199.	54.	28506	70.5	70.1	69.7

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-20.0	-0.102E 00
30 - 100 FT	-5.7	-0.332E 00
10 - 100 FT	-8.9	-0.561E 00

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	86	60670	105357	197.	57.	25007	71.3	70.6	70.2

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-35.0	-0.129E 00
30 - 100 FT	-5.7	-0.242E 00
10 - 100 FT	-12.2	-0.561E 00

ACFT
880

ACFT	PASS	DATE	EDT	YPRIME	ZPRIME	WIND DIR & SPEED	TEMPERATURES 10FT	30FT	100FT
880	87	60670	105921	190.	76.	24506	71.4	70.6	70.1

DATA STRATUM	LAPSE RATE (F DEG/1000FT)	AN ATMOSPHERIC INDEX
10 - 30 FT	-40.0	-0.201E 00
30 - 100 FT	-7.1	-0.413E 00
10 - 100 FT	-14.4	-0.903E 00

Table A. Errors in Vortex Age T" vs. Angle θ

	θ (degrees)									
Seconds	0	10	15	20	30	40	60	70	80	85
T"(minimum)	0	0.04	0.07	0.09	0.14	0.21	0.42	0.69	1.42	2.86
T"(maximum)	0	0.31	0.47	0.64	1.01	1.47	2.91	4.81	9.93	20.00

Table B. Overestimations of Transport Speed vs. Angle θ

	θ (degrees)			
	30	60	70	85
YP/C (Sec)	.387	.549	.426	.568
T-TE (Sec)	4.1	11.5	8.0	25.1
T" (Sec)	.22	.91	1.17	6.50
VU/VA	1.055	1.080	1.145	1.259

APPENDIX C

FIGURES

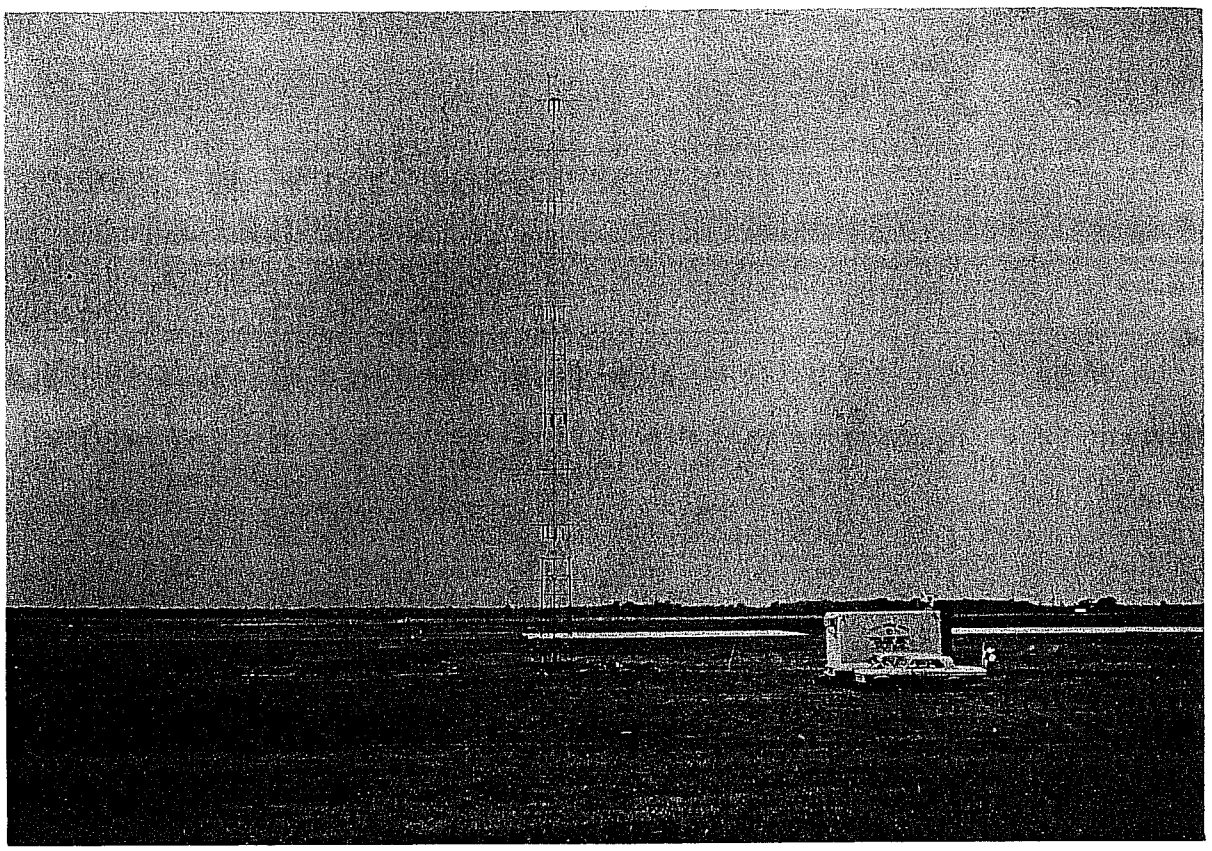


Figure A

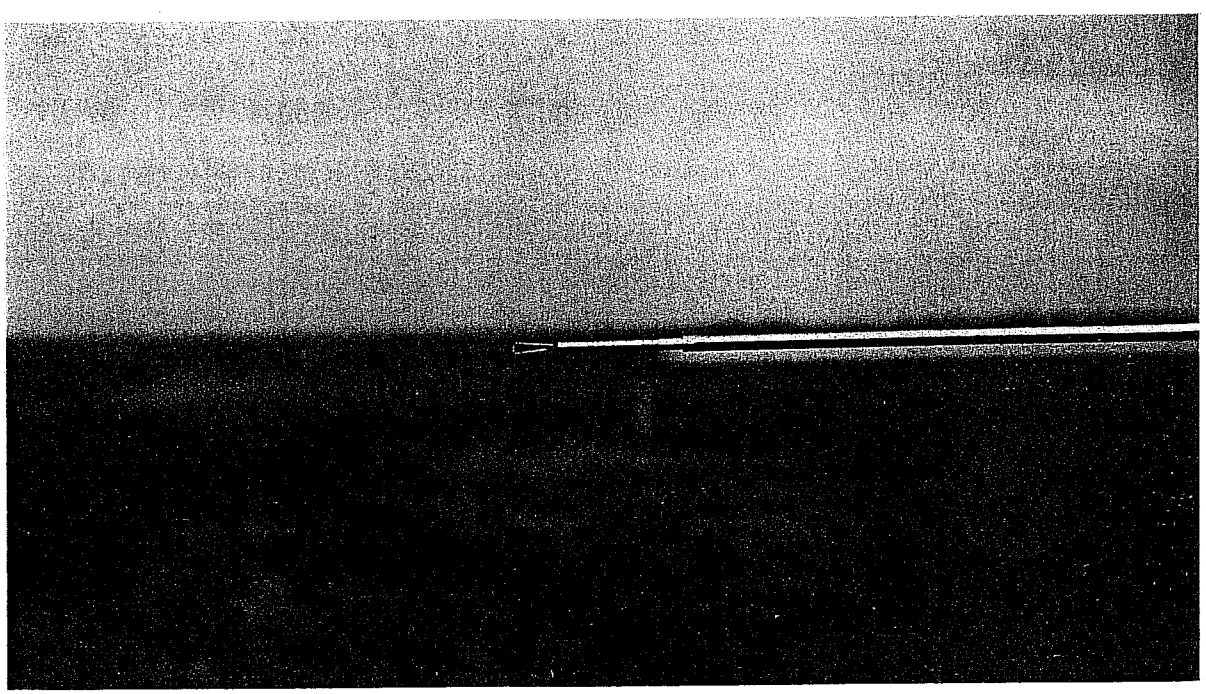


Figure B

DATA ACQU

HOT
SENS

ASPI
RESI
BULB

BEND
AERO

DATA EXTR

14
ANAI

TEMI
STR
REC

AERC
STRI
WIND

HOT
TRAC
OUTP

ANAL
OF H
VOLT

DATA ACQUISITION SYSTEMS

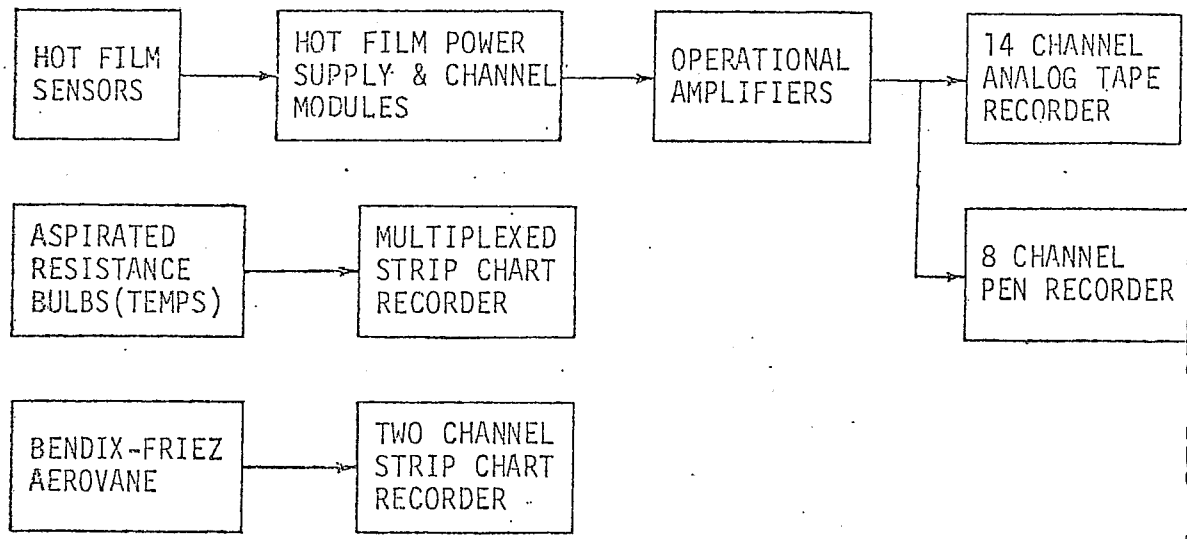


Figure A

DATA EXTRACTION

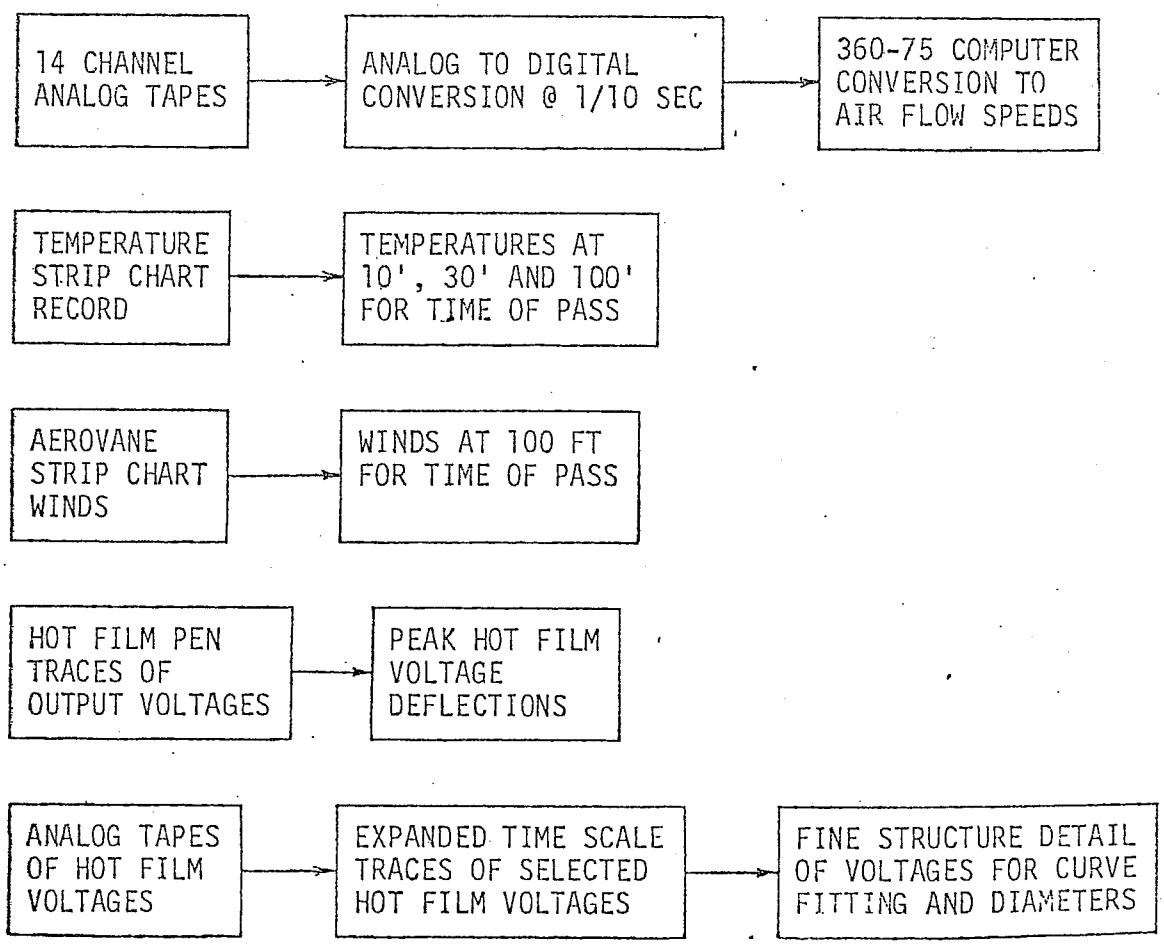
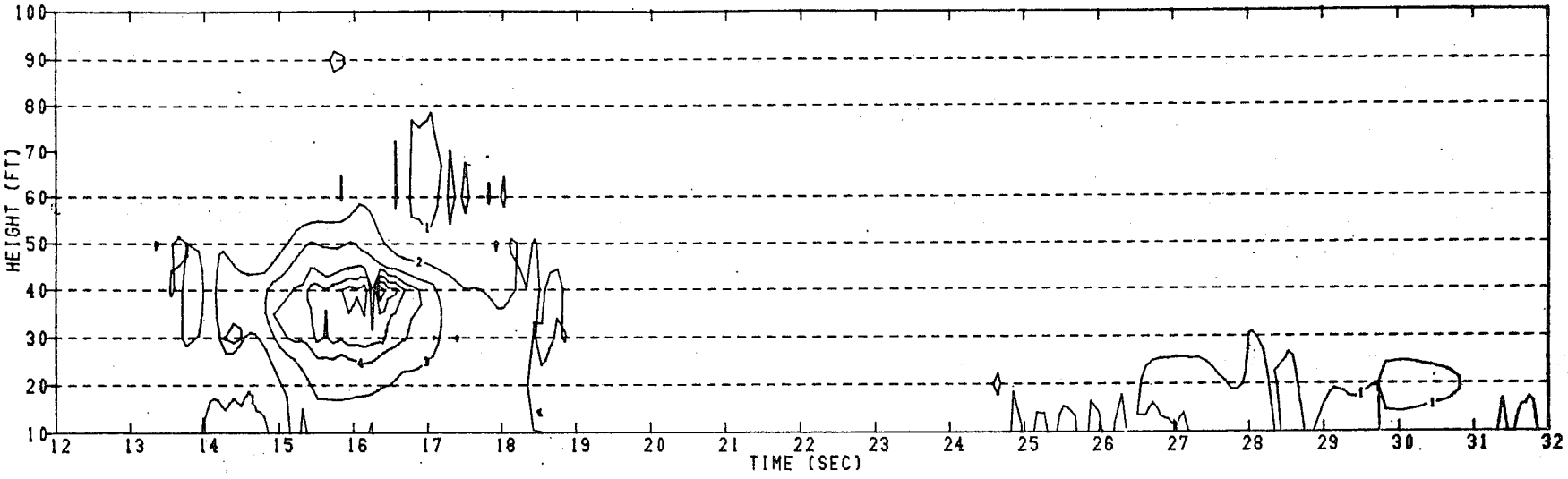
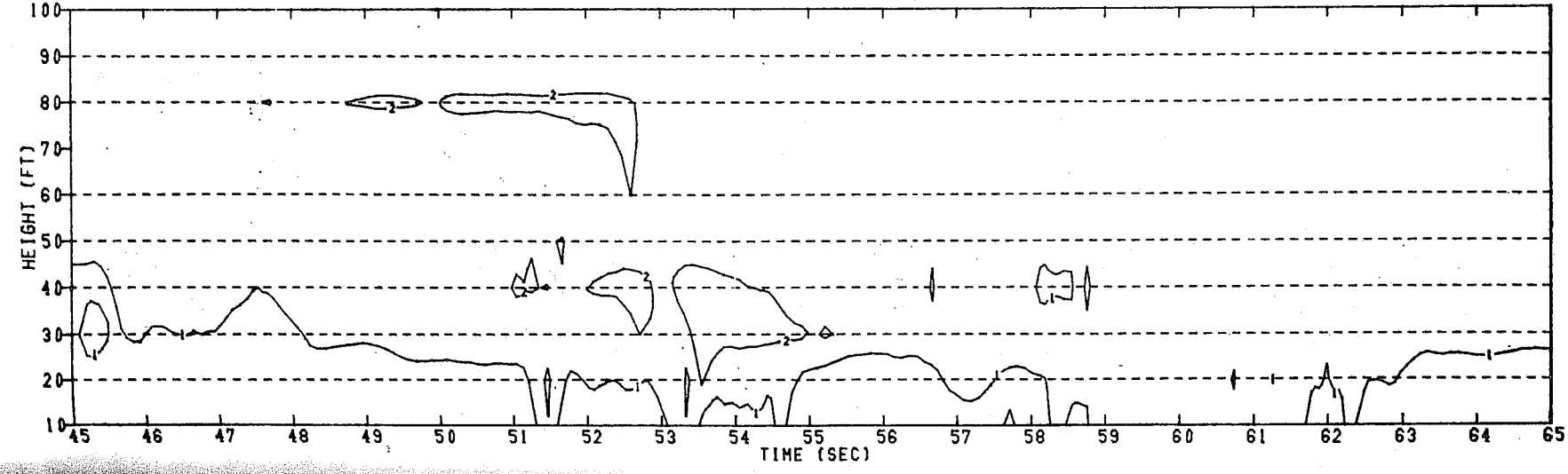


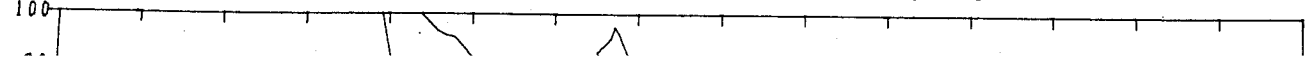
Figure B

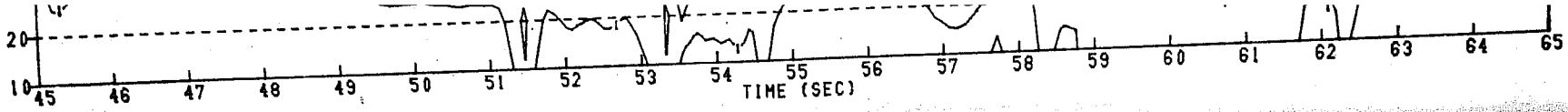
727 PASS 01 05/27/70 0638 13 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS



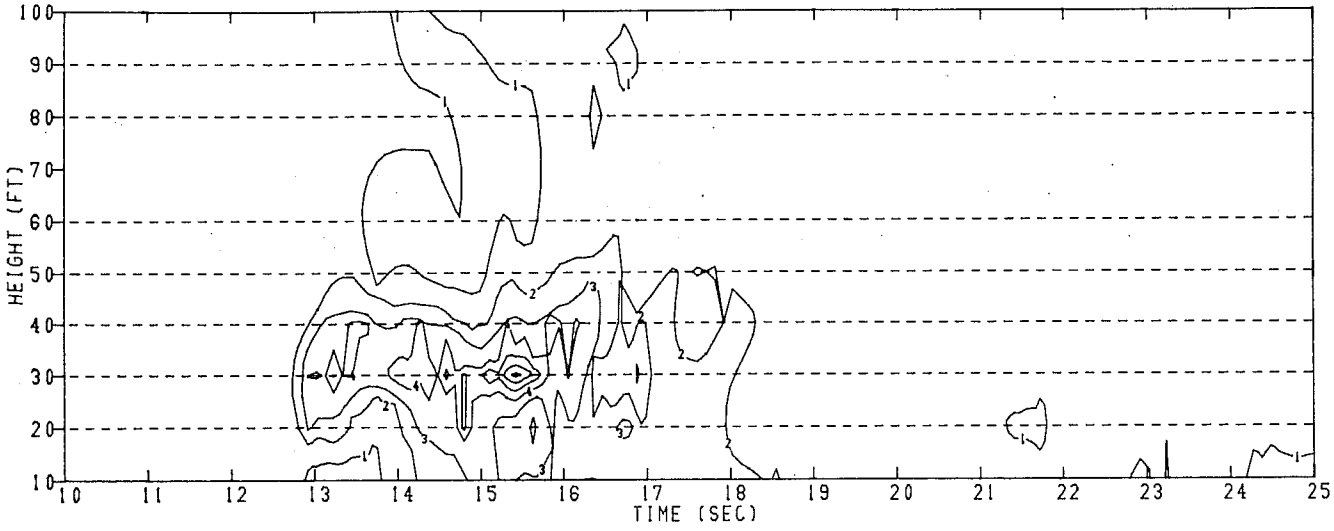


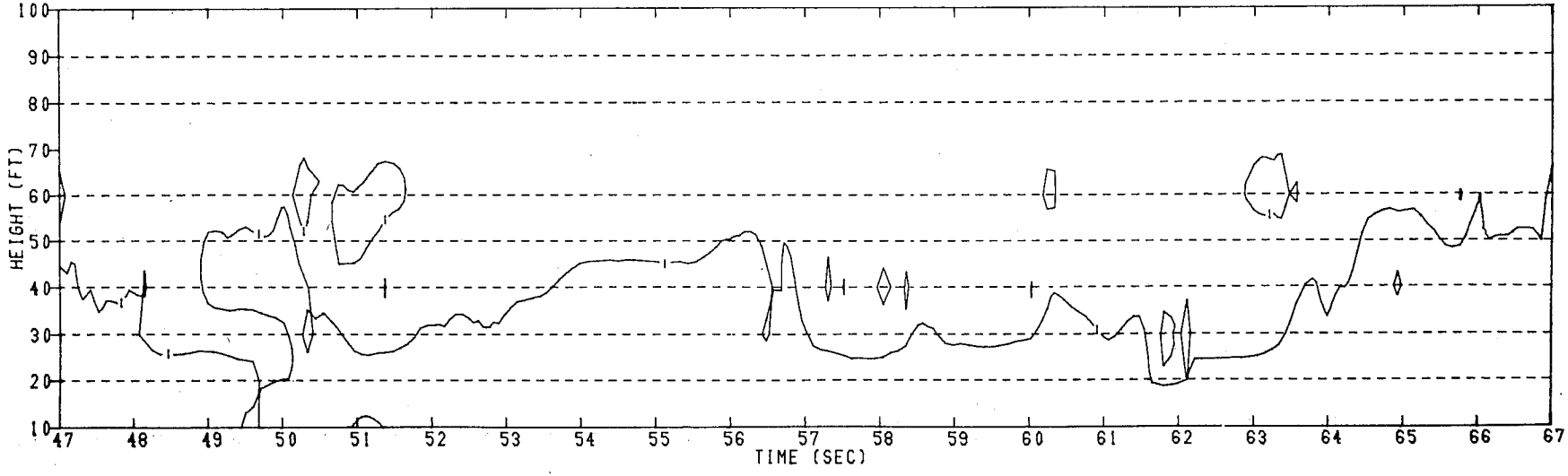
727 PASS 02 05/27/70 0648 36 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS



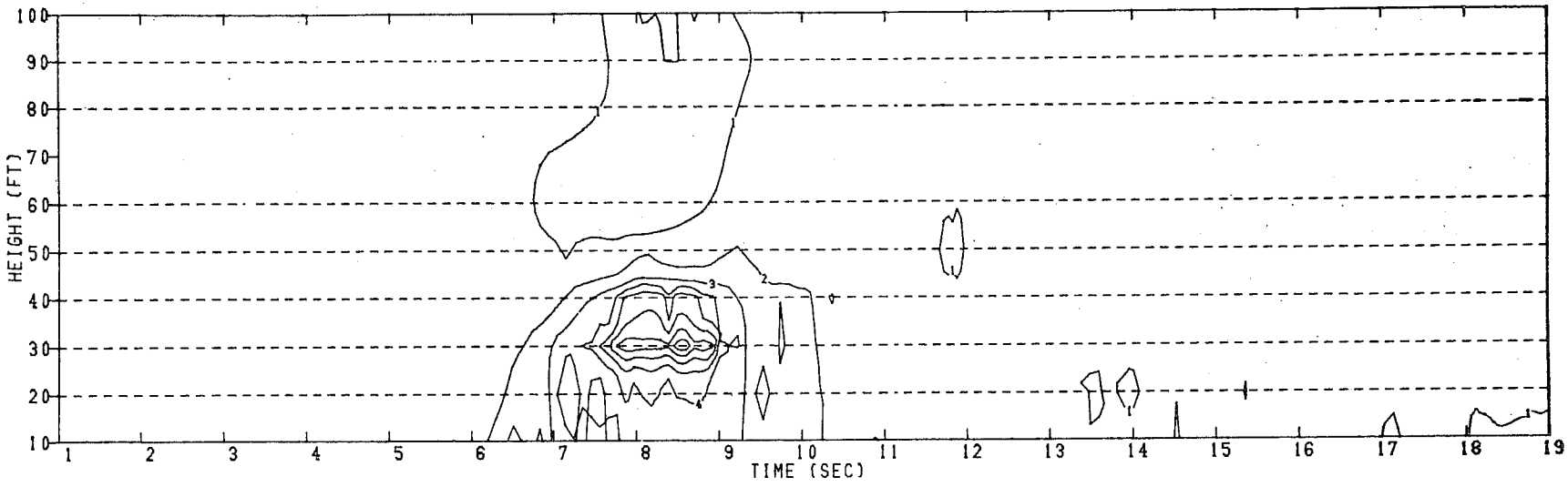


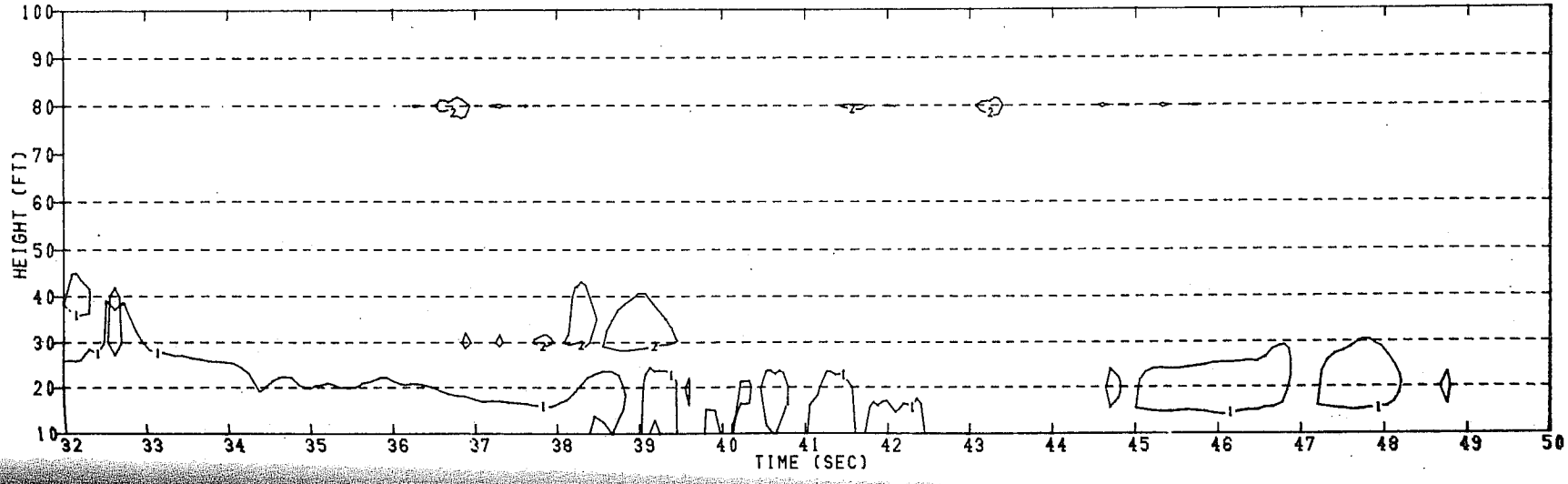
727 PASS 02 05/27/70 0648 36 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS

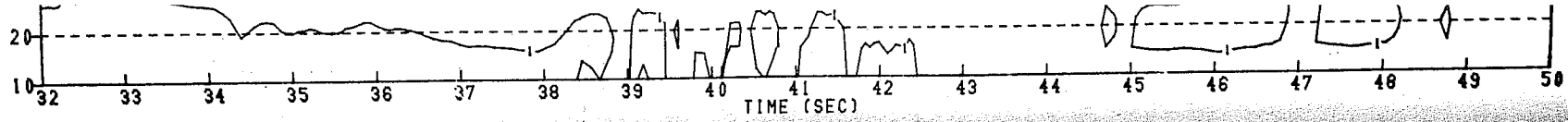




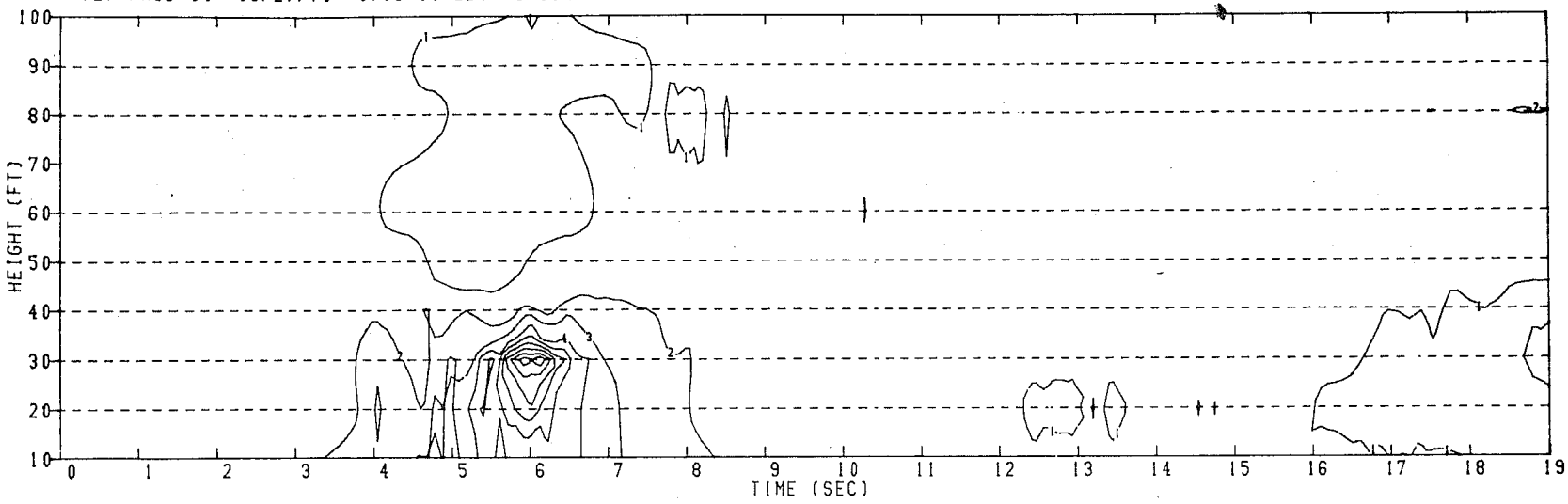
727 PASS 03 05/27/70 0657 32 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS

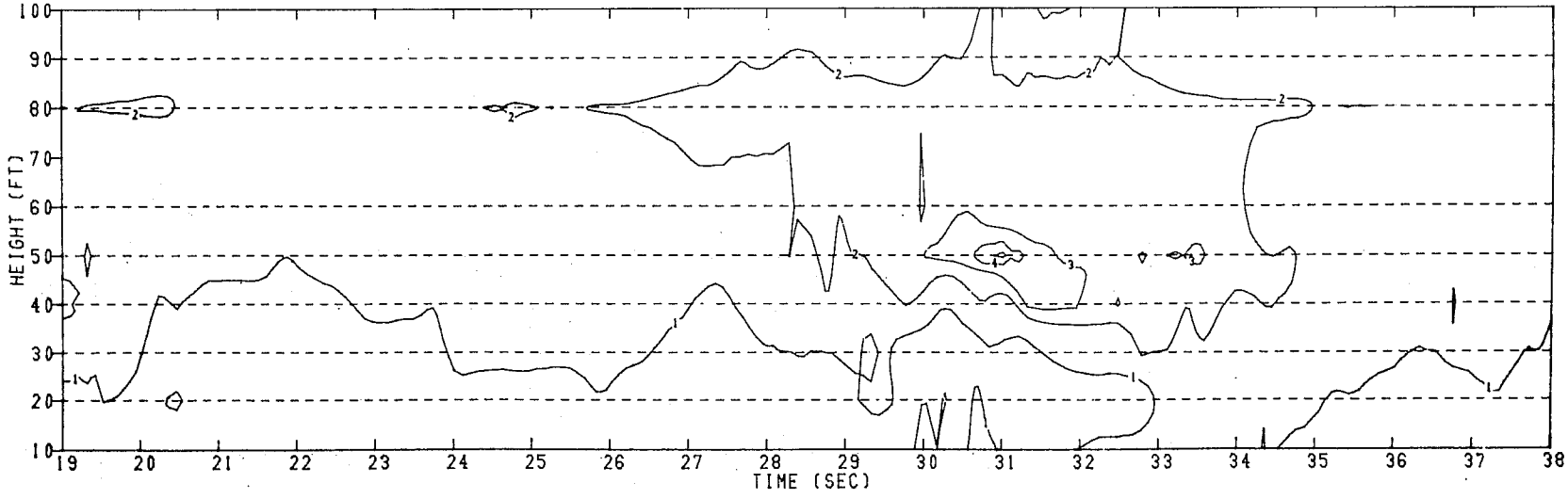




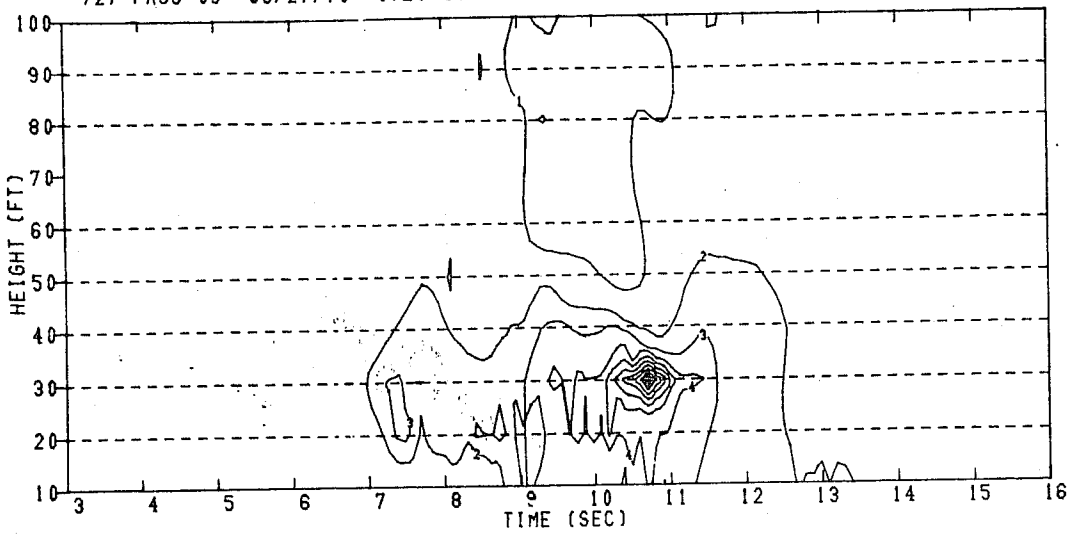


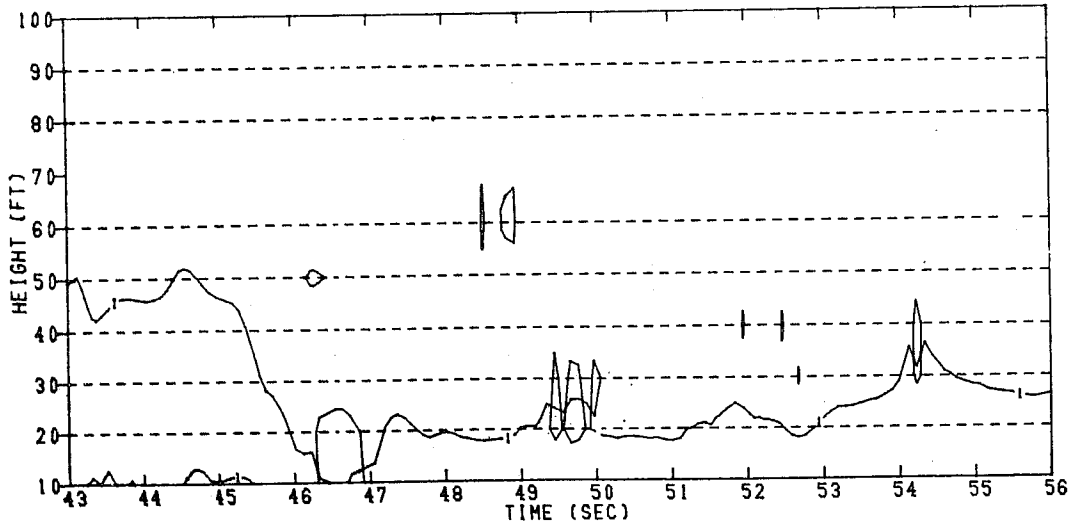
727 PASS 04 05/27/70 0706 11 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS



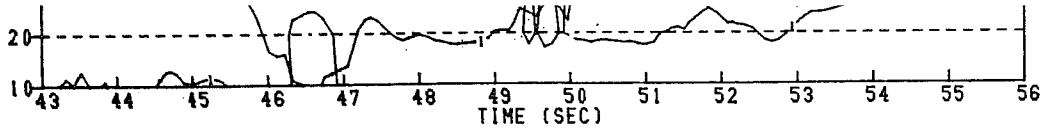


727 PASS 05 05/27/70 0720 40 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS

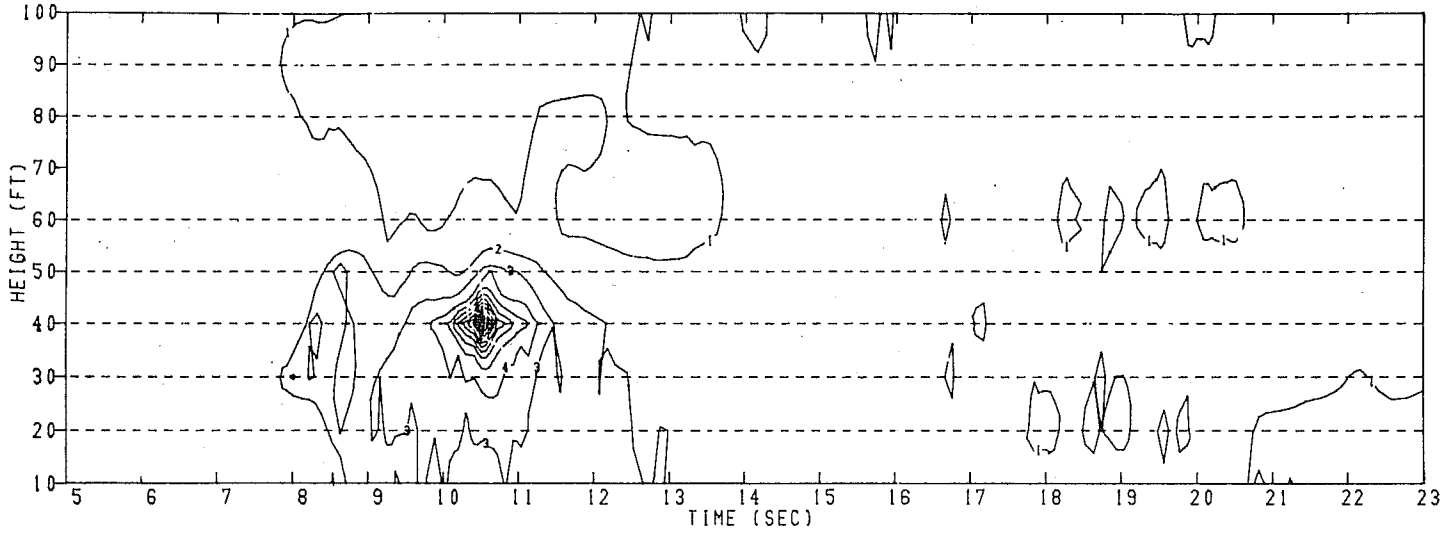


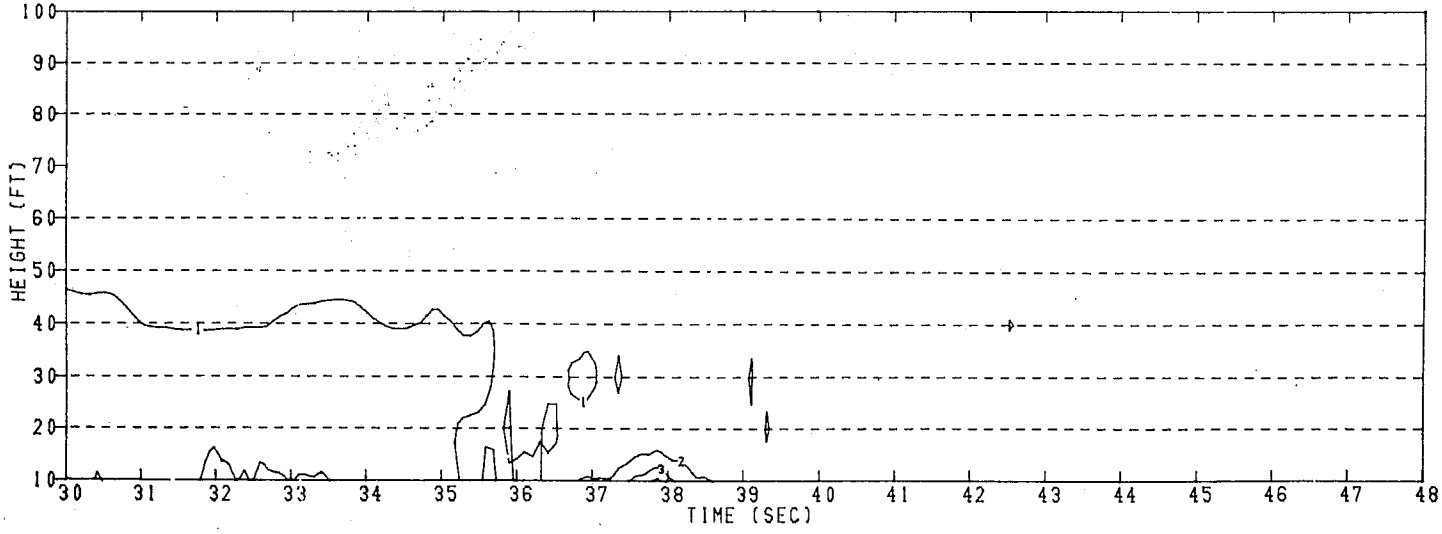


727 PASS 06 05/27/70 0729 22 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS

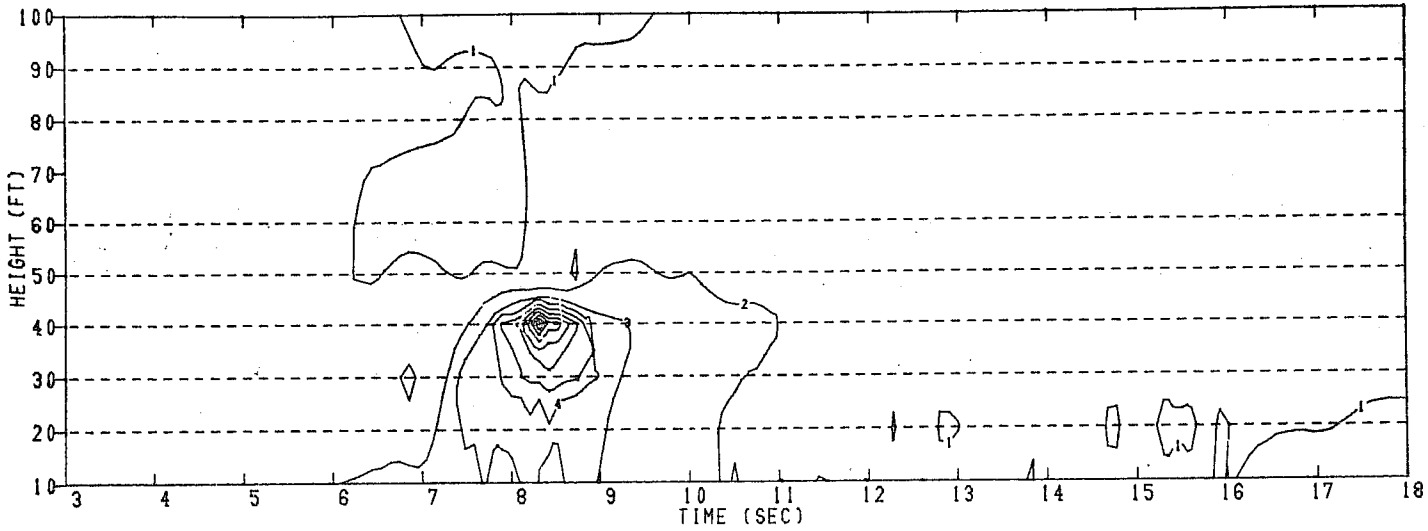


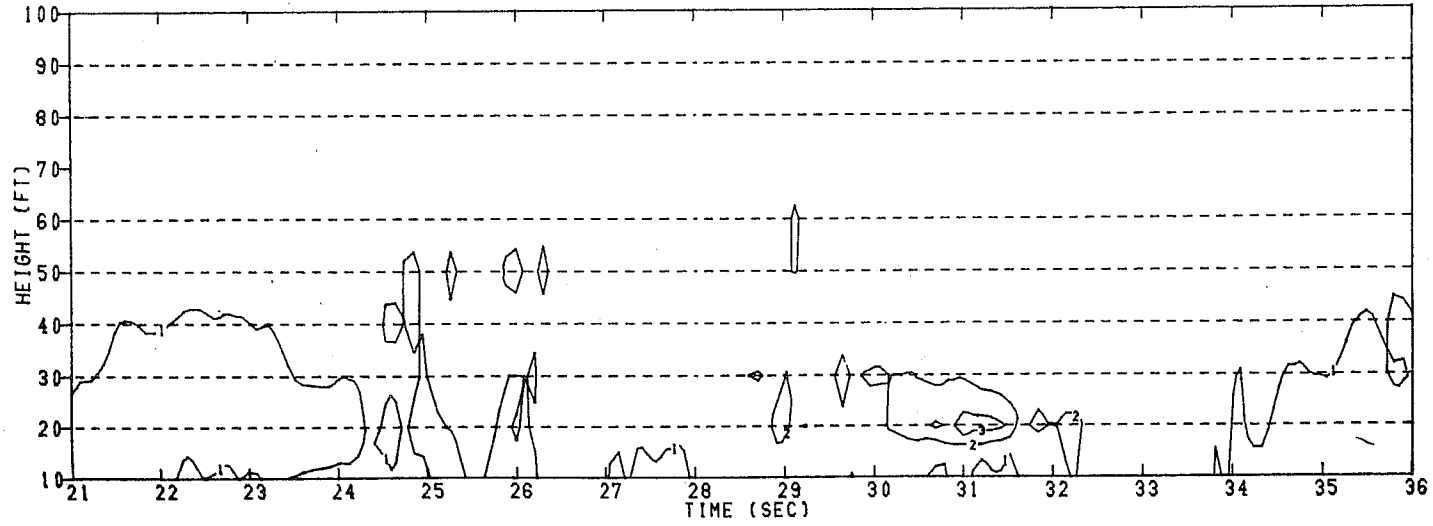
727 PASS 06 05/27/70 0729 22 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS



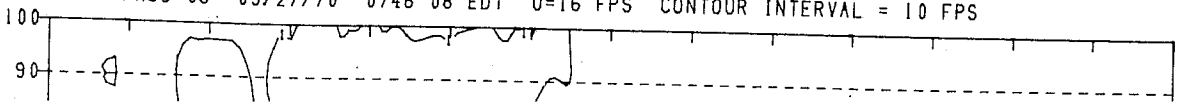


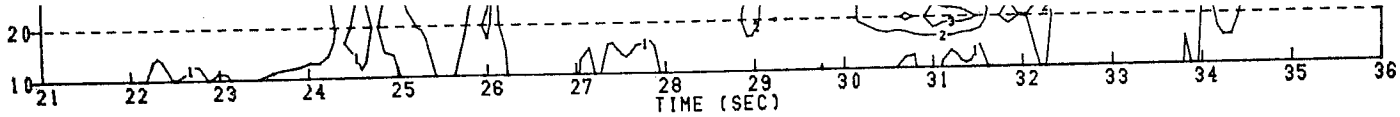
727 PASS 07 05/27/70 0738 49 EDT U=17 FPS CONTOUR INTERVAL = 10 FPS



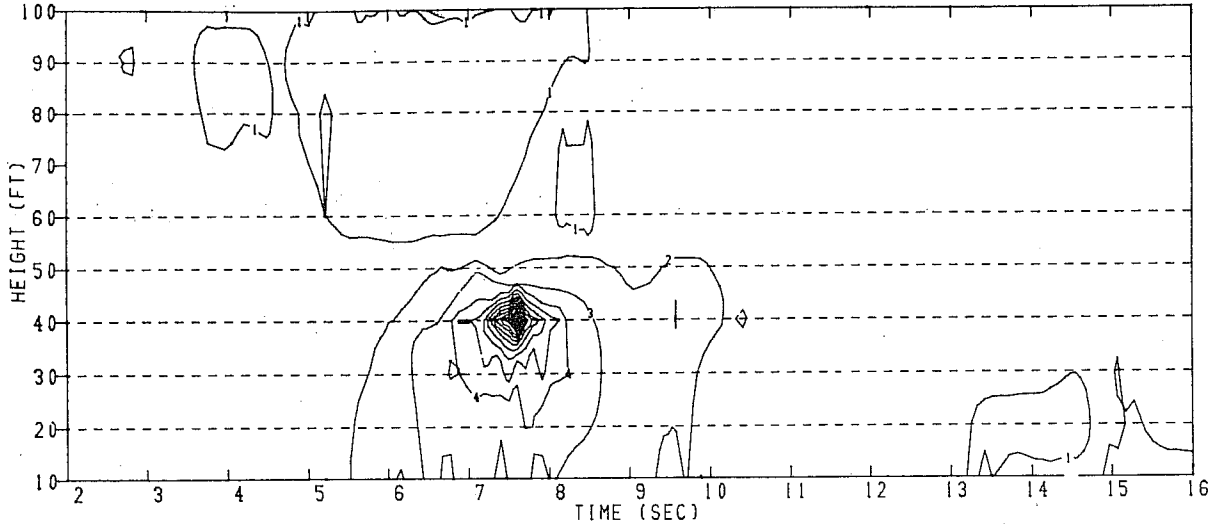


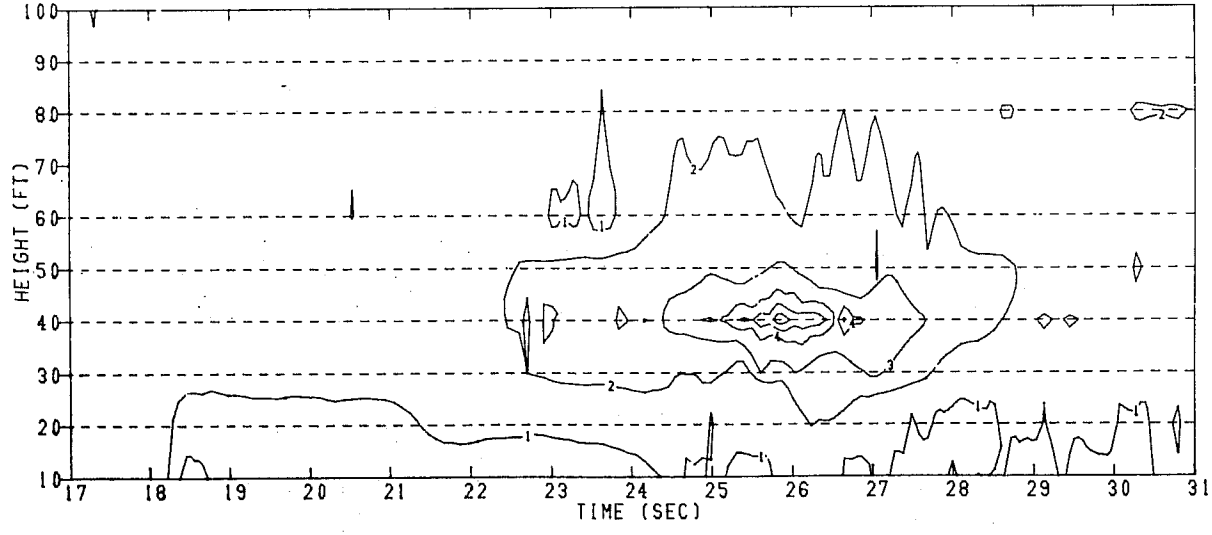
727 PASS 08 05/27/70 0746 08 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS



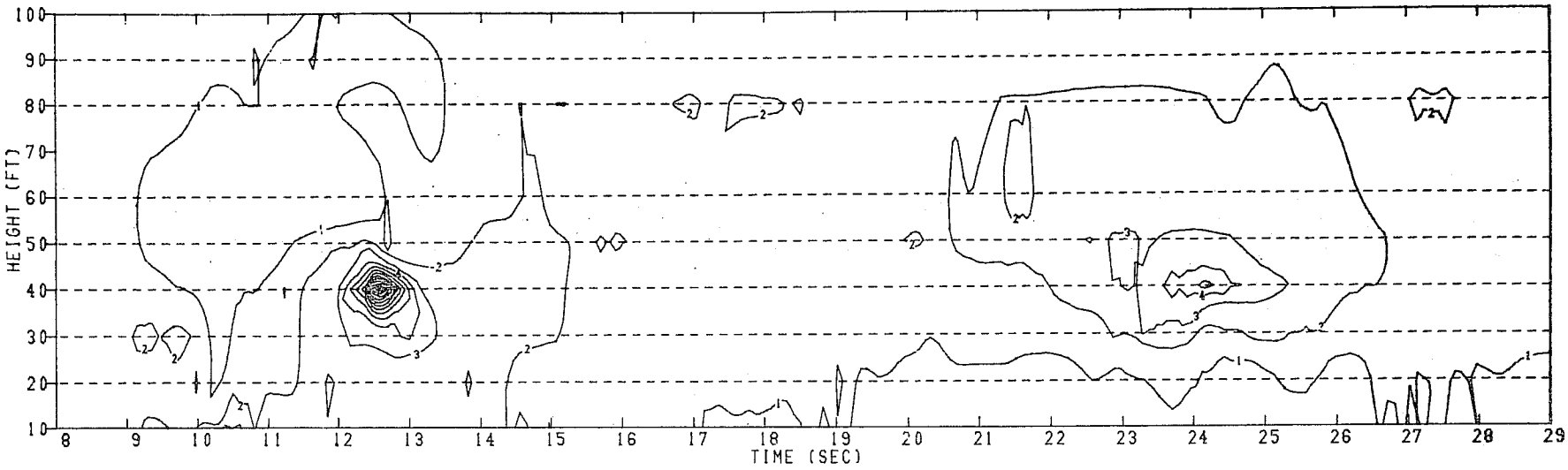


727 PASS 08 05/27/70 0746 08 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS

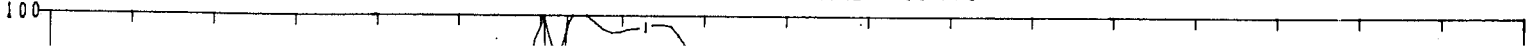




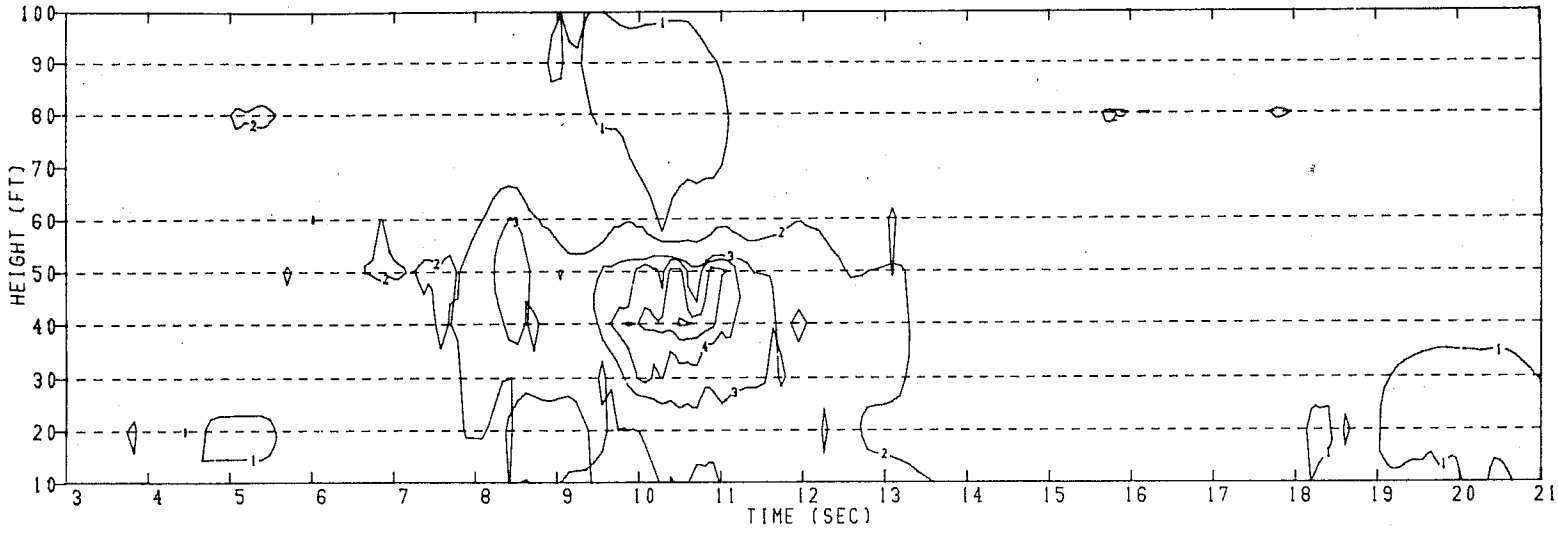
727 PASS 09 05/27/70 0758 44 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS

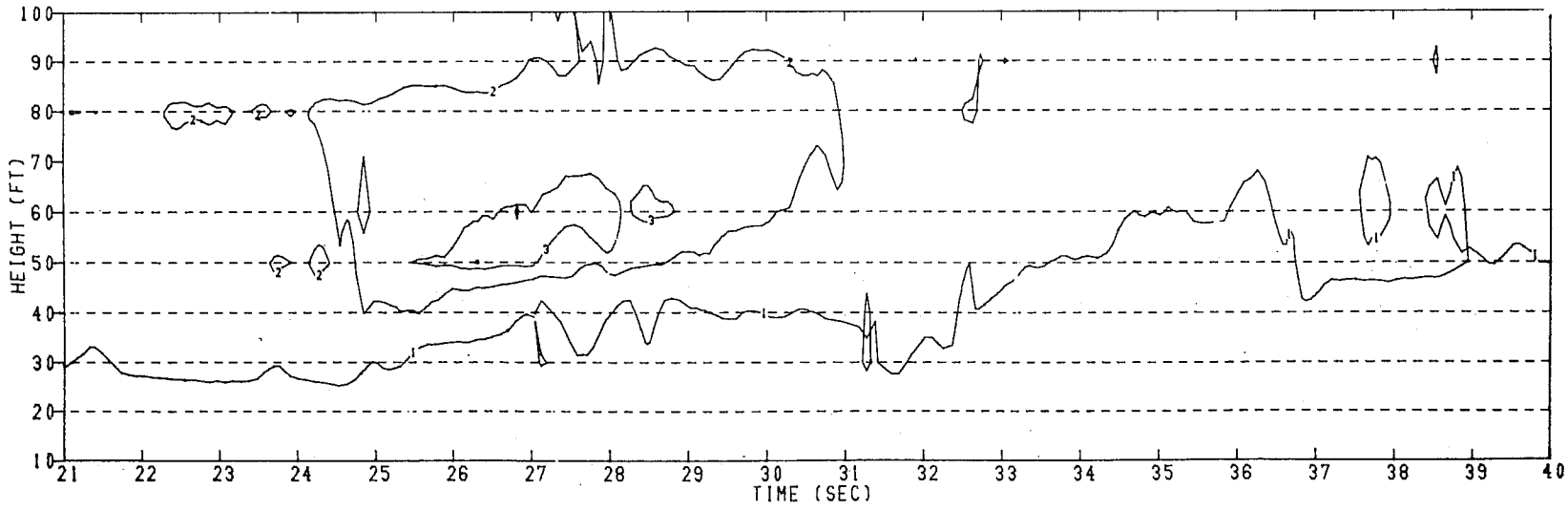


727 PASS 10 05/27/70 0806 09 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS

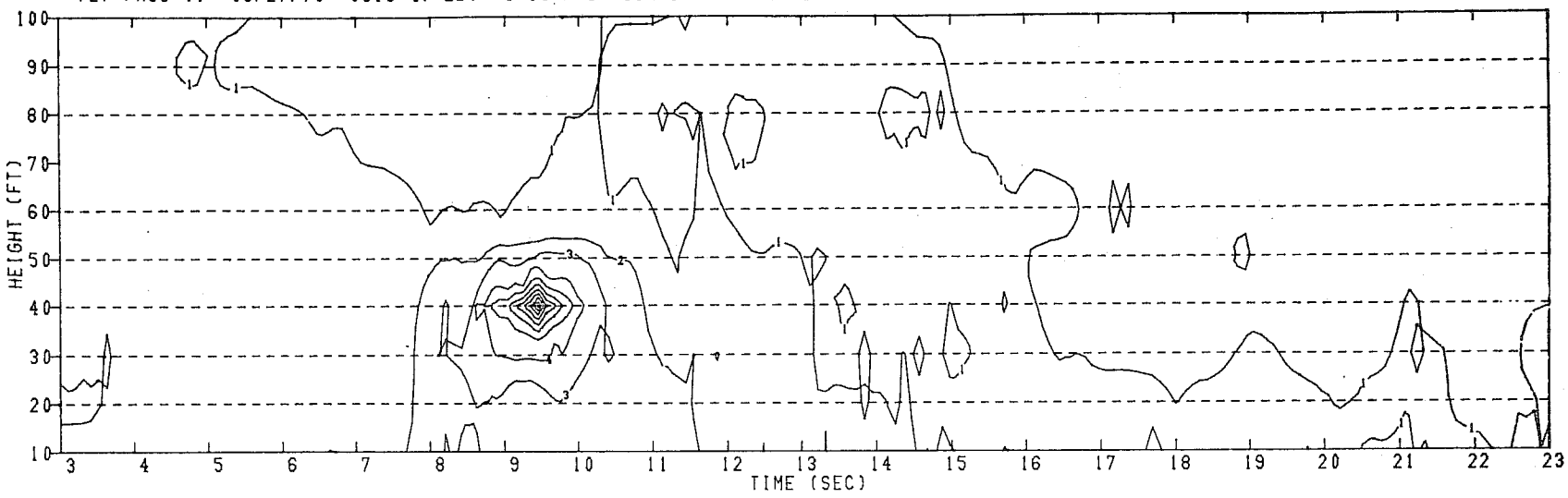


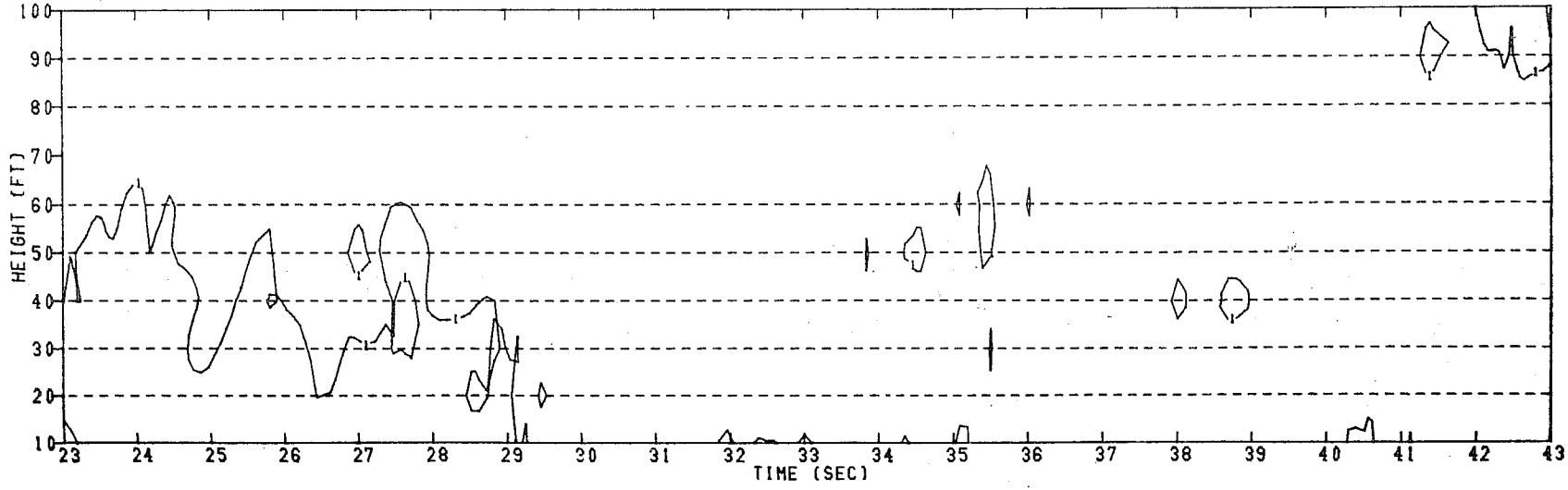
727 PASS 10 05/27/70 0806 09 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS



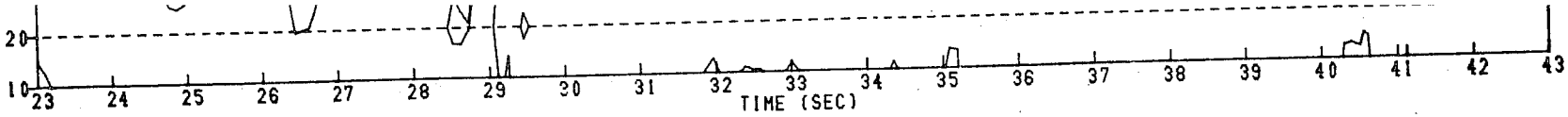


727 PASS 11 05/27/70 0813 47 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS





727 PASS 12 05/27/70 0827 51 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS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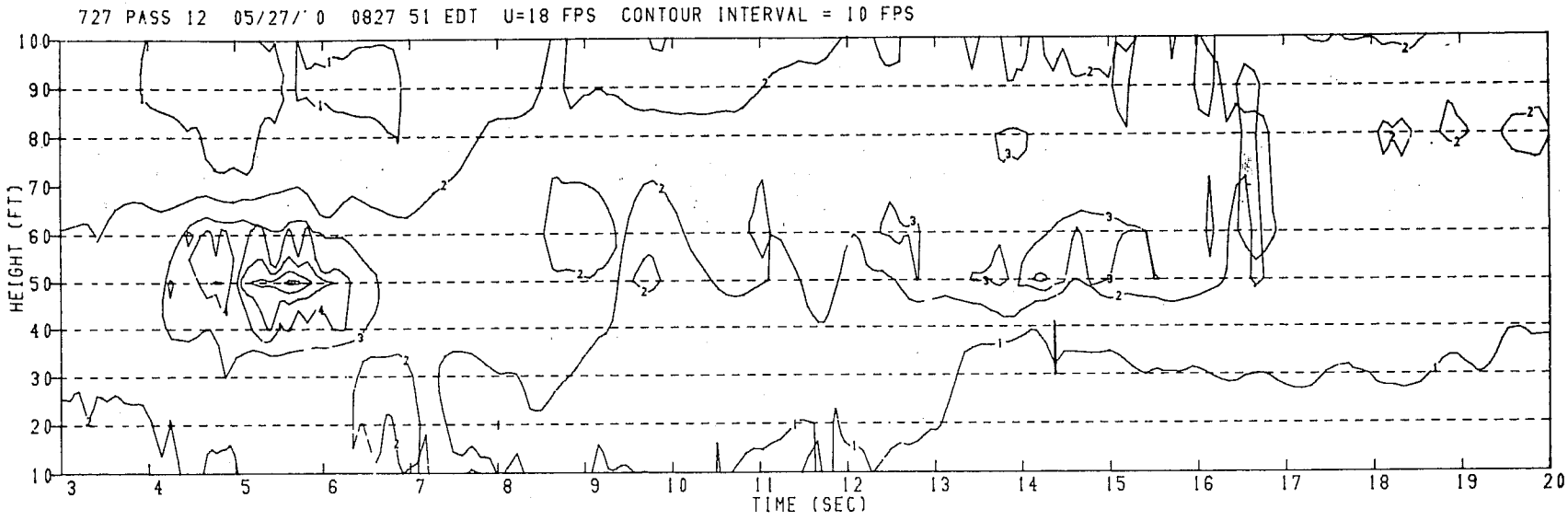
TIME (SEC)


727 PASS 12 05/27/' 0 0827 51 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
100
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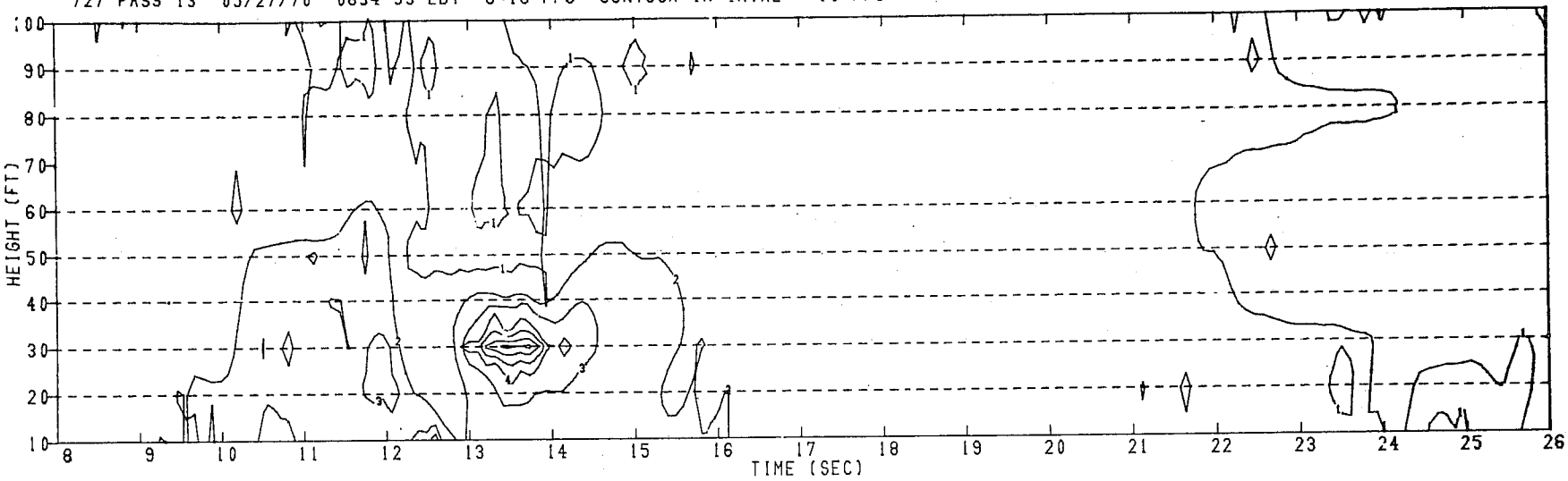
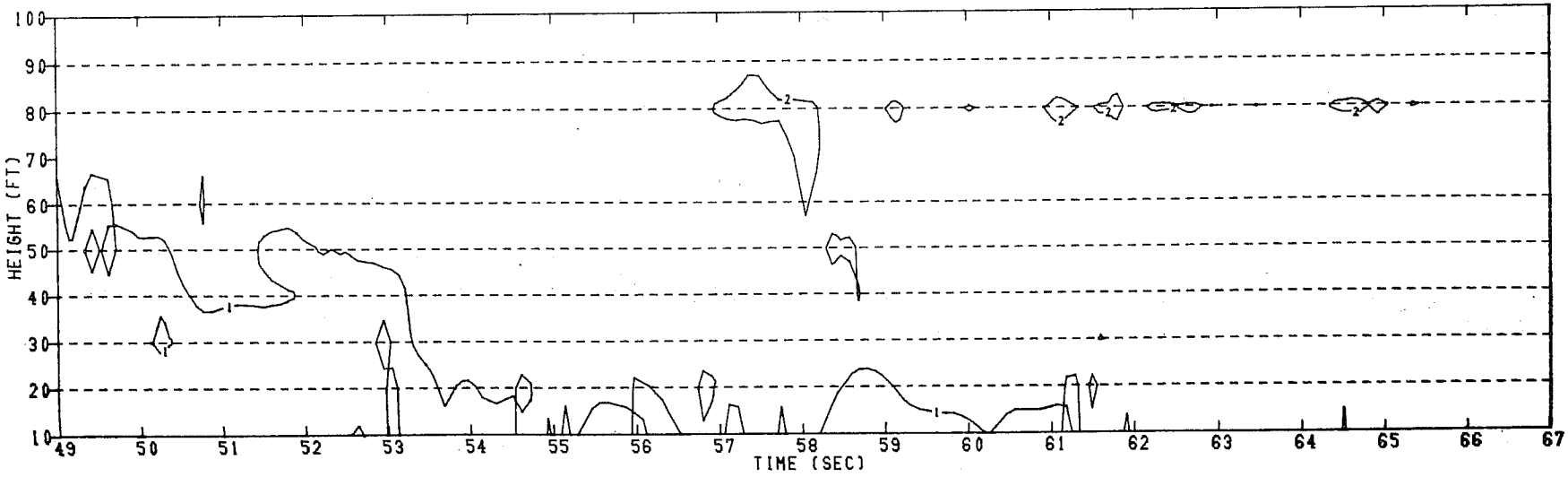
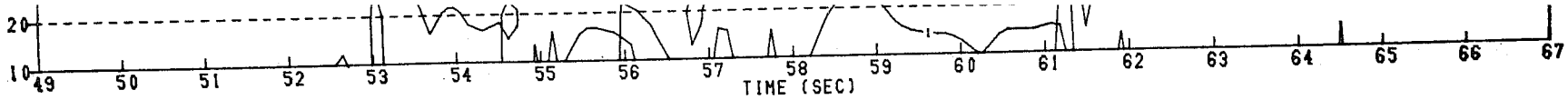
TIME (SEC)

727 PASS 13 05/27/70 0834 59 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS





727 PASS 14 05/27/70 1022 25 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS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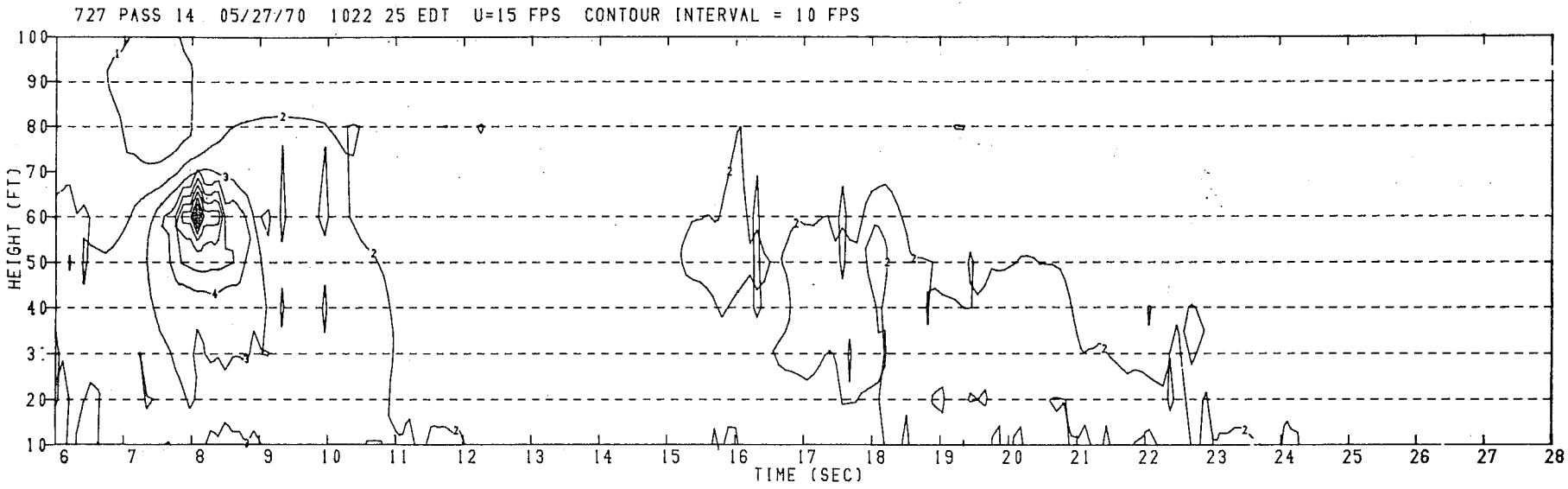
66
67
TIME (SEC)


727 PASS 14 05/27/70 1022 25 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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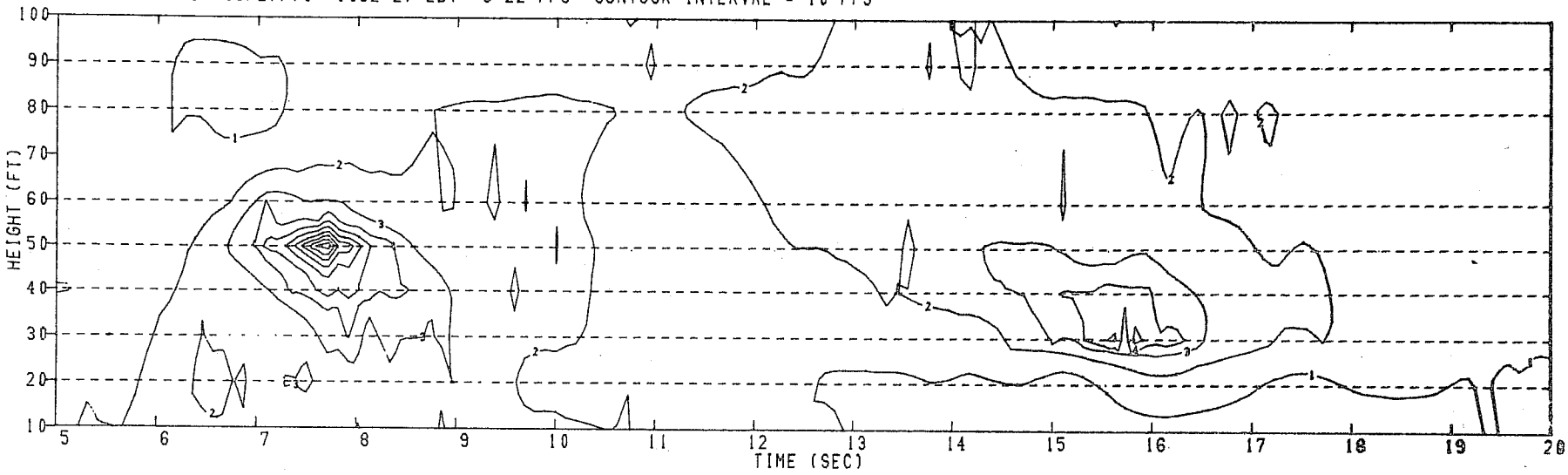
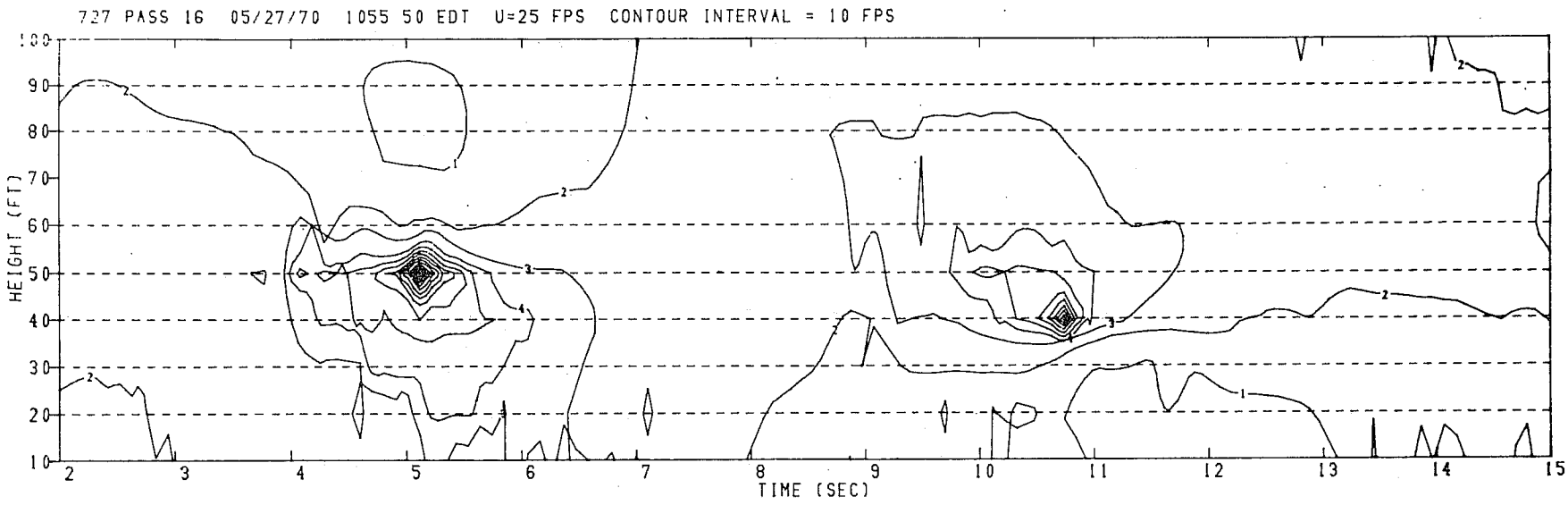
TIME (SEC)

727 PASS 15 05/27/70 1032 27 EDT U=22 FPS CONTOUR INTERVAL = 10 FPS



727 PASS 16 05/27/70 1055 50 EDT U=25 FPS CONTOUR INTERVAL = 10 FPS

100


727 PASS 16 05/27/70 1055 50 EDT U=25 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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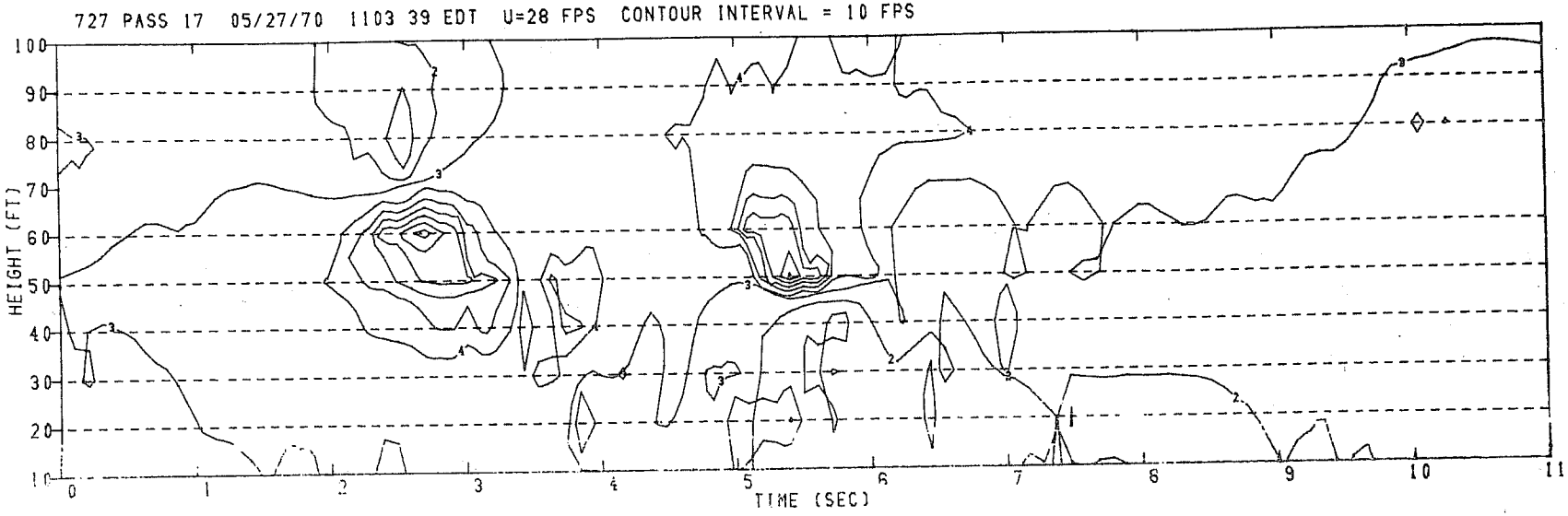
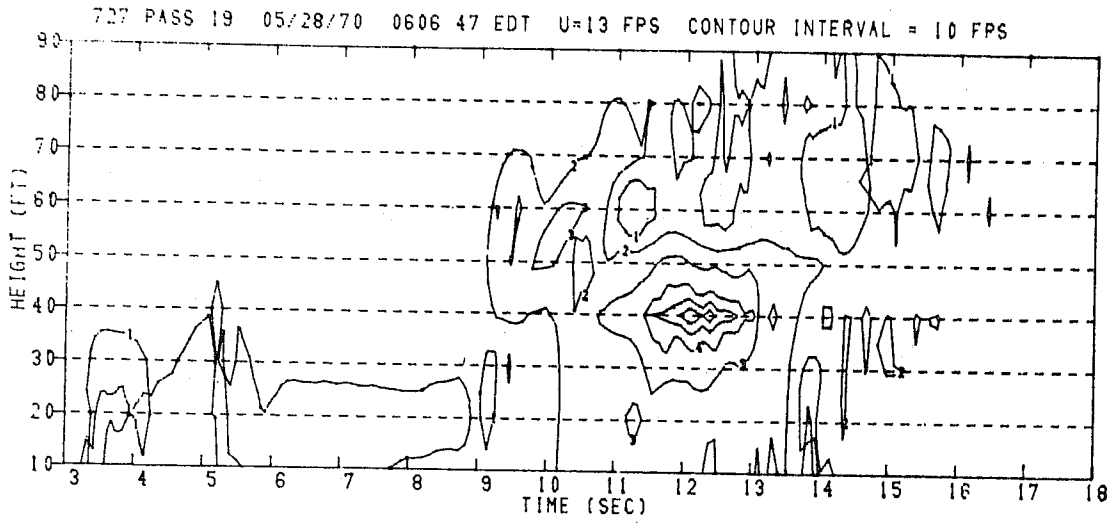
TIME (SEC)

727 PASS 17 05/27/70 1103 39 EDT U=28 FPS CONTOUR INTERVAL = 10 FPS



727 PASS 19 05/28/70 0606 47 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS


727 PASS 19 05/28/70 0606 47 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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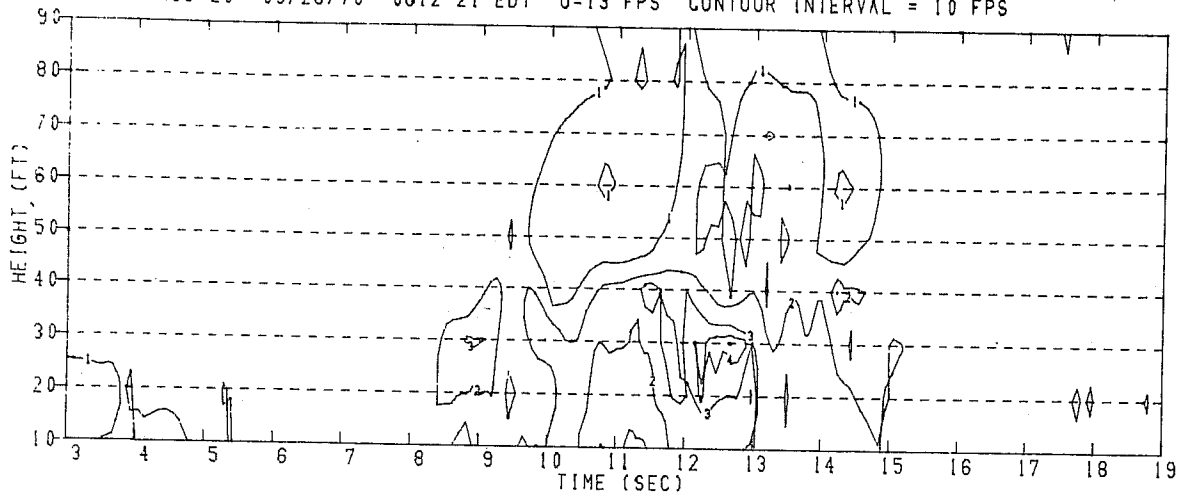
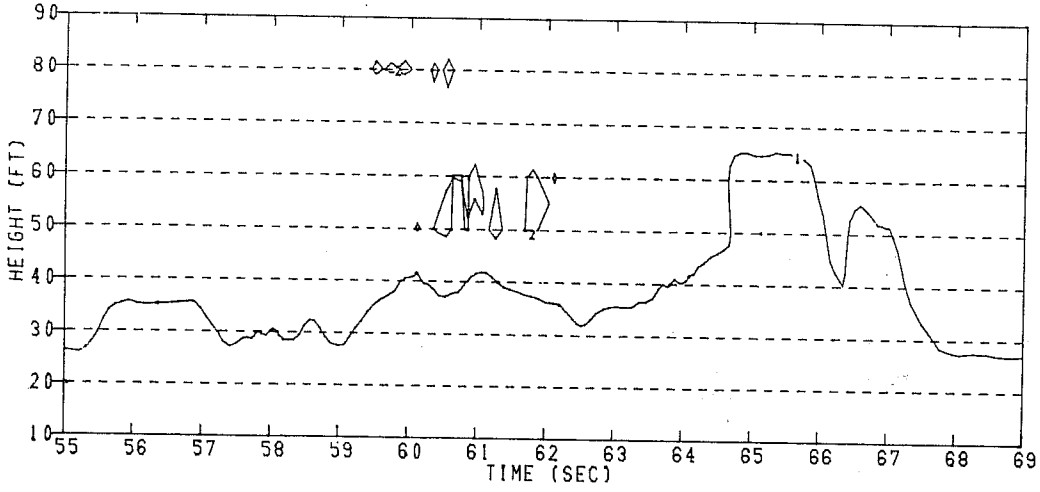
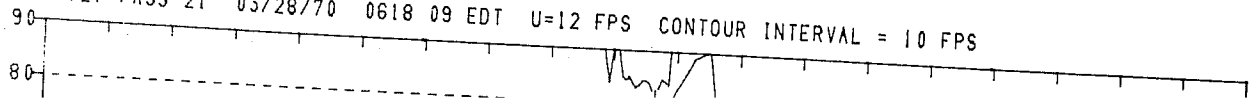
TIME (SEC)

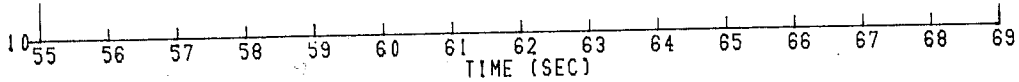
727 PASS 20 05/28/70 0612 21 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS

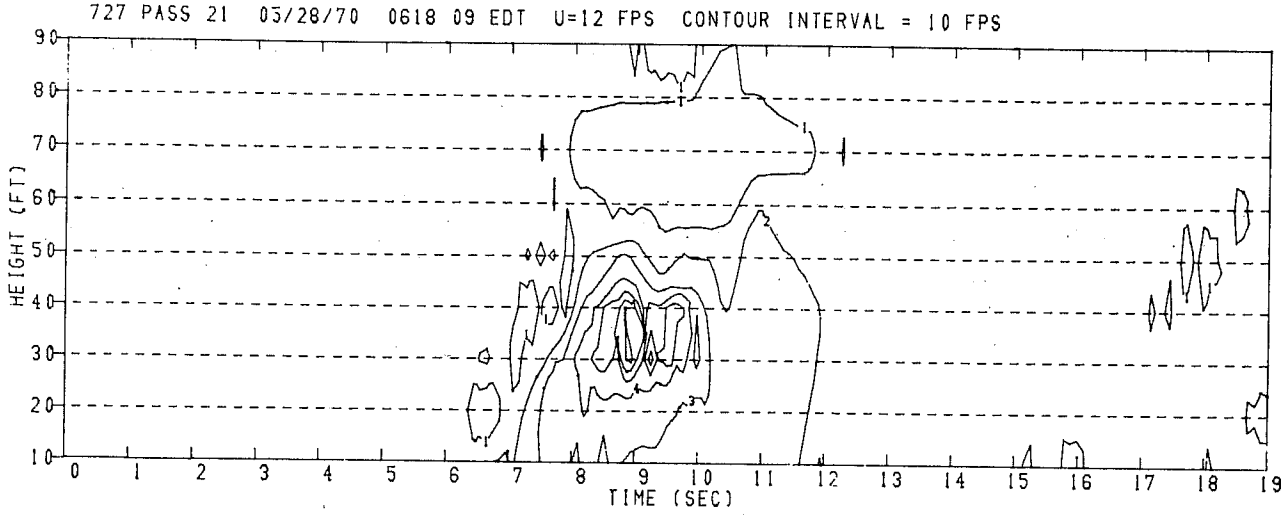


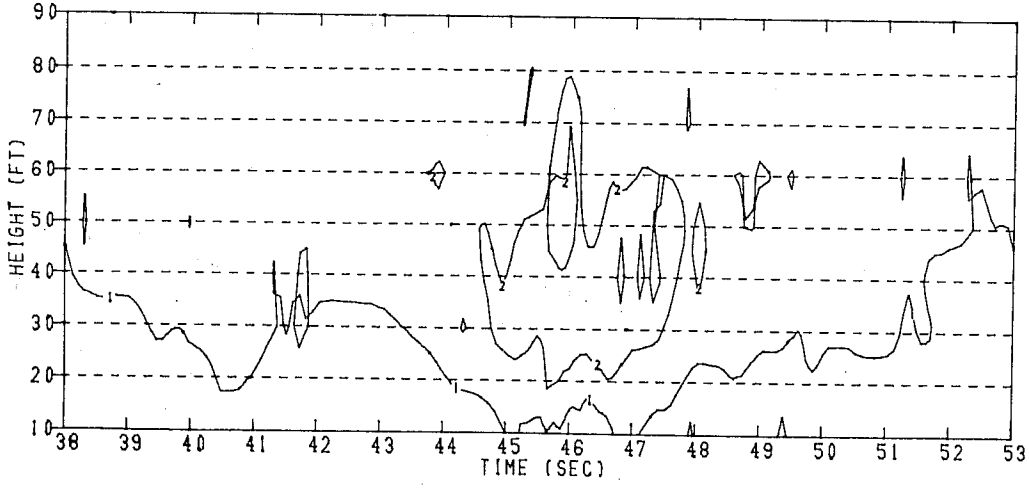


727 PASS 21 05/28/70 0618 09 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS

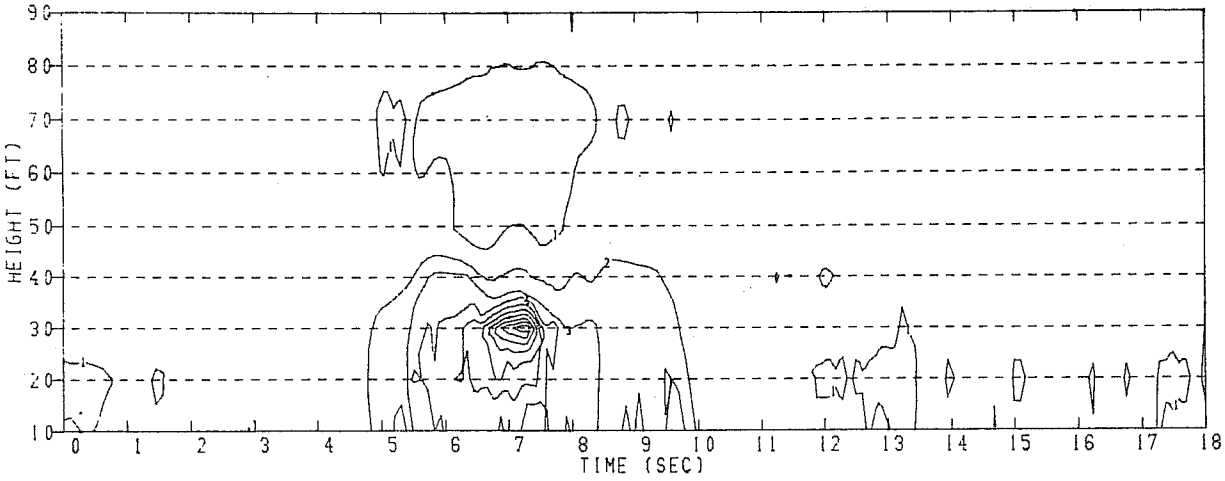



10
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
TIME (SEC)

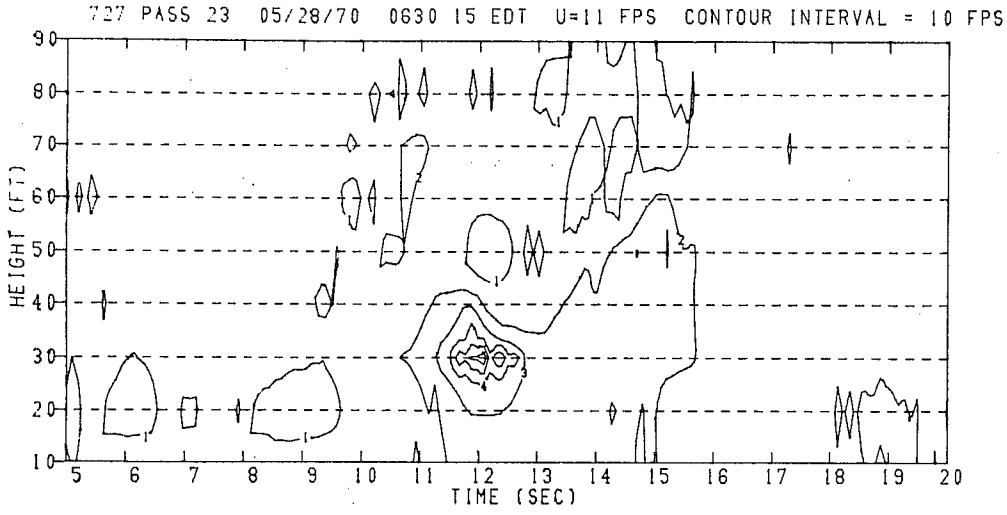

727 PASS 21 05/28/70 0618 09 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90 80 70 60 50 40 30 20 10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
TIME (SEC)


HEIGHT (FT)
90 80 70 60 50 40 30 20 10
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
TIME (SEC)

727 PASS 22 05/28/70 0623 42 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS



727 PASS 23 05/28/70 0630 15 EDT


727 PASS 23 05/28/70 0630 15 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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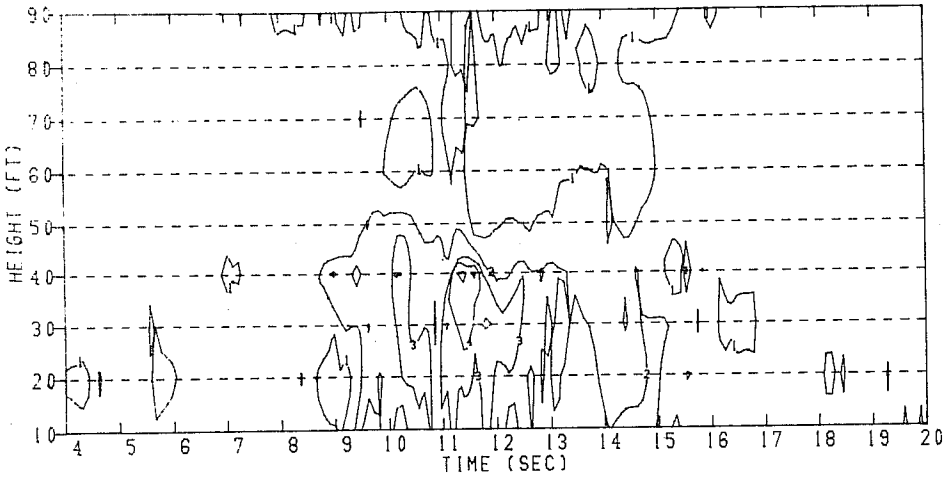
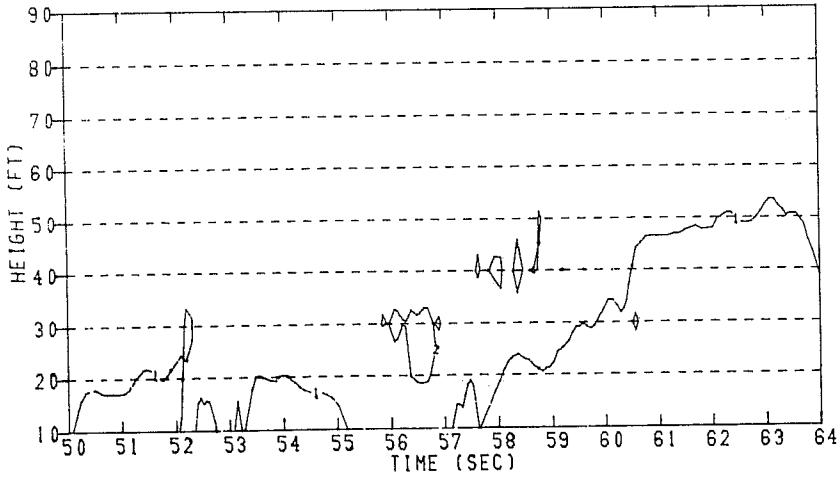
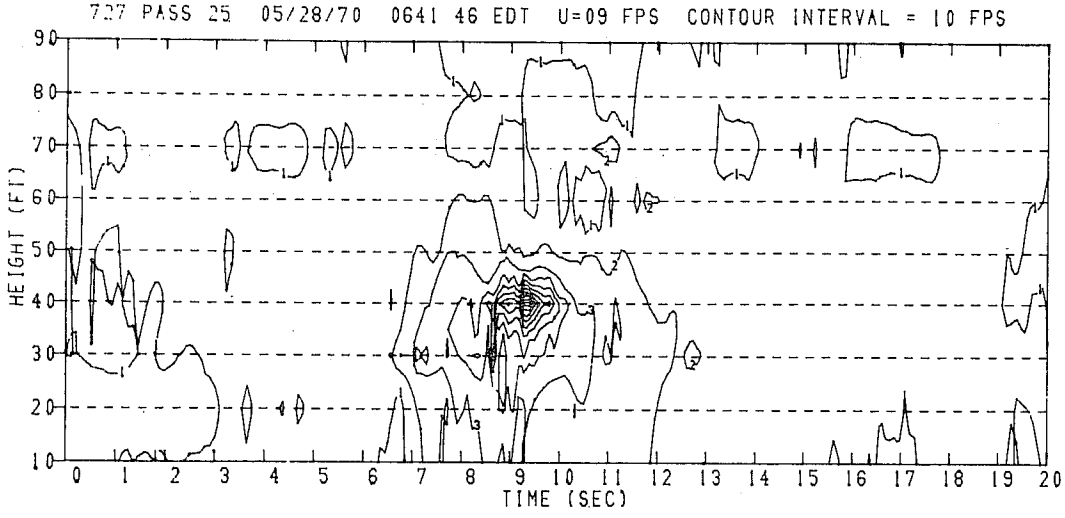
TIME (SEC)

727 PASS 24 05/28/70 0635 54 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS

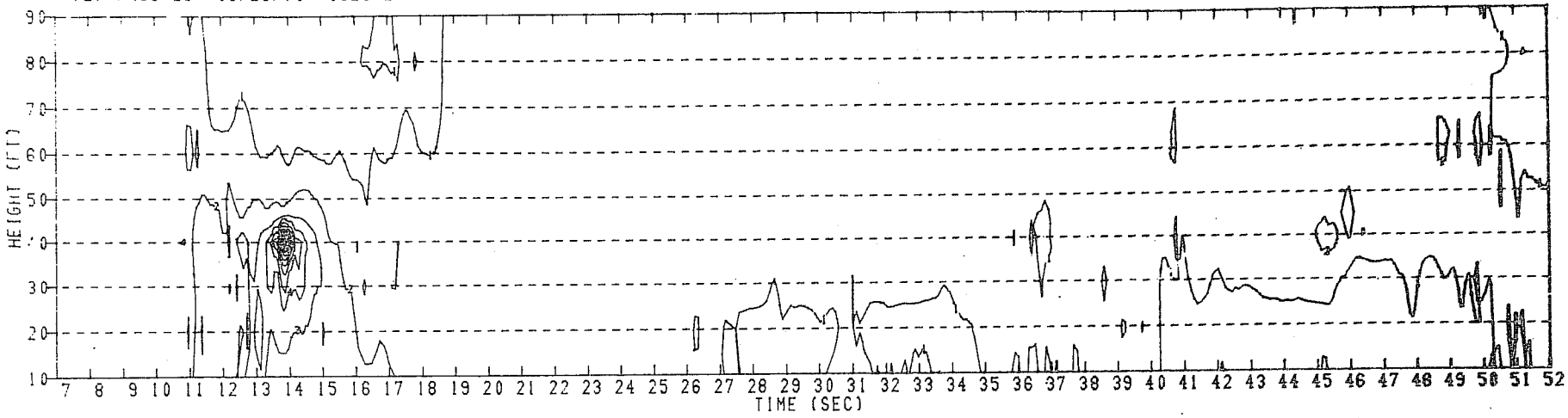


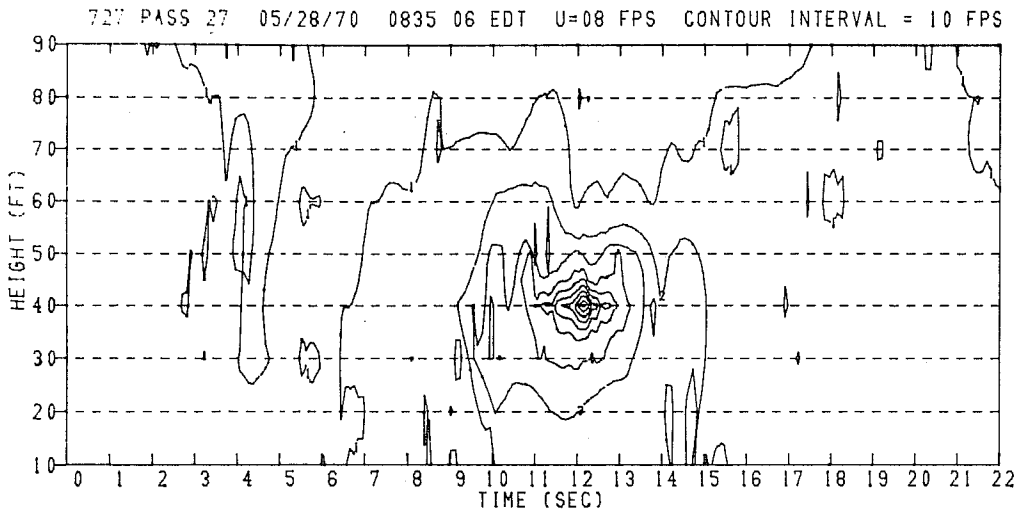


727 PASS 25 05/28/70 0641 46 EDT U=09 FPS CONTOUR

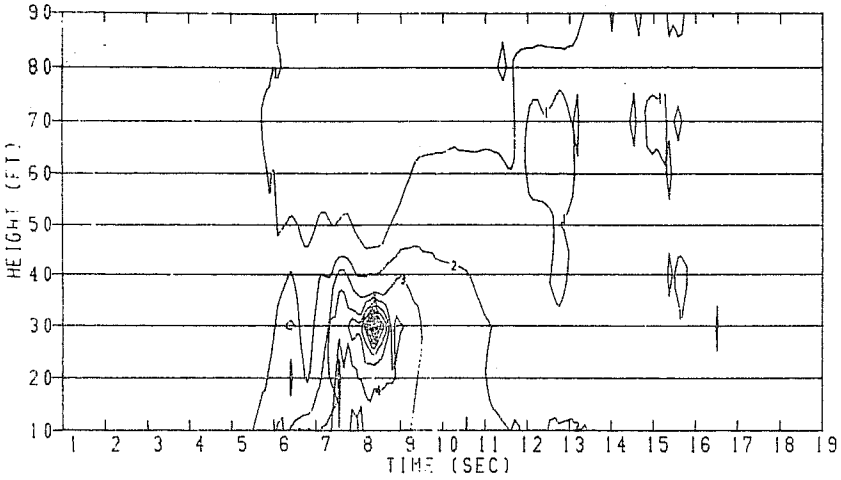

727 PASS 25 05/28/70 0641 46 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
TIME (SEC)

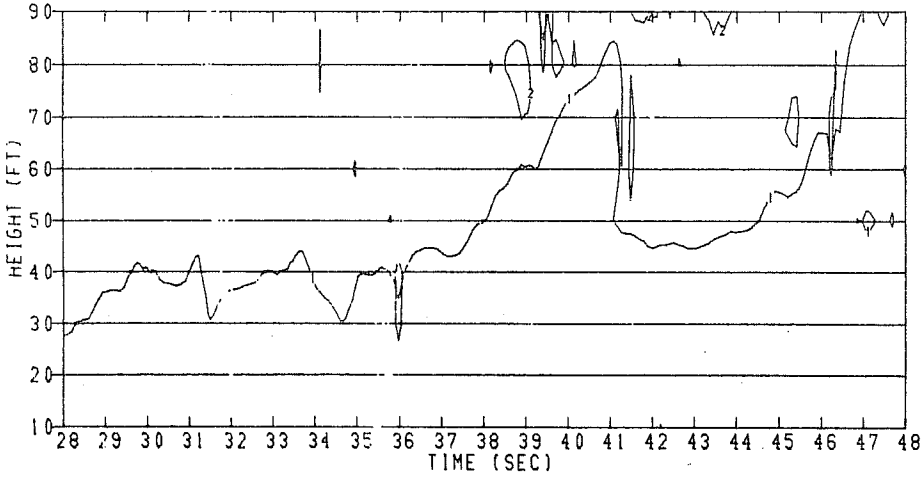
727 PASS 26 05/28/70 0829 23 EDT U=07 FPS CONTOUR INTERVAL = 10 FPS



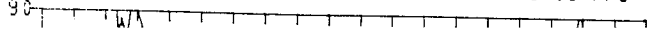

727 PASS 27 05/28/70 0835 06 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
TIME (SEC)

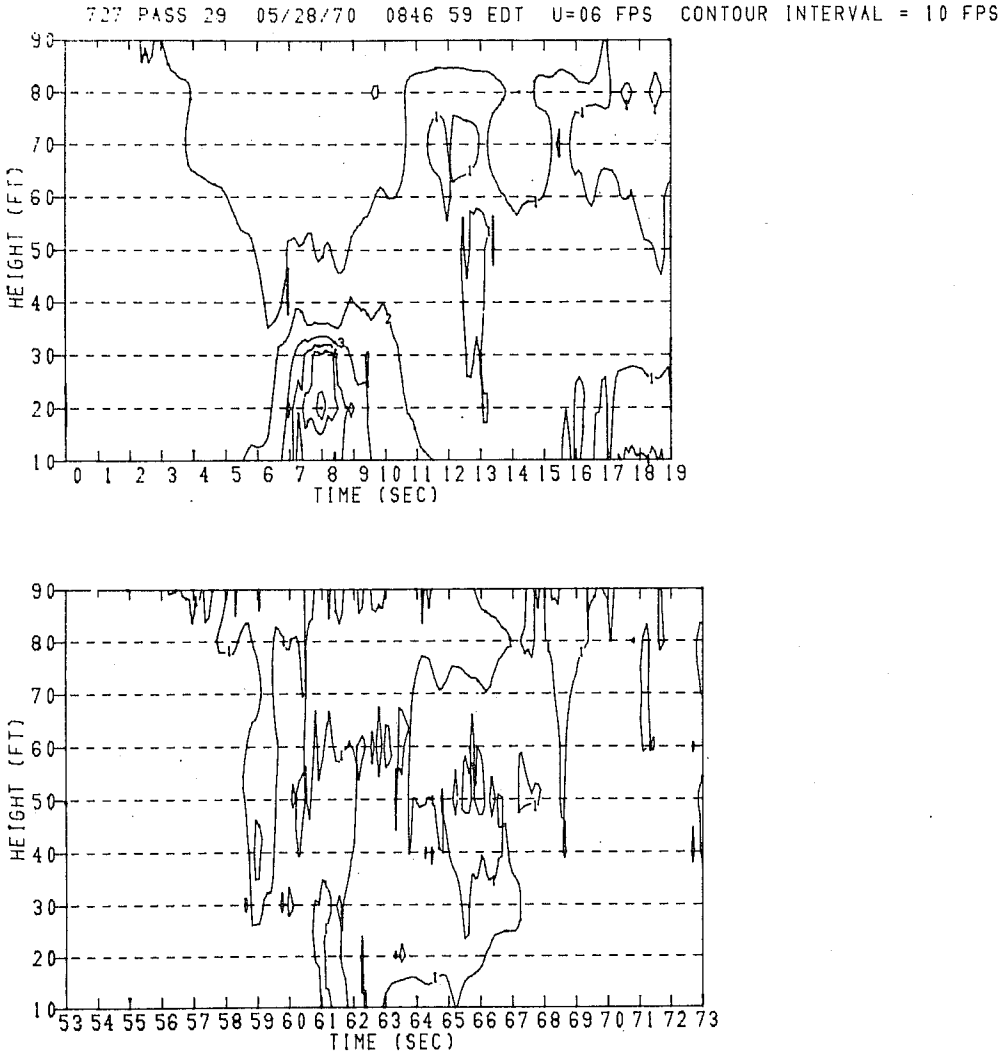
727 PASS 28 05/28/70 0841 23 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS



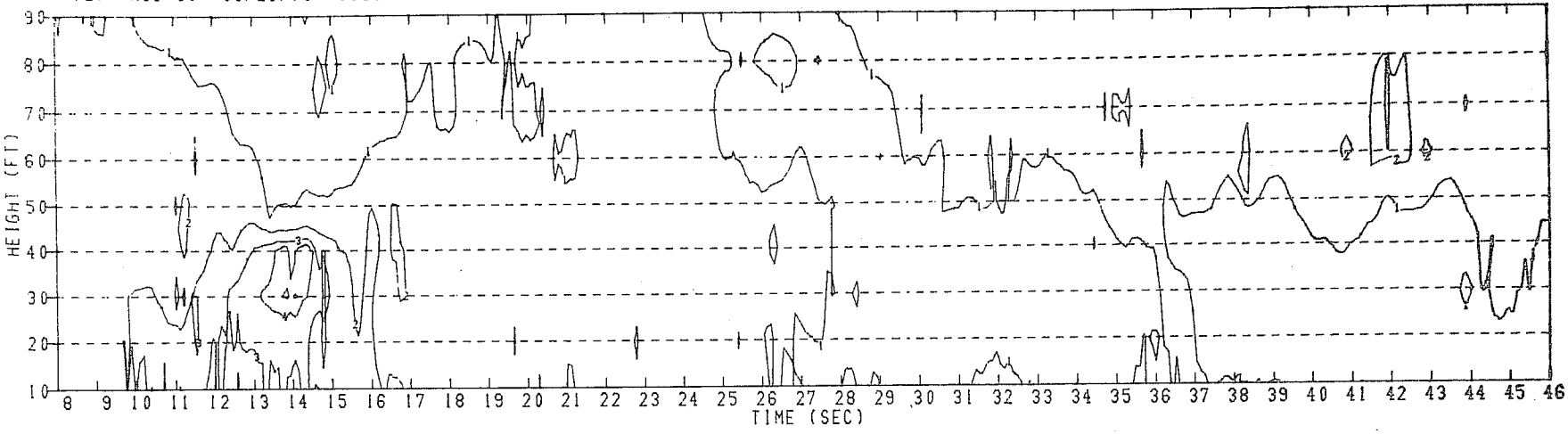


727 PASS 29 05/28/70 0846 59 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS

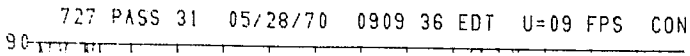



727 PASS 29 05/28/70 0846 59 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
TIME (SEC)
HEIGHT (FT)
TIME (SEC)

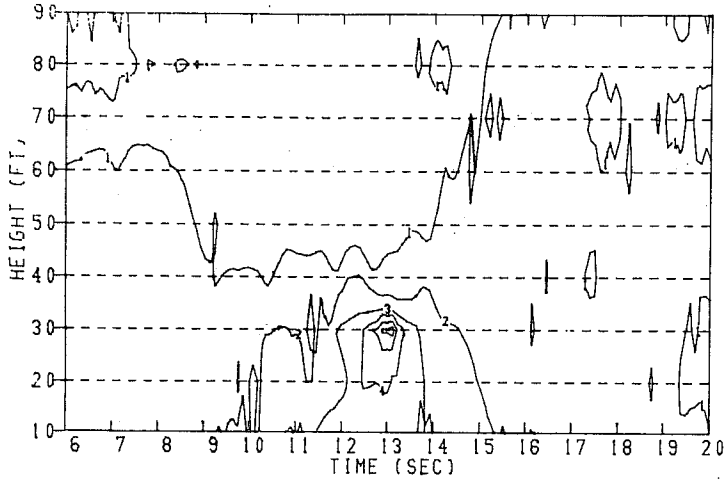
727 PASS 30 05/28/70 0901 21 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS

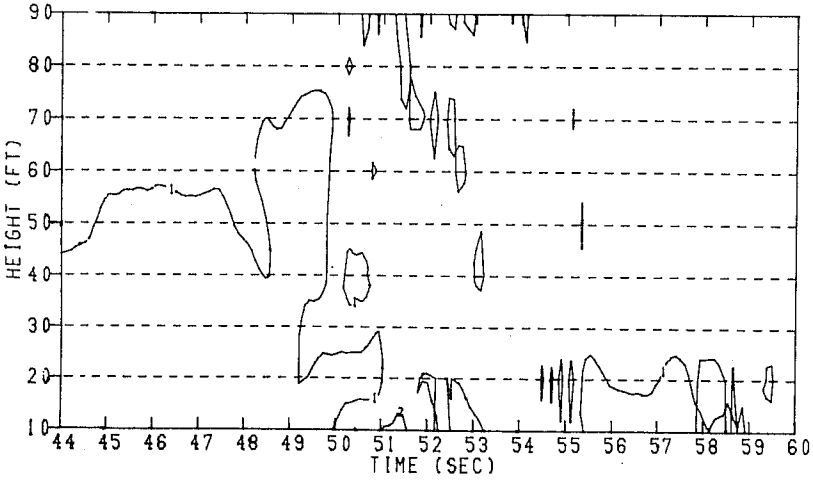


727 PASS 31 05/28/70 0909 36 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

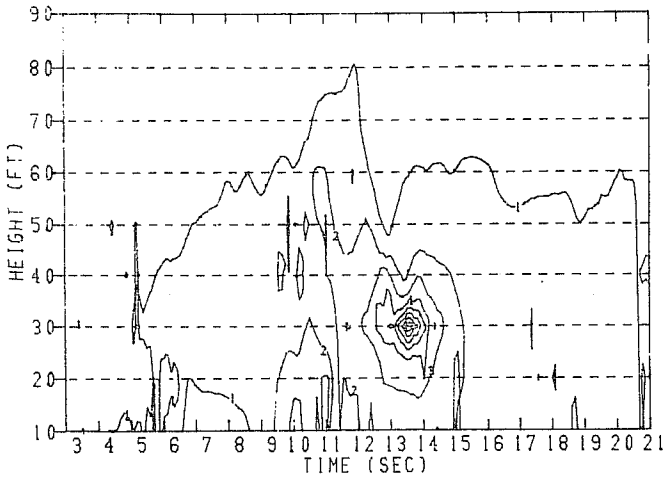


727 PASS 31 05/28/70 0909 36 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS



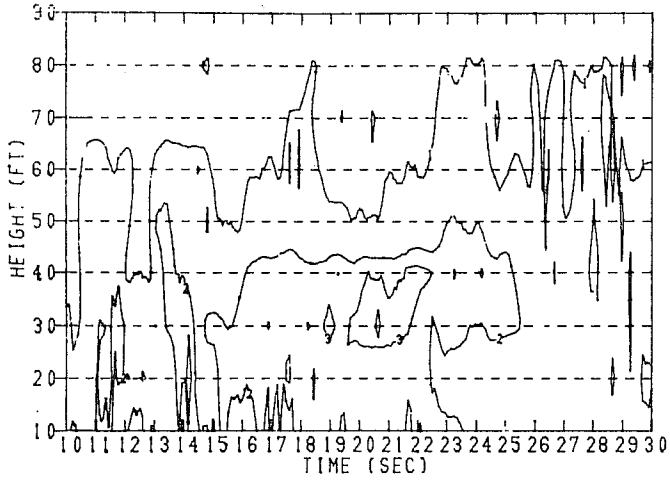


727 PASS 32 05/28/70 0917 06 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS

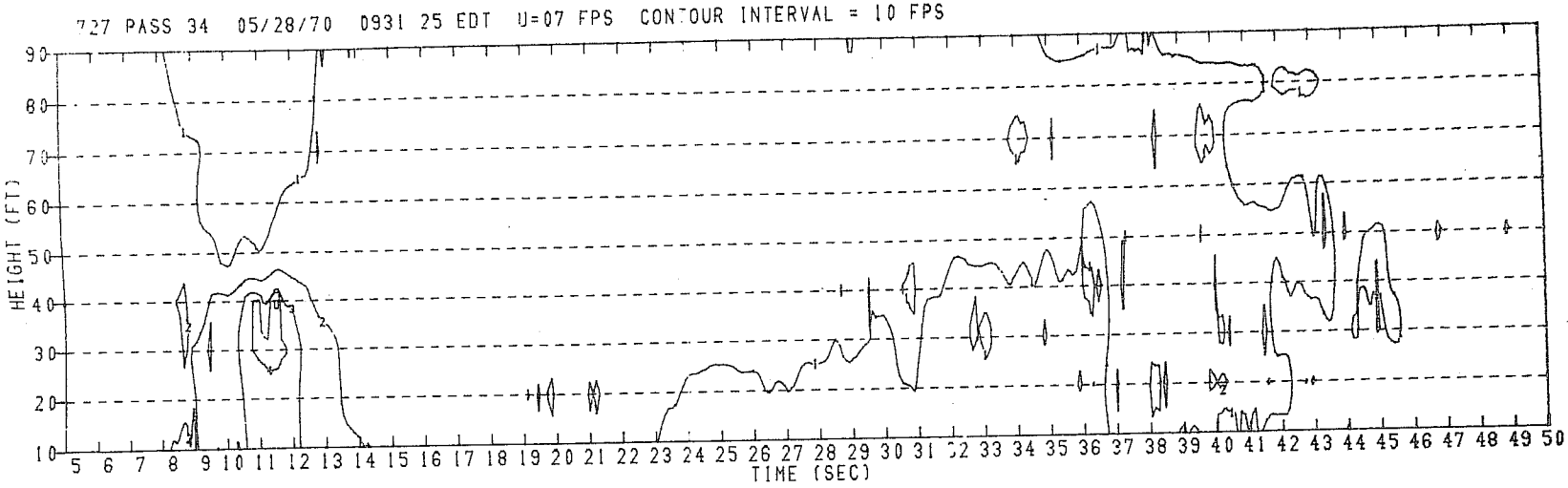


727 PASS 33 05/28/70 0924 14 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS

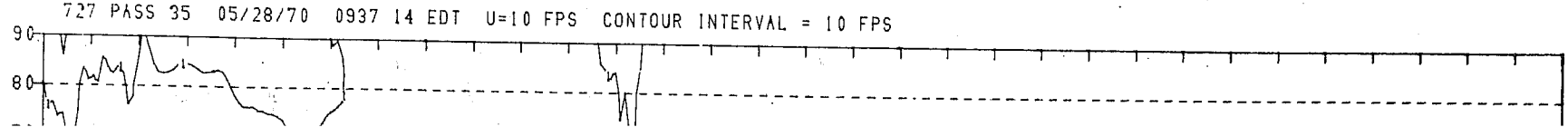
727 PASS 33 05/28/70 0924 14 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS

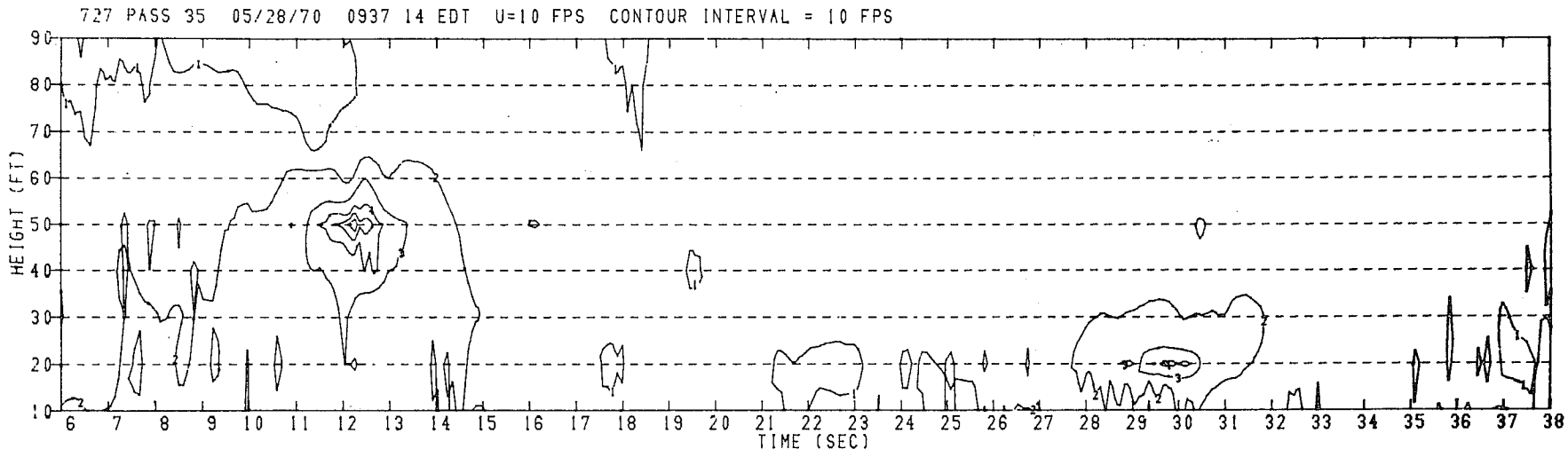


727 PASS 34 05/28/70 0931 25 EDT U=07 FPS CONTOUR INTERVAL = 10 FPS

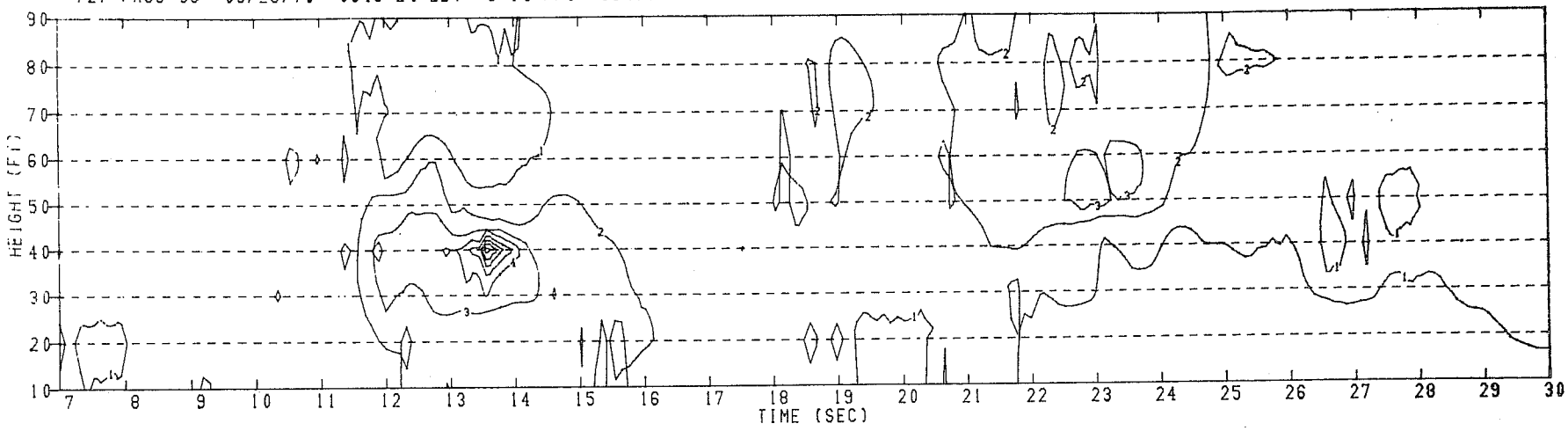


727 PASS 35 05/28/70 0937 14 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS

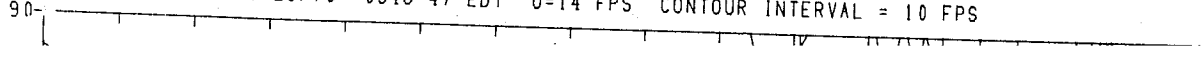



727 PASS 35 05/28/70 0937 14 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
TIME (SEC)

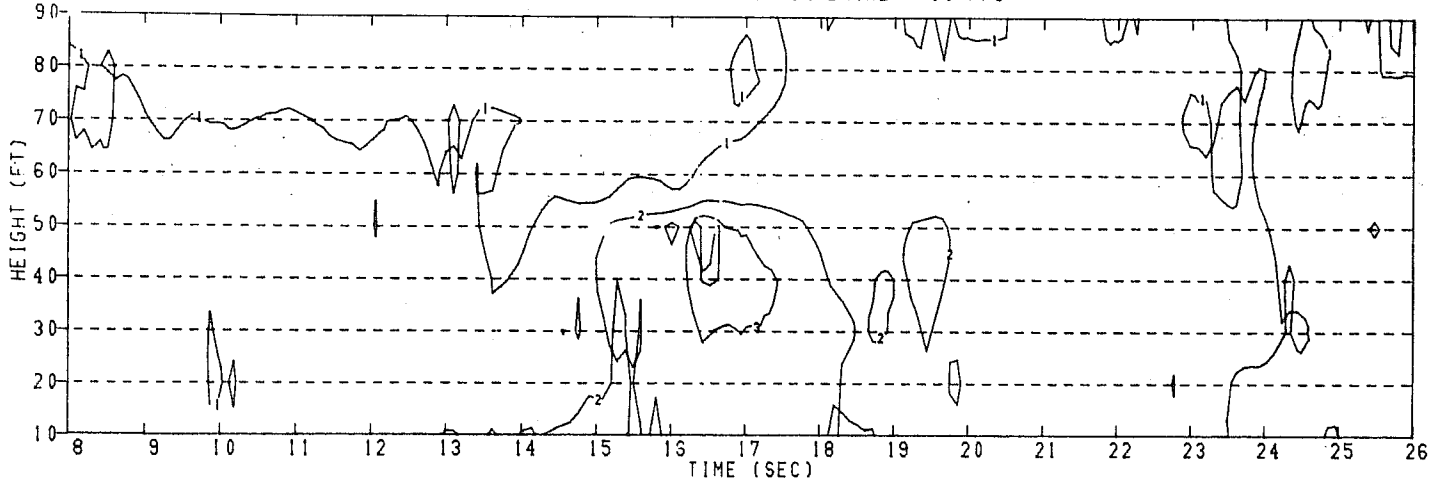
727 PASS 36 05/28/70 0943 24 EDT U=14 FPS CONTOUR INTERVAL = 10 FPS

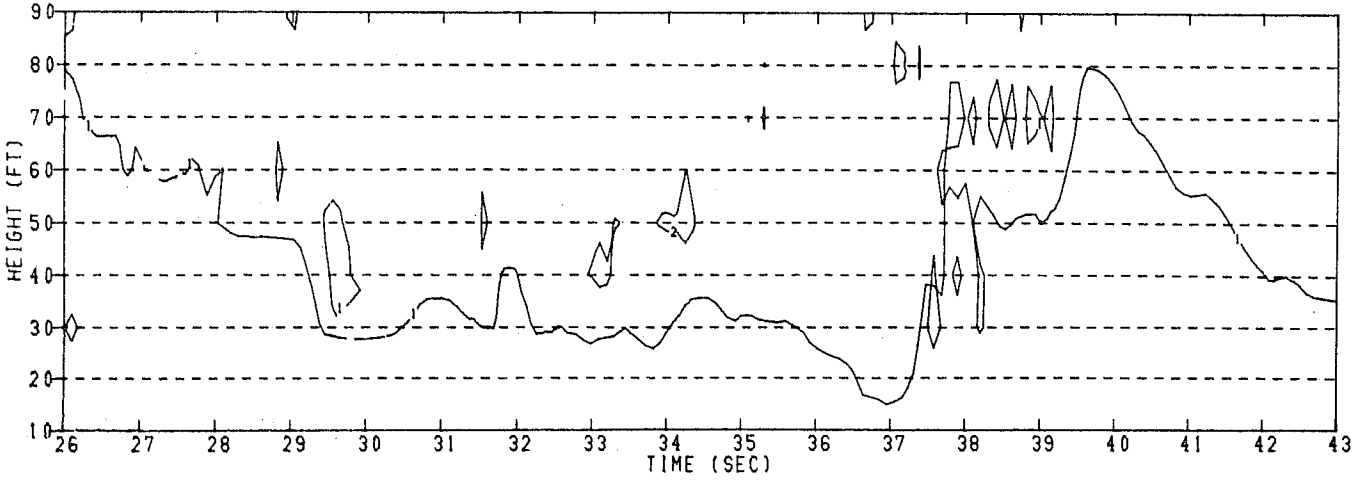


727 PASS 37 05/28/70 0948 47 EDT U=14 FPS CONTOUR INTERVAL = 10 FPS

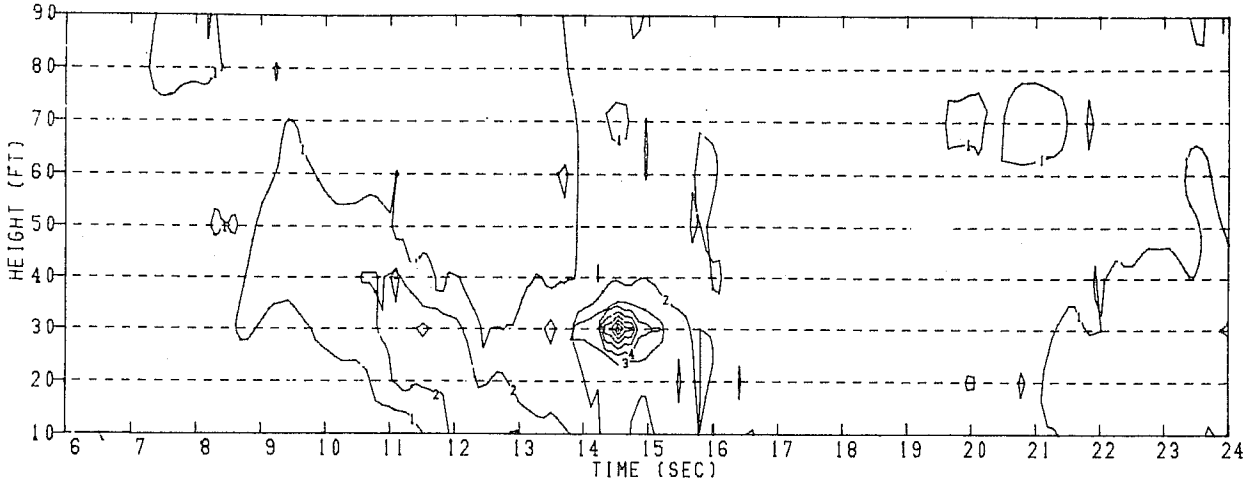


727 PASS 37 05/28/70 0948 47 EDT U=14 FPS CONTOUR INTERVAL = 10 FPS

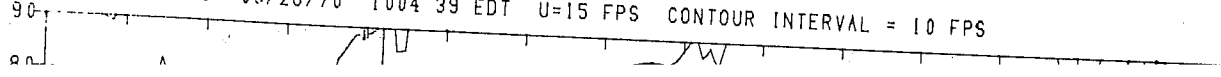


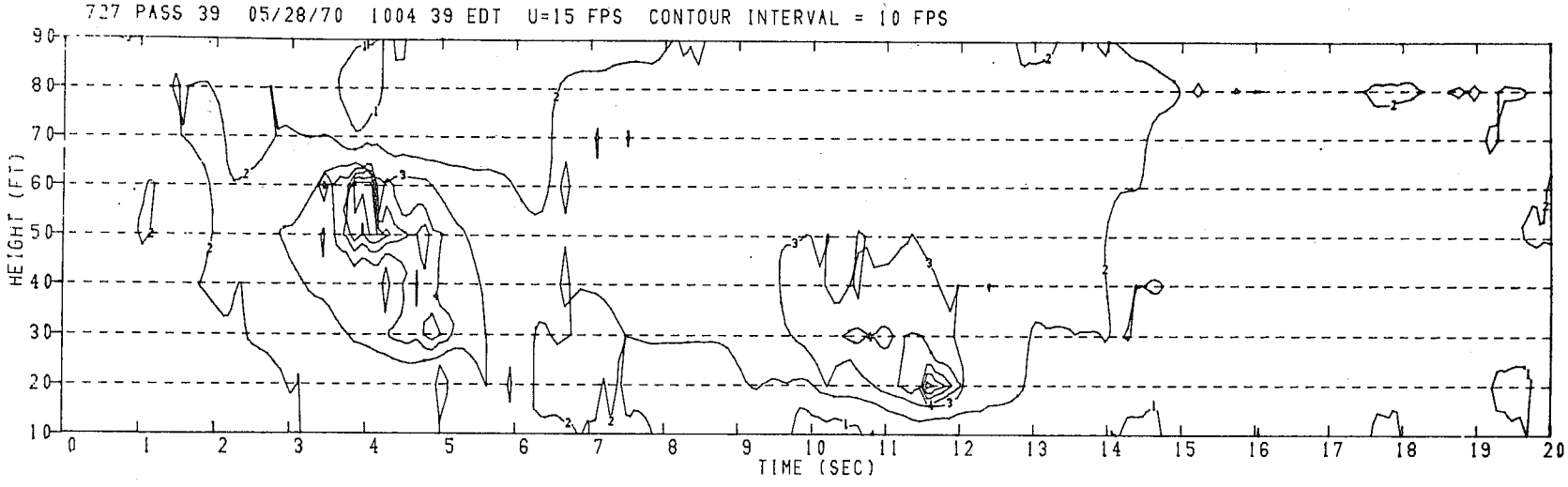


727 PASS 38 05/28/70 0955 25 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS

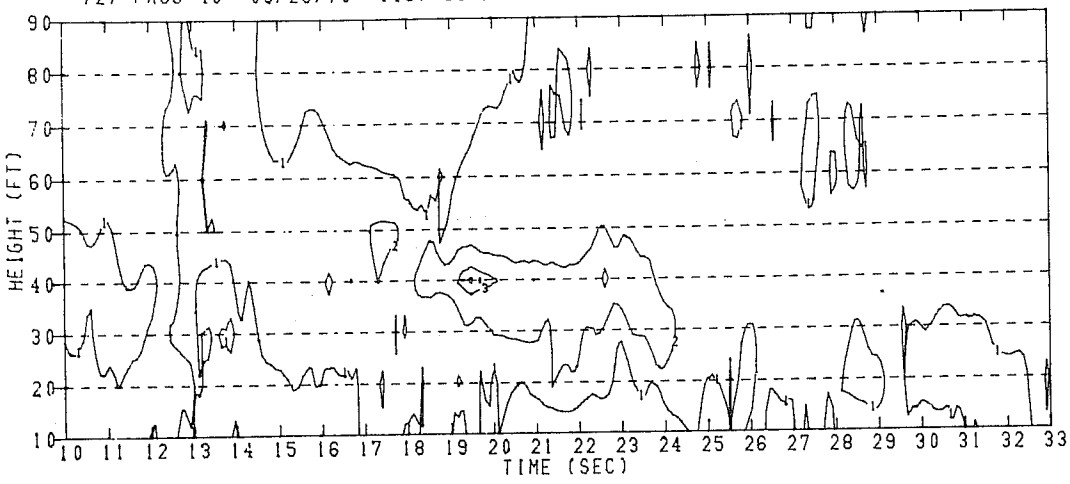


727 PASS 39 05/28/70 1004 39 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS

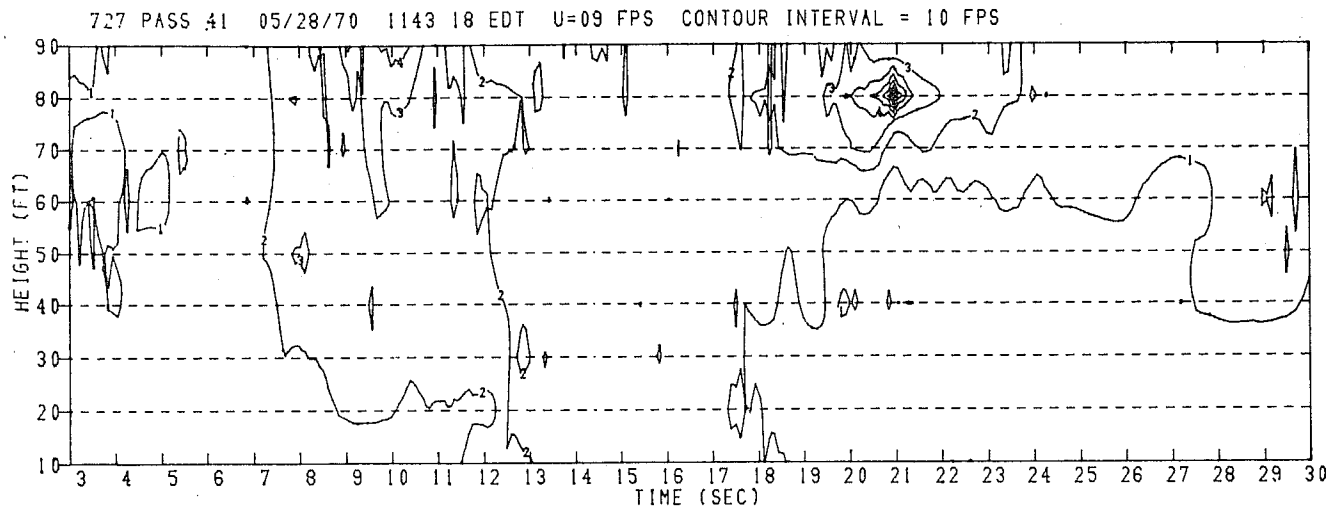



727 PASS 39 05/28/70 1004 39 EDT U=15 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
TIME (SEC)

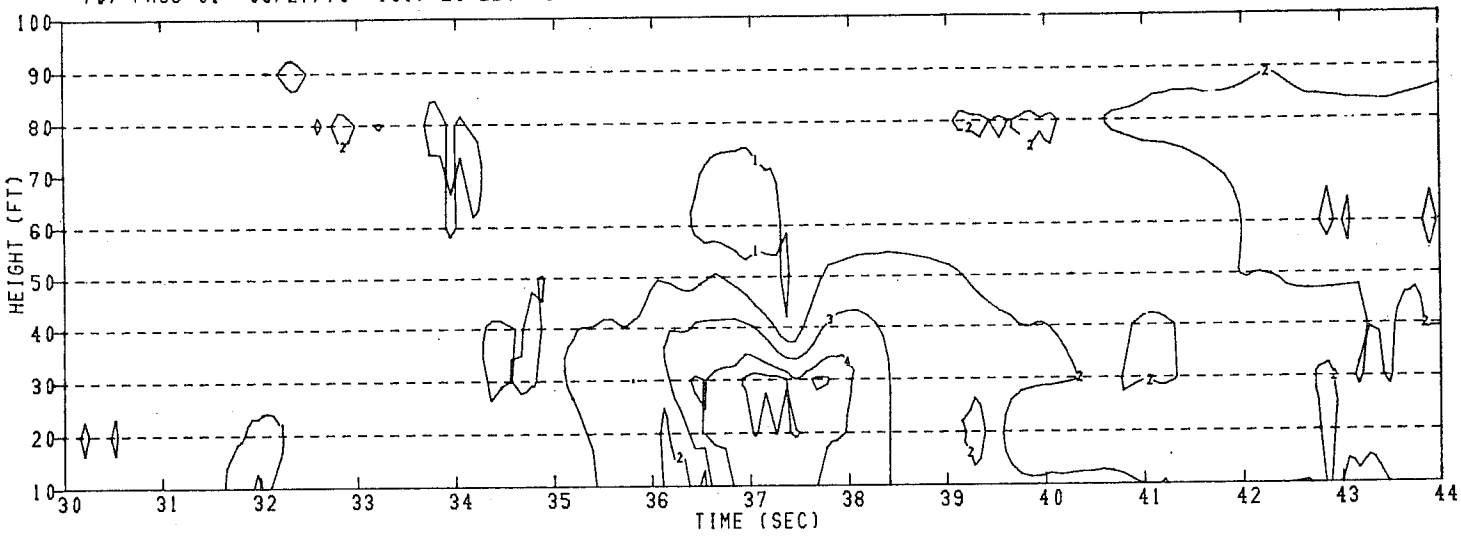
727 PASS 40 05/28/70 1137 35 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS



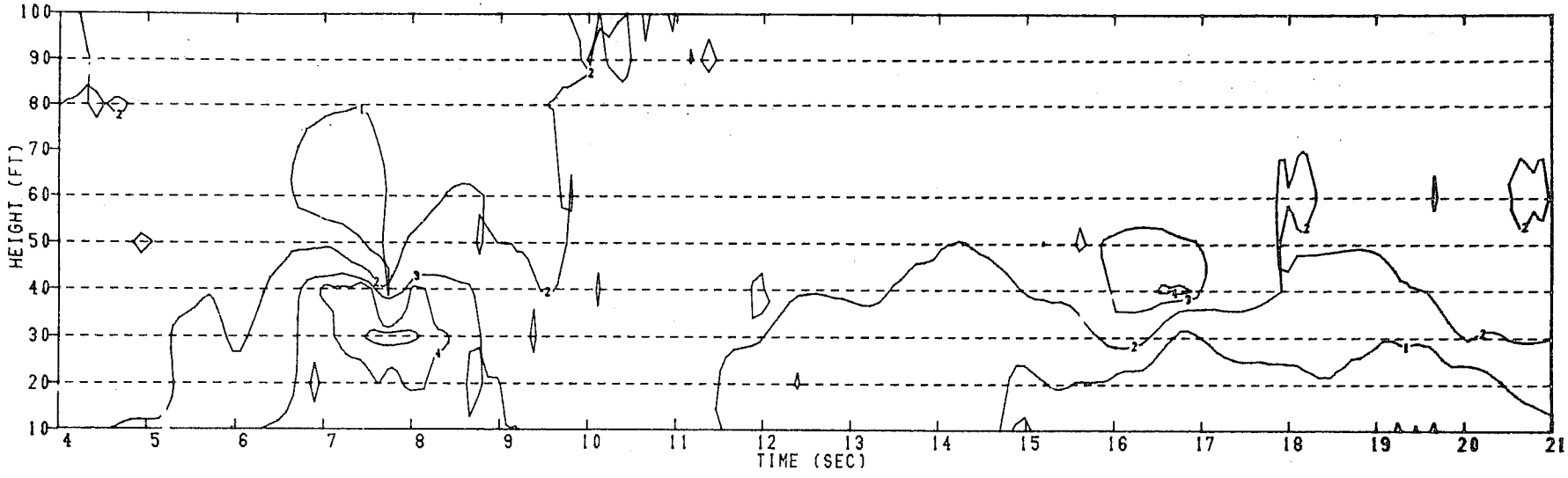
727 PASS 41 05/28/70 1143 18 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS


727 PASS 41 05/28/70 1143 18 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
TIME (SEC)

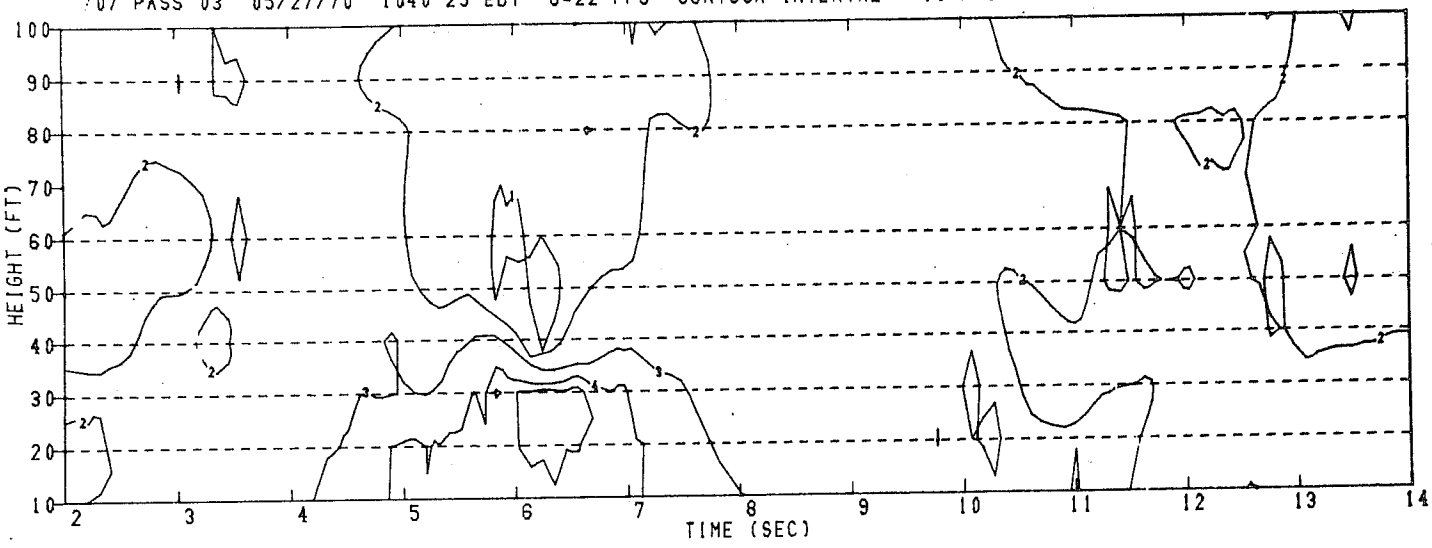
707 PASS 01 05/27/70 1017 20 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS

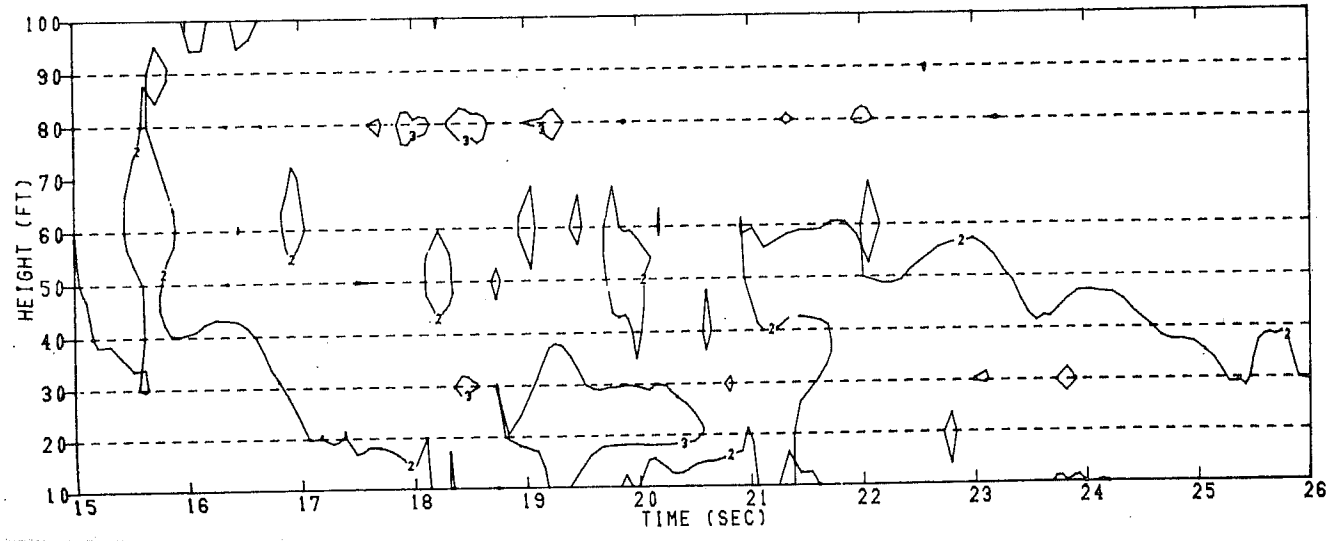


707 PASS 02 05/27/70 1029 33 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS

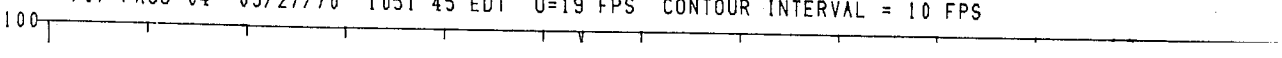


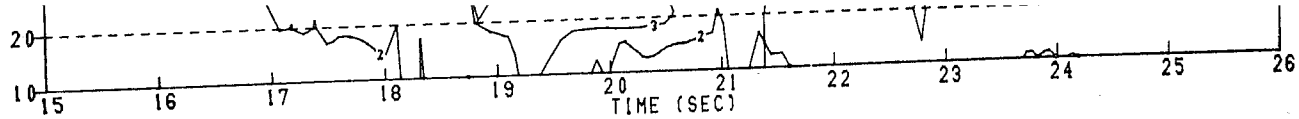
707 PASS 03 05/27/70 1040 25 EDT U=22 FPS CONTOUR INTERVAL = 10 FPS



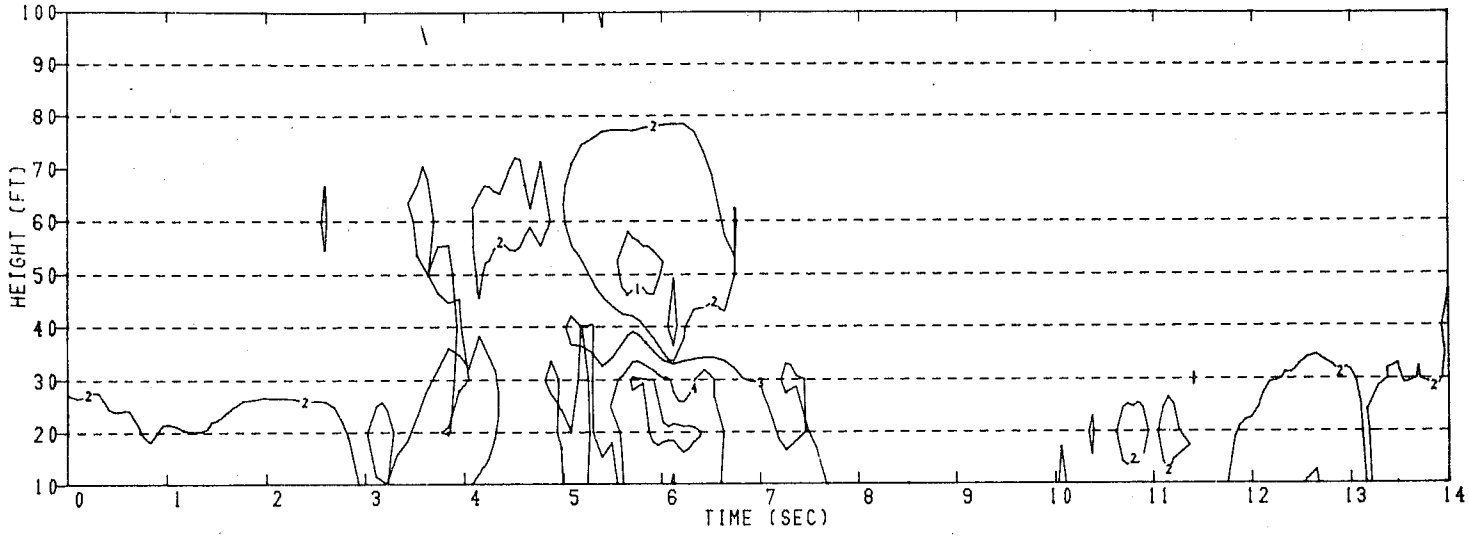


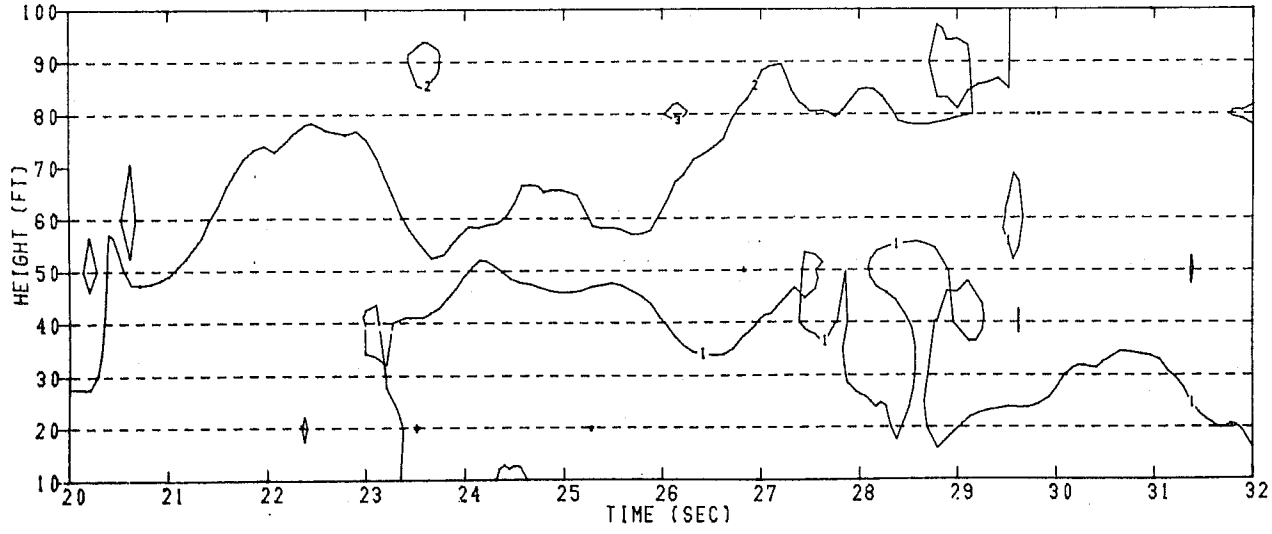
707 PASS 04 05/27/70 1051 45 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS



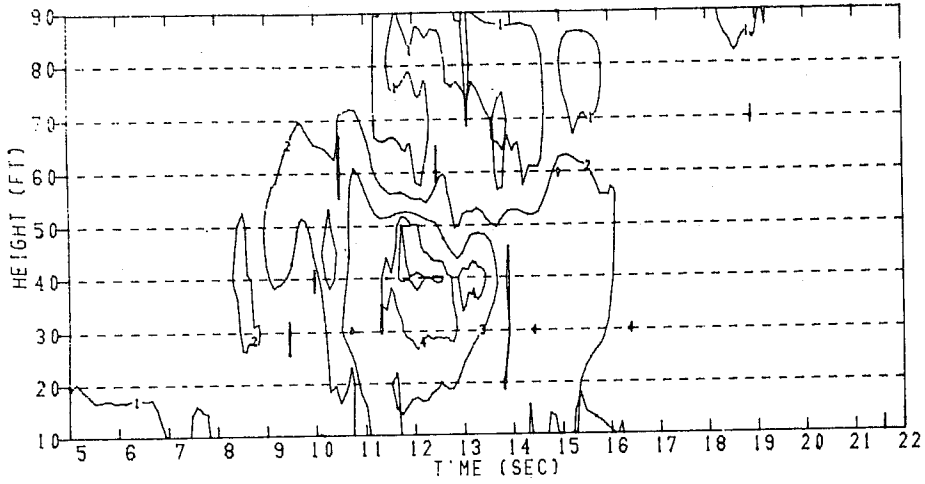


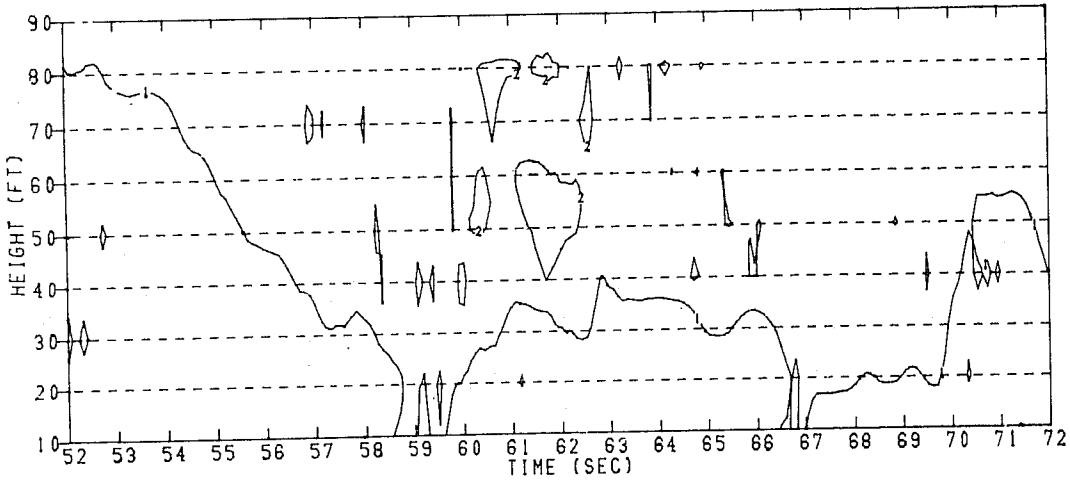
707 PASS 04 05/27/70 1051 45 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS



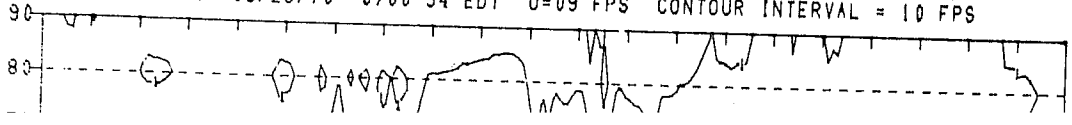


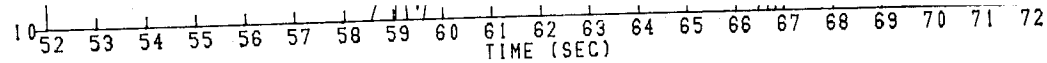
707 PASS 05 05/28/70 0654 42 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

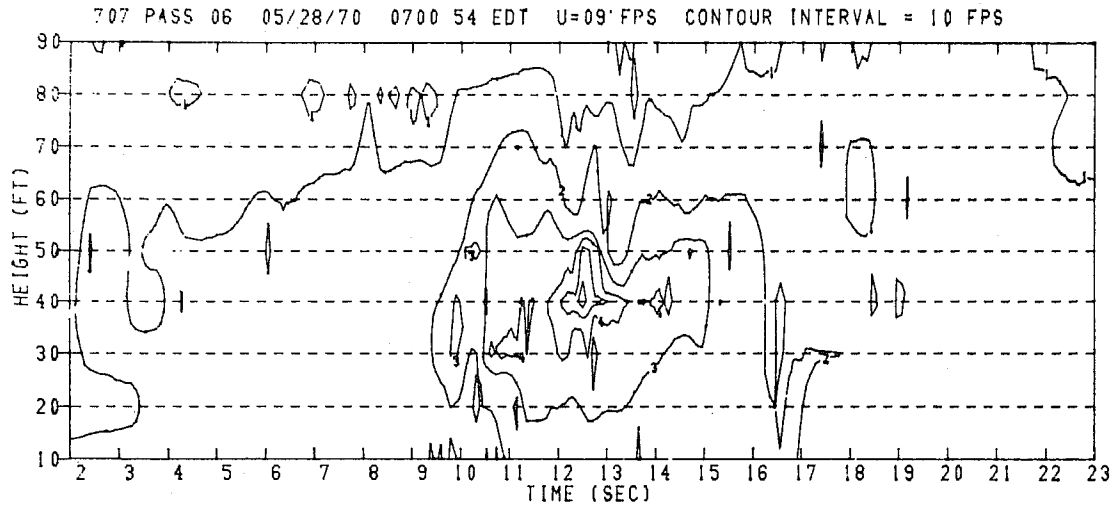




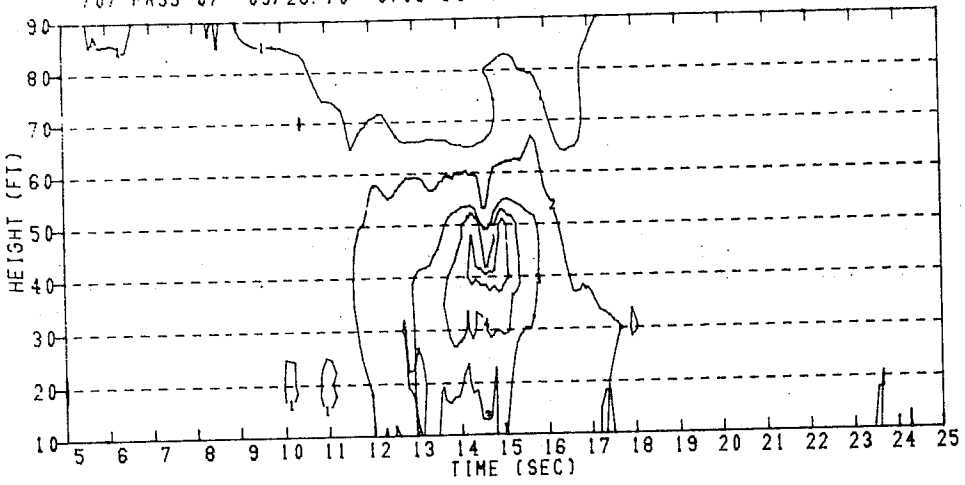
707 PASS 06 05/28/70 0700 54 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

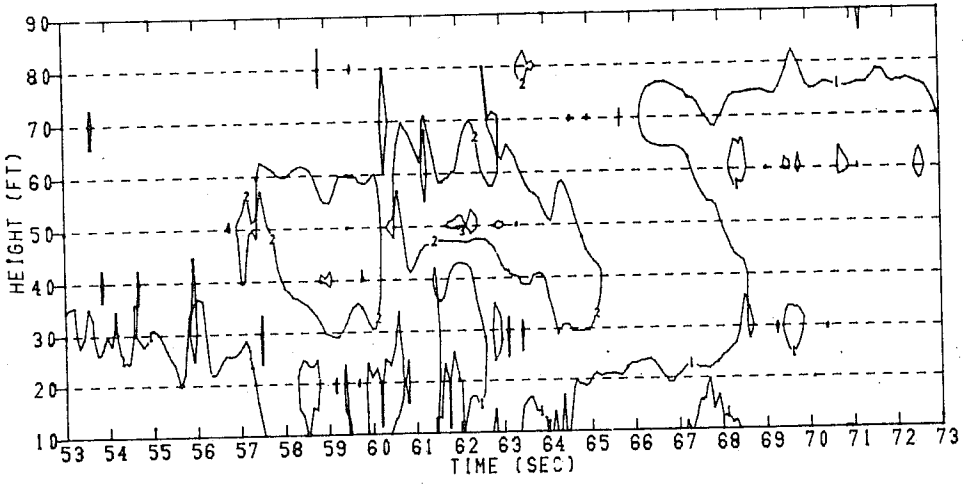



10
52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
TIME (SEC)


707 PASS 06 05/28/70 0700 54 EDT U=09' FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
TIME (SEC)

707 PASS 07 05/28/70 0706 34 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS

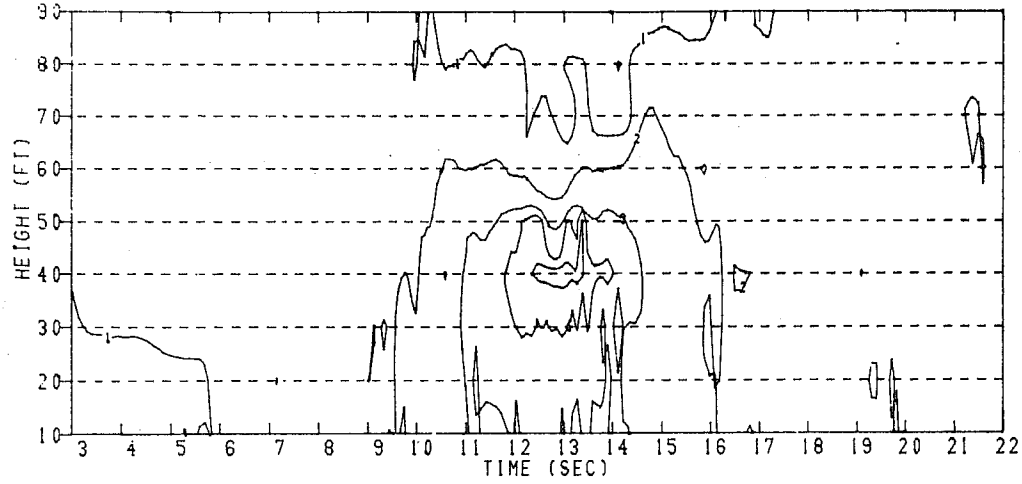


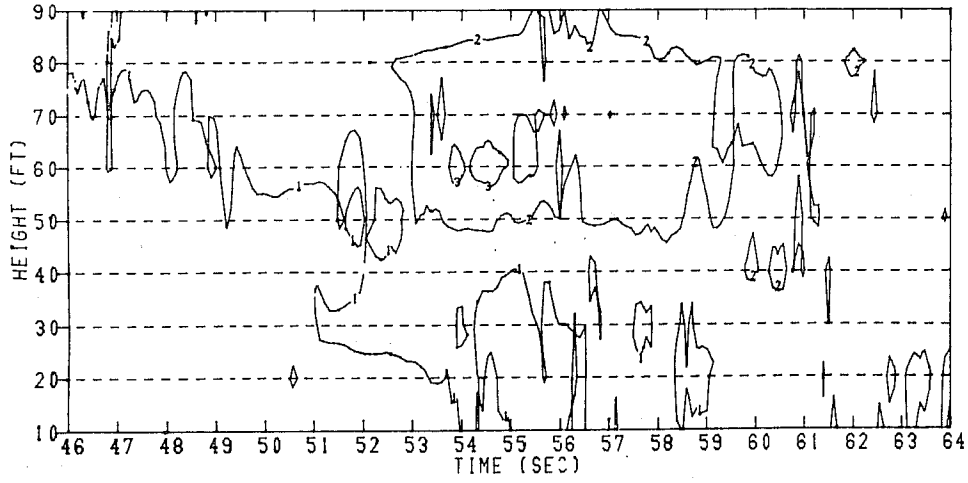


707 PASS 08 05/28/70 0712 43 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

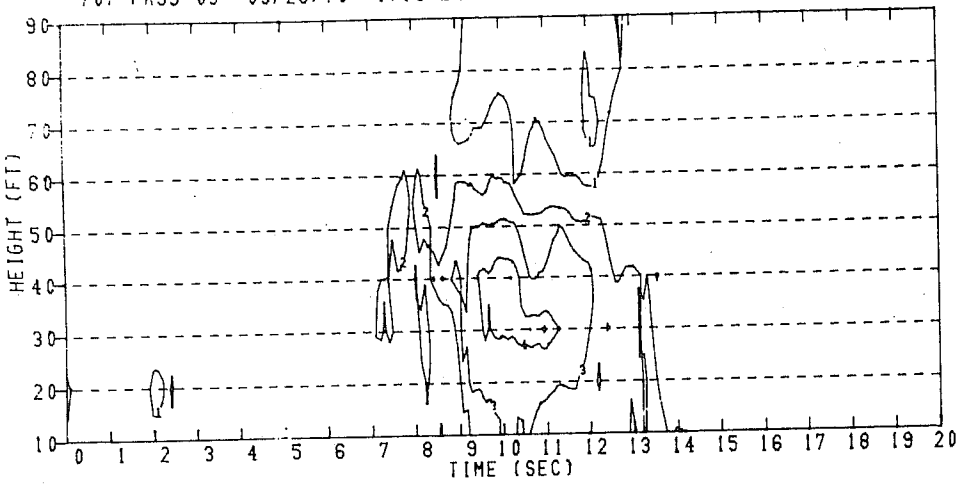
53 54 55 56 57 58 59 60 61 TIME (SEC)

707 PASS 08 05/28/70 0712 43 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS





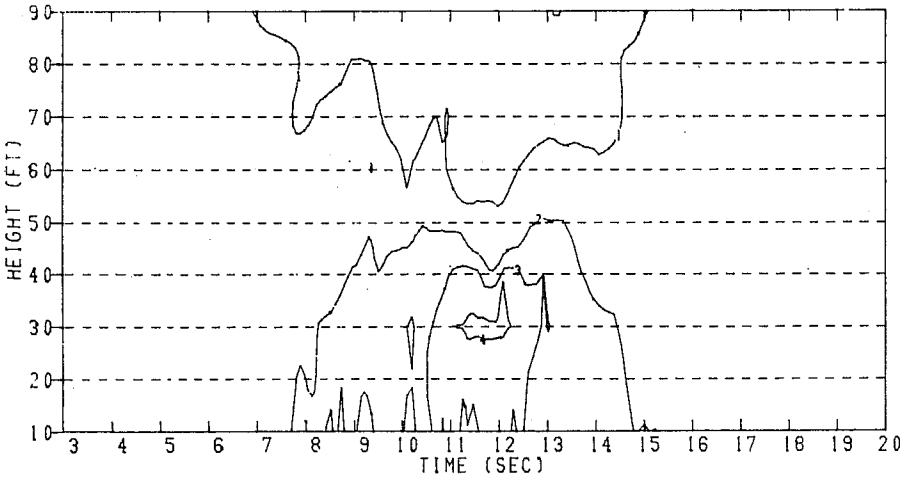
707 PASS 09 05/28/70 0718 24 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS

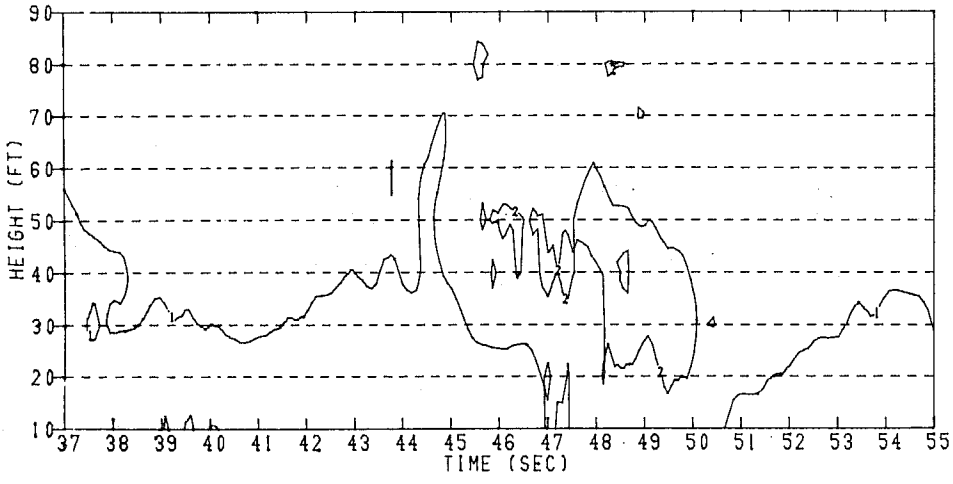


707 PASS 10 05/28/70 0858 49 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

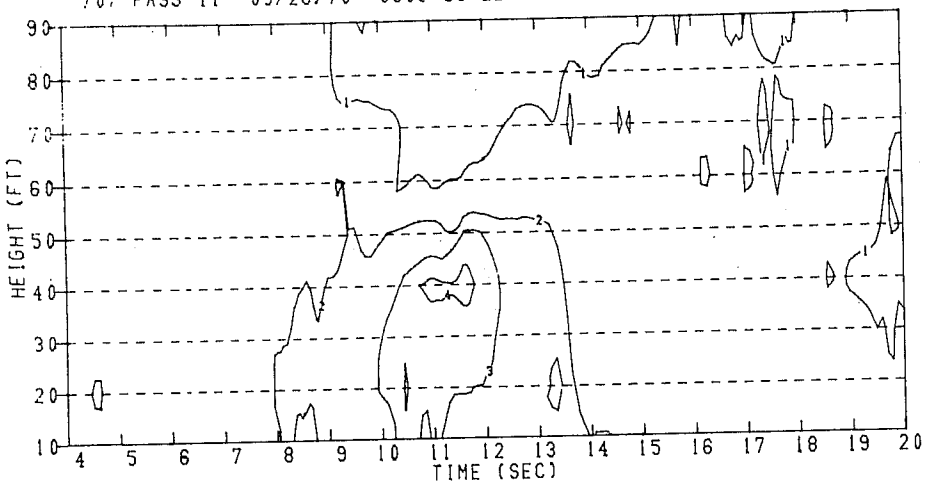
90

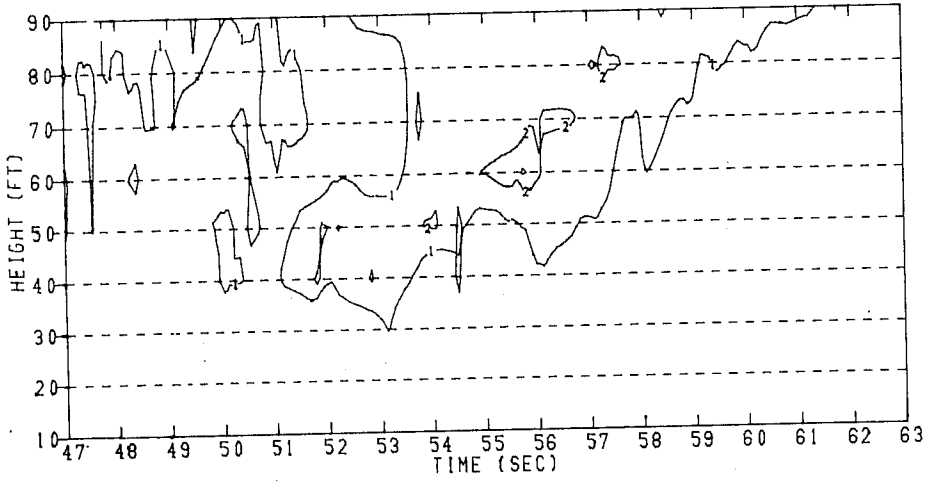
707 PASS 10 05/28/70 0858 49 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

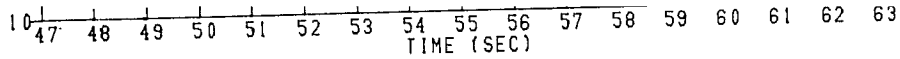


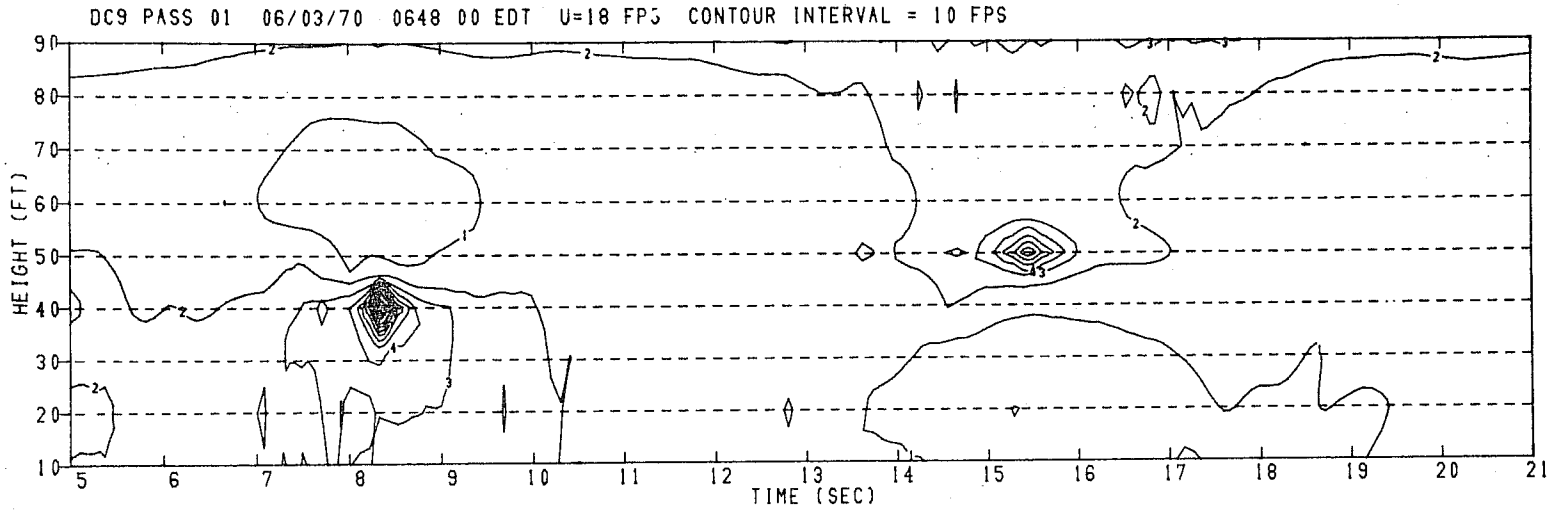


707 PASS 11 05/28/70 0906 36 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS






10
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63
TIME (SEC)


DC9 PASS 01 06/03/70 0648 00 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
80
70
60
50
40
30
20
10
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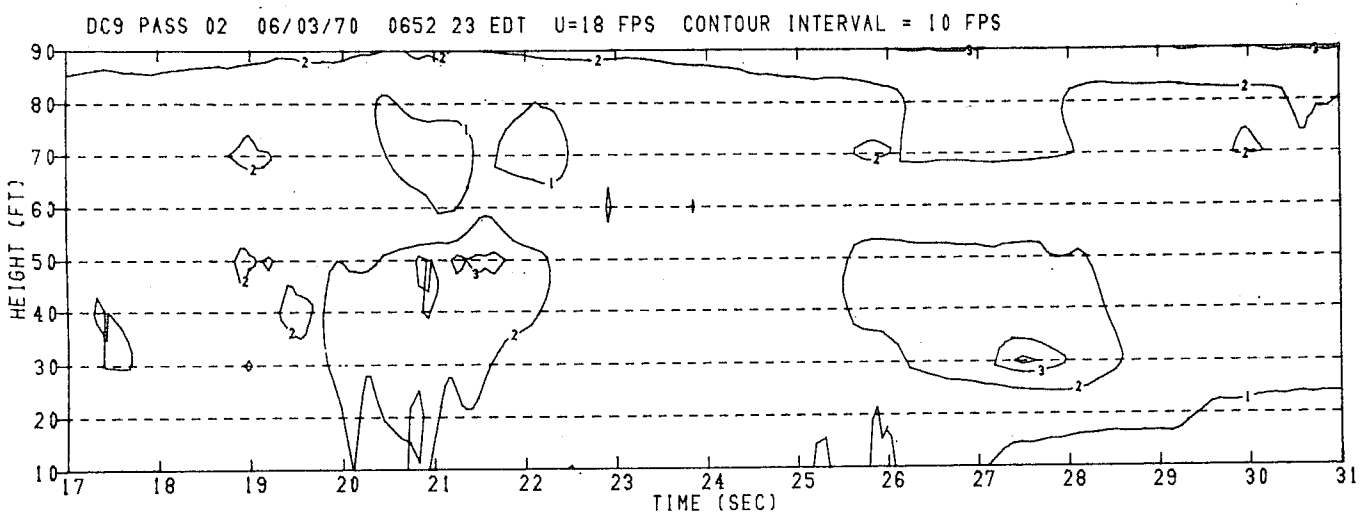
TIME (SEC)


DC9 PASS 02 06/03/70 0652 23 EDT U=18 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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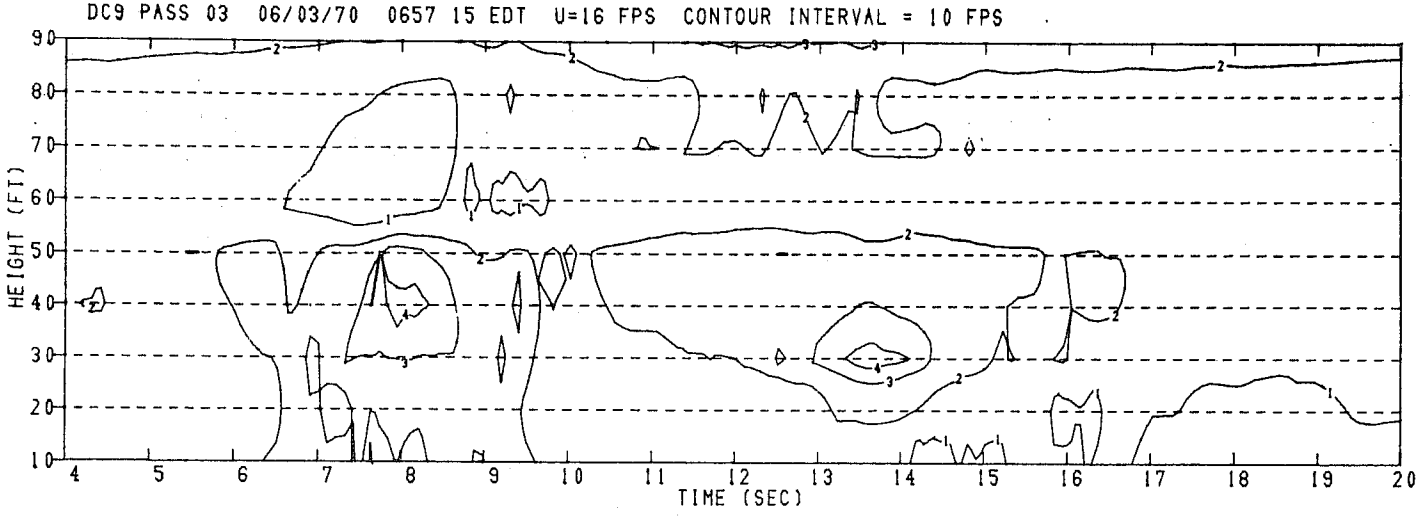
TIME (SEC)


DC9 PASS 03 06/03/70 0657 15 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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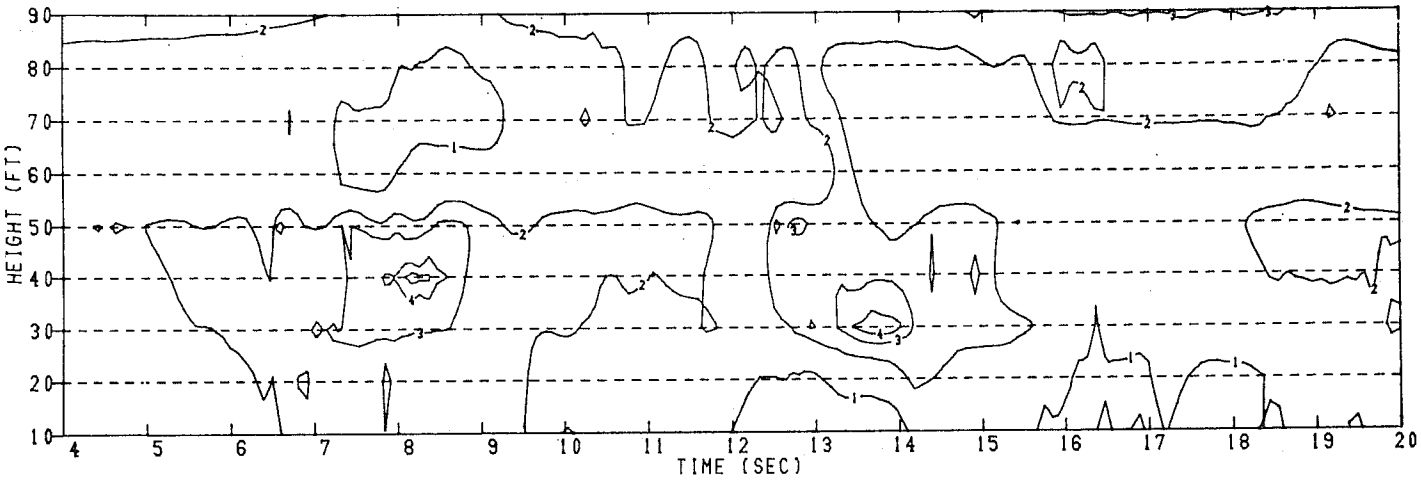
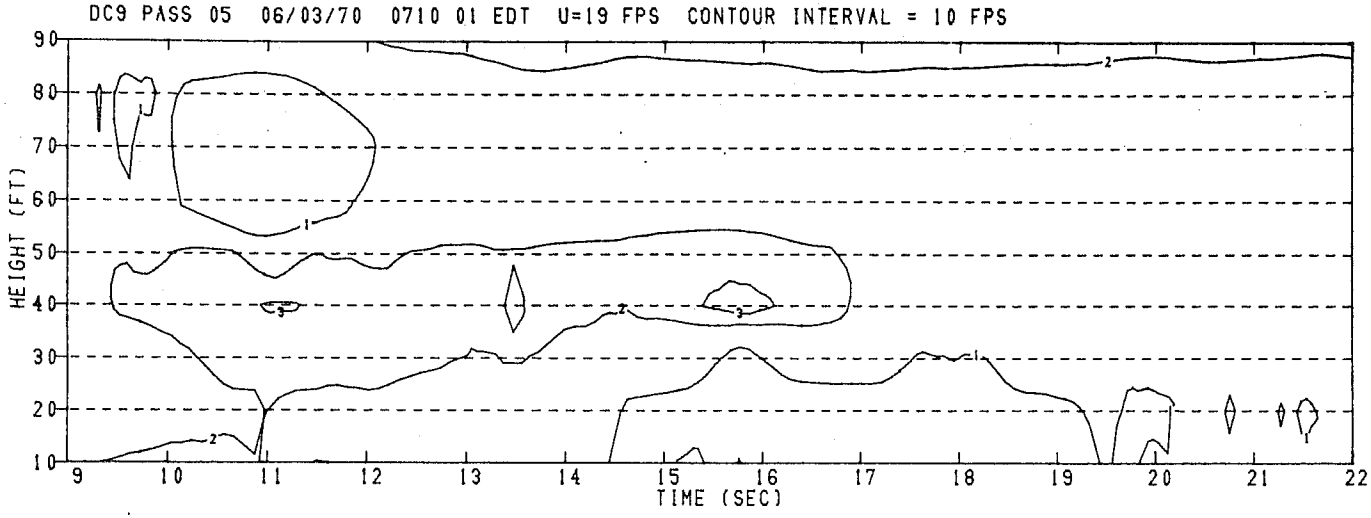
TIME (SEC)

DC9 PASS 04 06/03/70 0704 24 EDT U=16 FPS CONTOUR INTERVAL = 10 FPS




DC9 PASS 05 06/03/70 0710 01 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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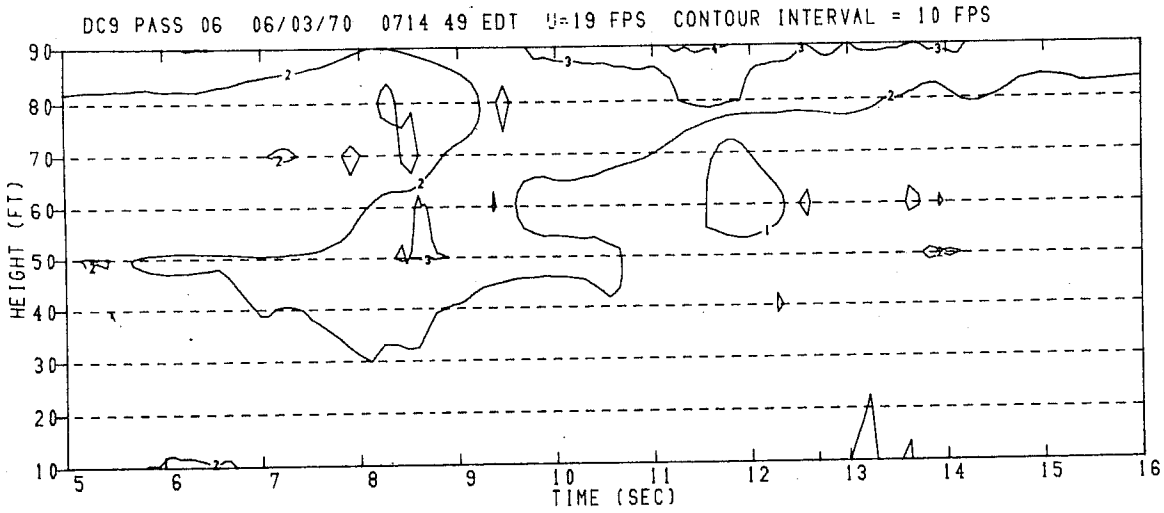
TIME (SEC)


DC9 PASS 06 06/03/70 0714 49 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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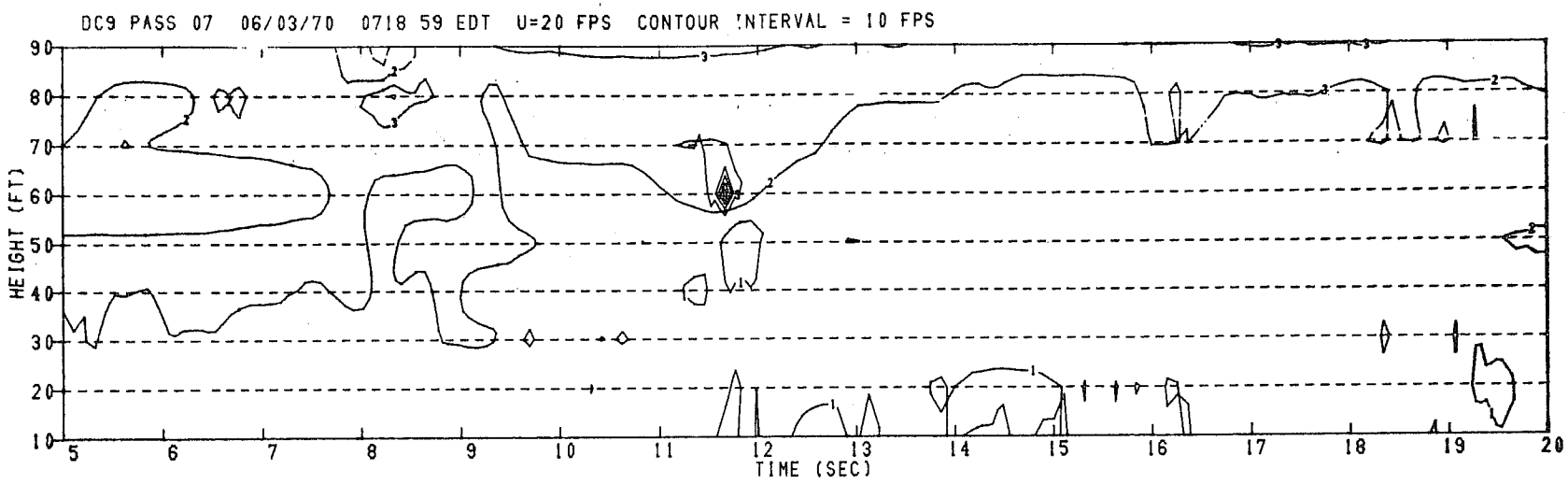
TIME (SEC)


DC9 PASS 07 06/03/70 0718 59 EDT U=20 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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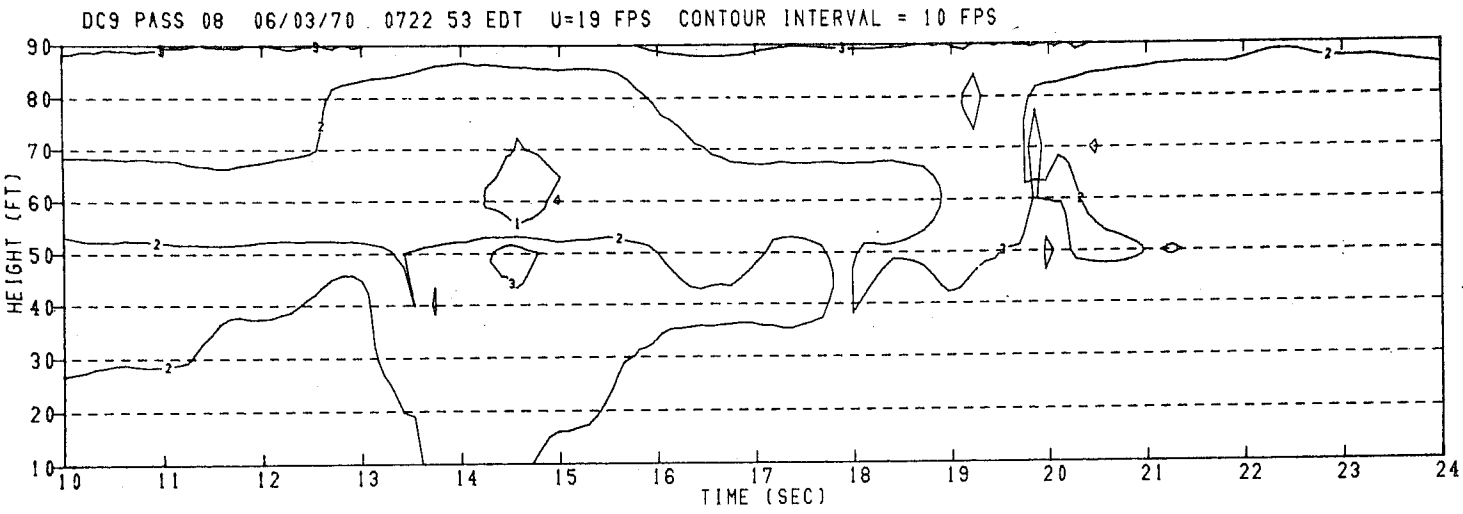
TIME (SEC)


DC9 PASS 08 06/03/70 0722 53 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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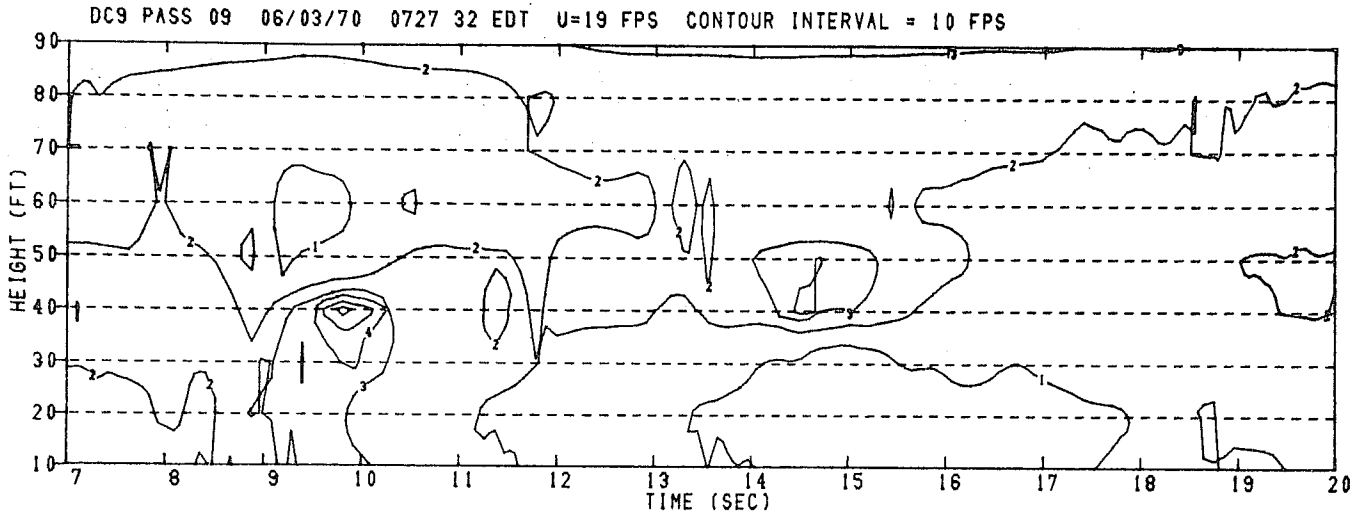
TIME (SEC)


DC9 PASS 09 06/03/70 0727 32 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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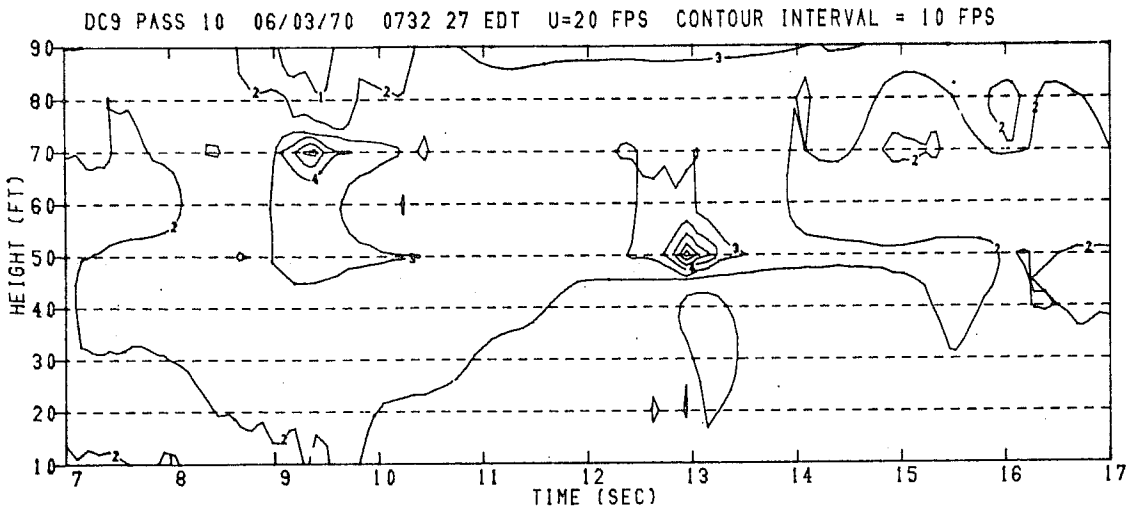
TIME (SEC)


DC9 PASS 10 06/03/70 0732 27 EDT U=20 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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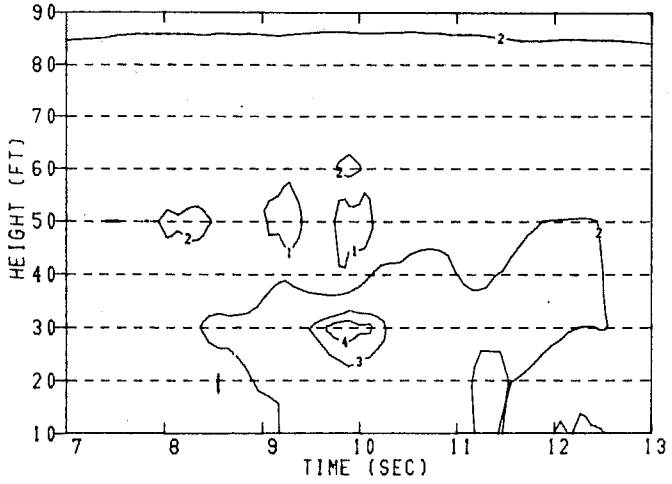
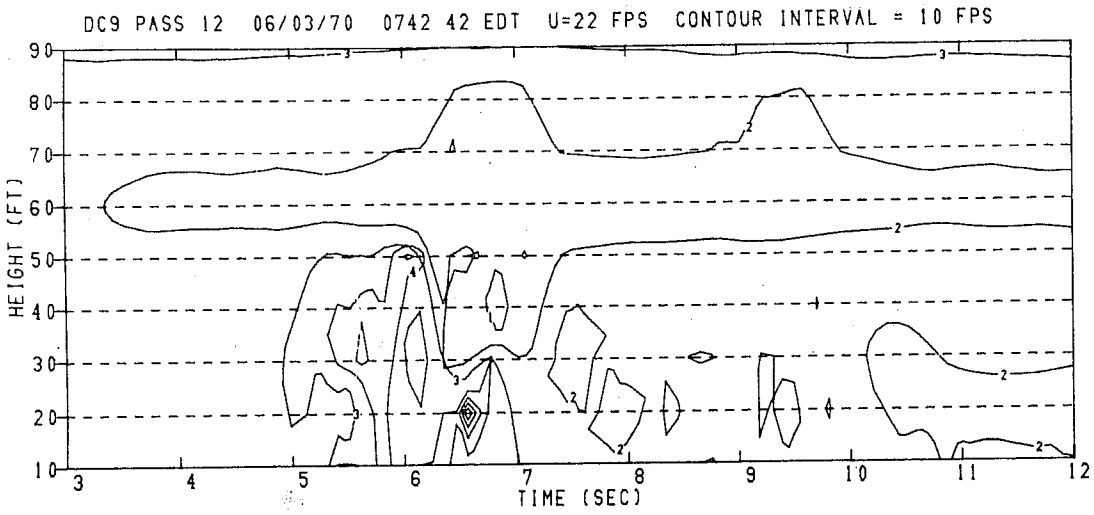
TIME (SEC)

DC9 PASS 11 06/03/70 0738 01 EDT U=19 FPS CONTOUR INTERVAL = 10 FPS




DC9 PASS 12 06/03/70 0742 42 EDT U=22 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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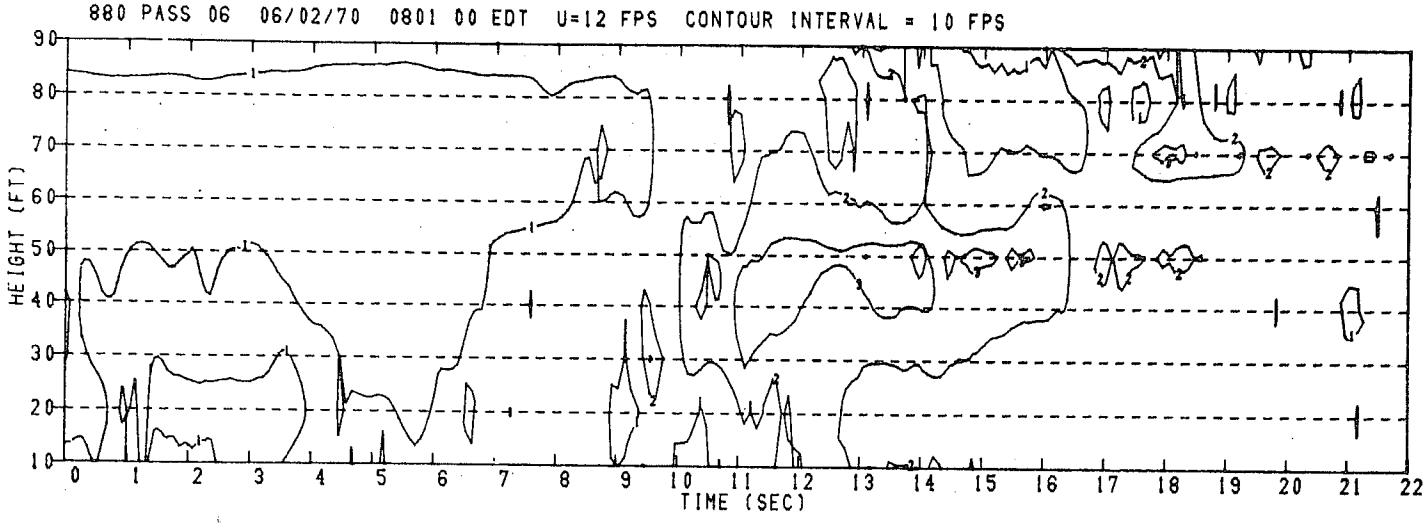
TIME (SEC)


880 PASS 06 06/02/70 0801 00 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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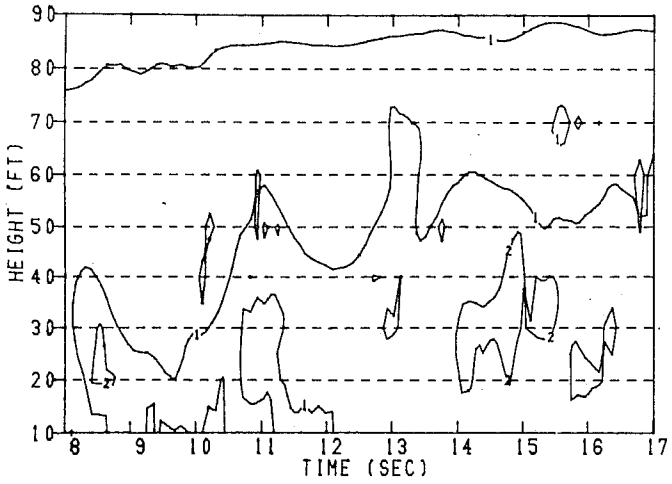
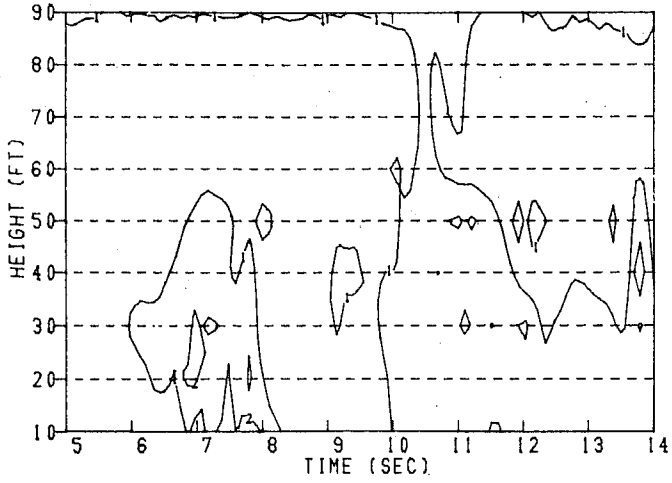
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
TIME (SEC)

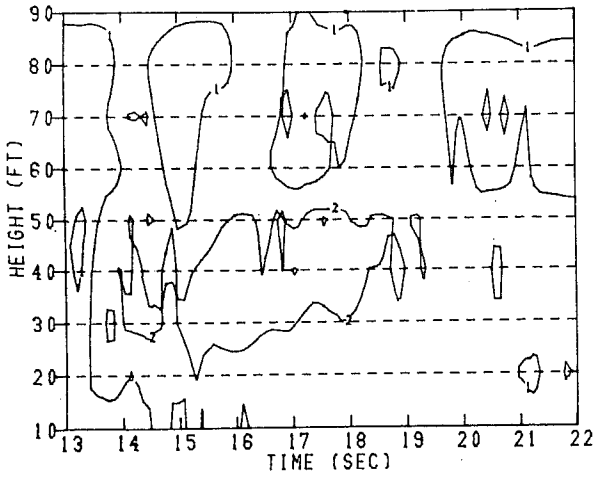
880 PASS 07 06/02/70 0811 13 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS



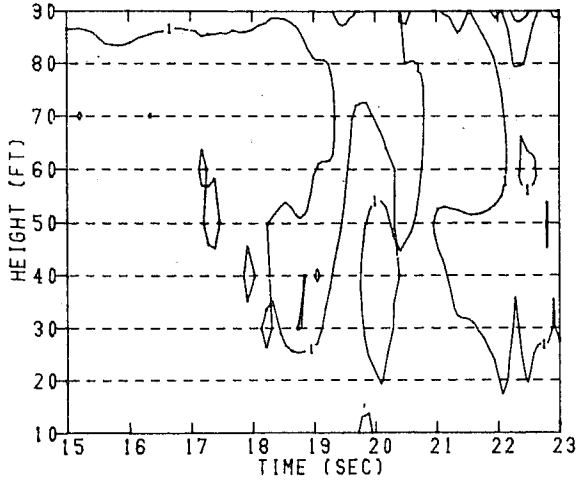
880 PASS 08 06/02/70 0818 33 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS

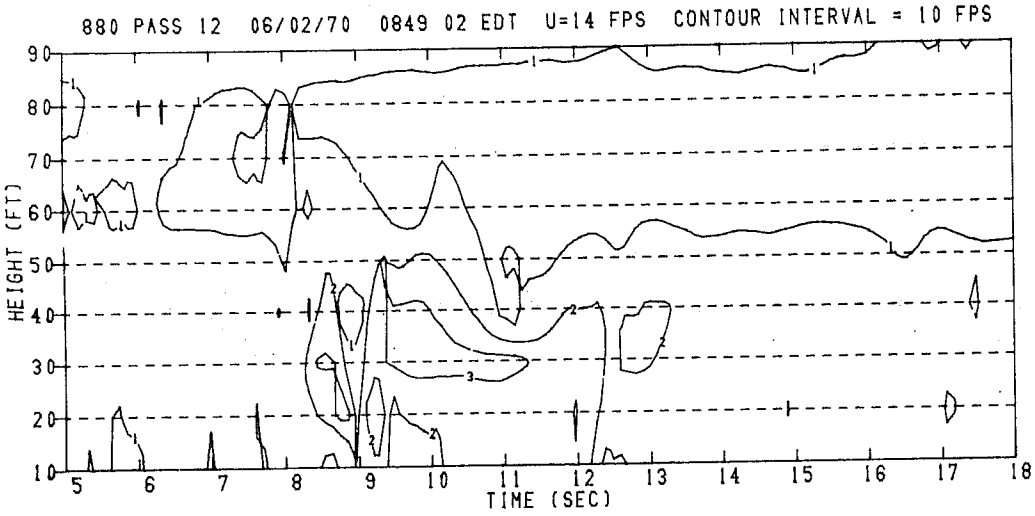


880 PASS 09 06/02/70 0830 27 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 10 06/02/70 0837 12 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 12 06/02/70 0849 02 EDT U=14 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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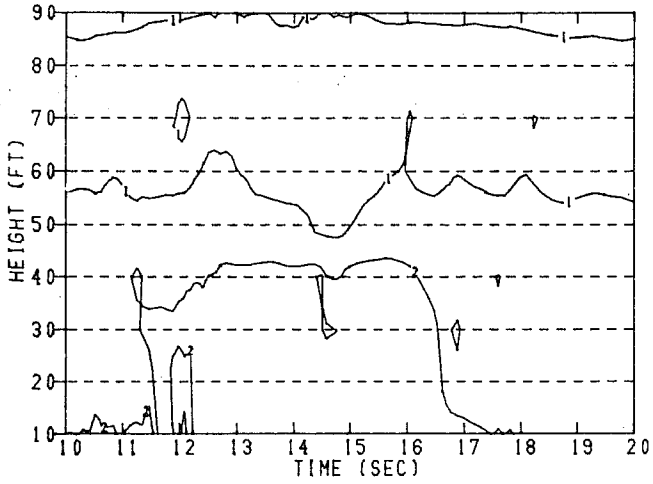
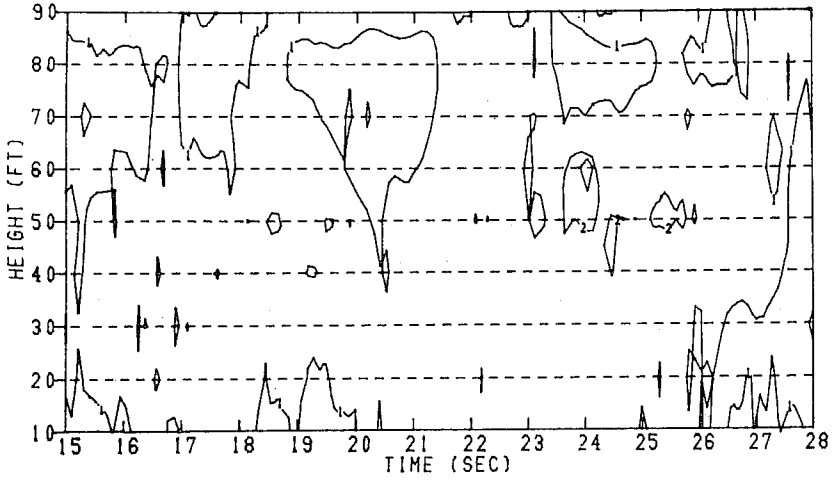
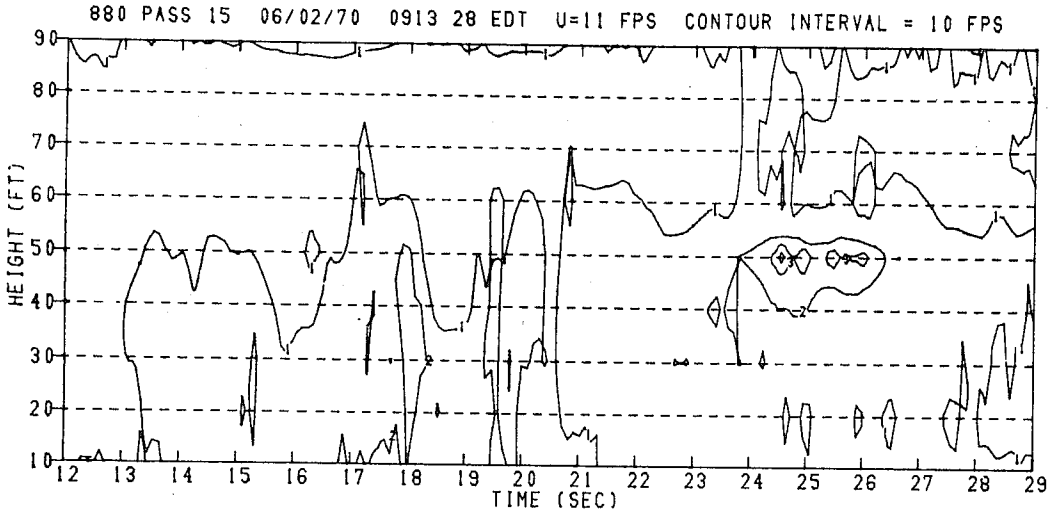
TIME (SEC)

880 PASS 13 06/02/70 0900 41 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 14 06/02/70 0906 56 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 15 06/02/70 0913 28 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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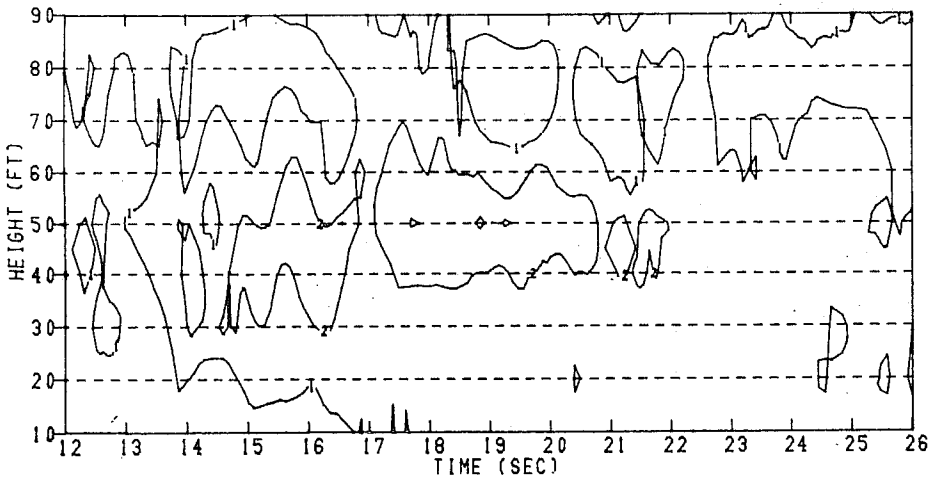
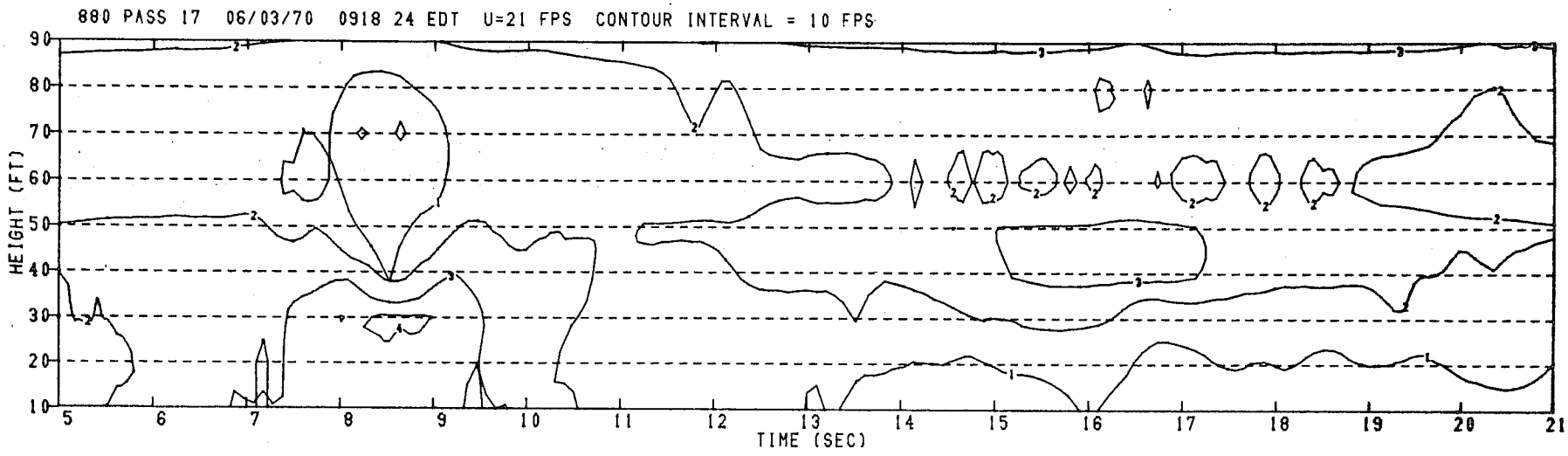
TIME (SEC)

880 PASS 16 06/02/70 0919 25 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 17 06/03/70 0918 24 EDT U=21 FPS CONTOUR INTERVAL = 10 FPS


880 PASS 17 06/03/70 0918 24 EDT U=21 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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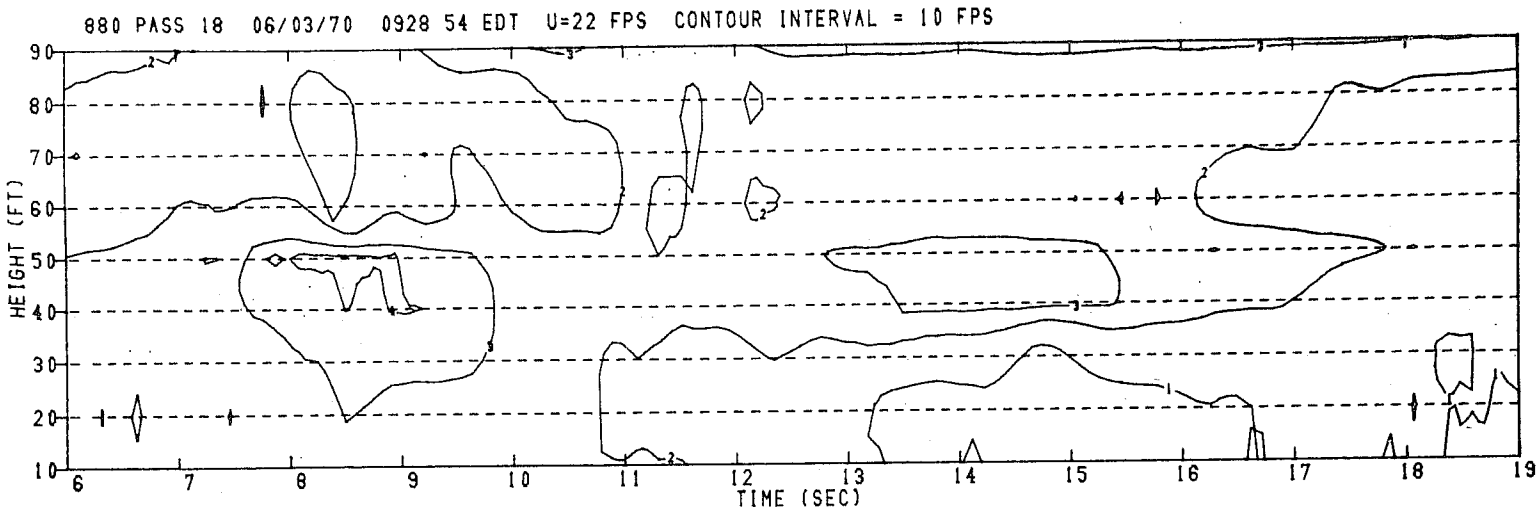
TIME (SEC)


880 PASS 18 06/03/70 0928 54 EDT U=22 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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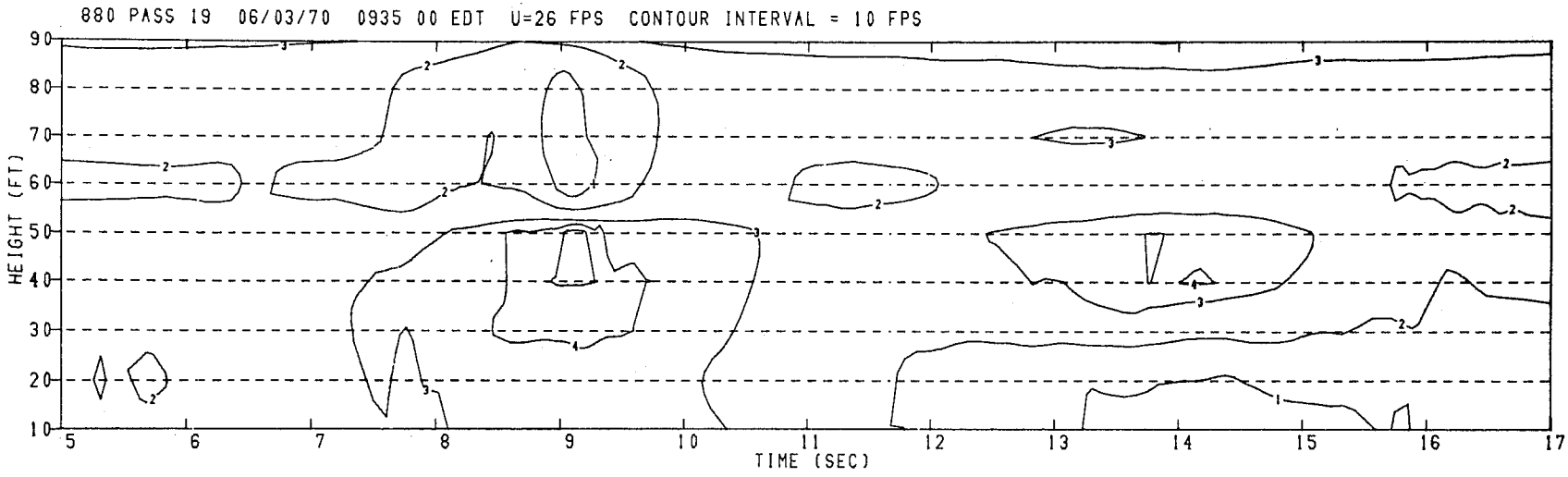
TIME (SEC)


880 PASS 19 06/03/70 0935 00 EDT U=26 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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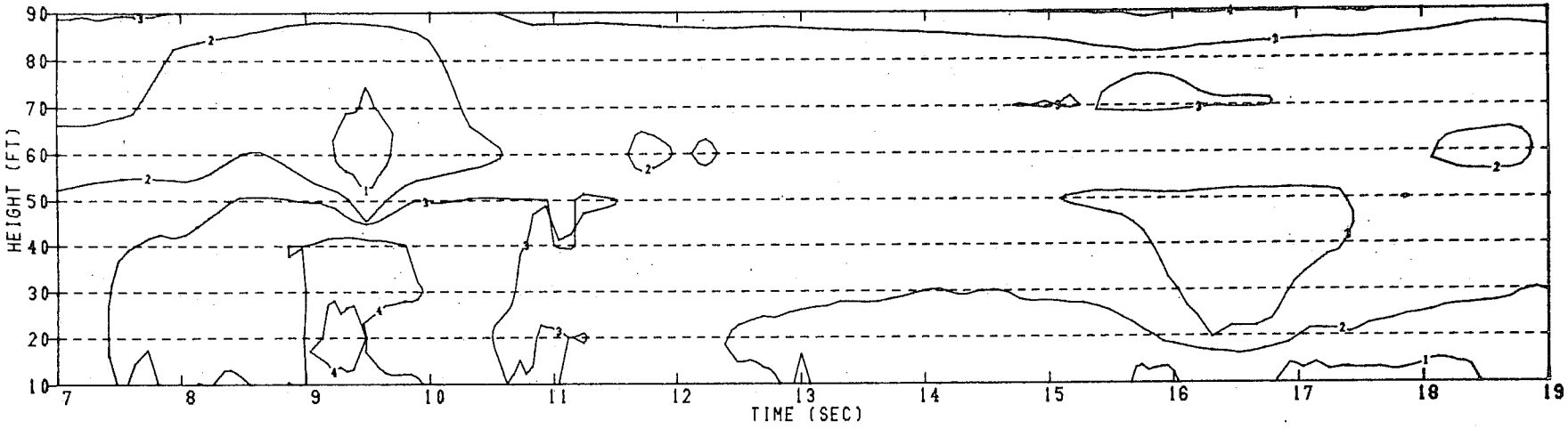
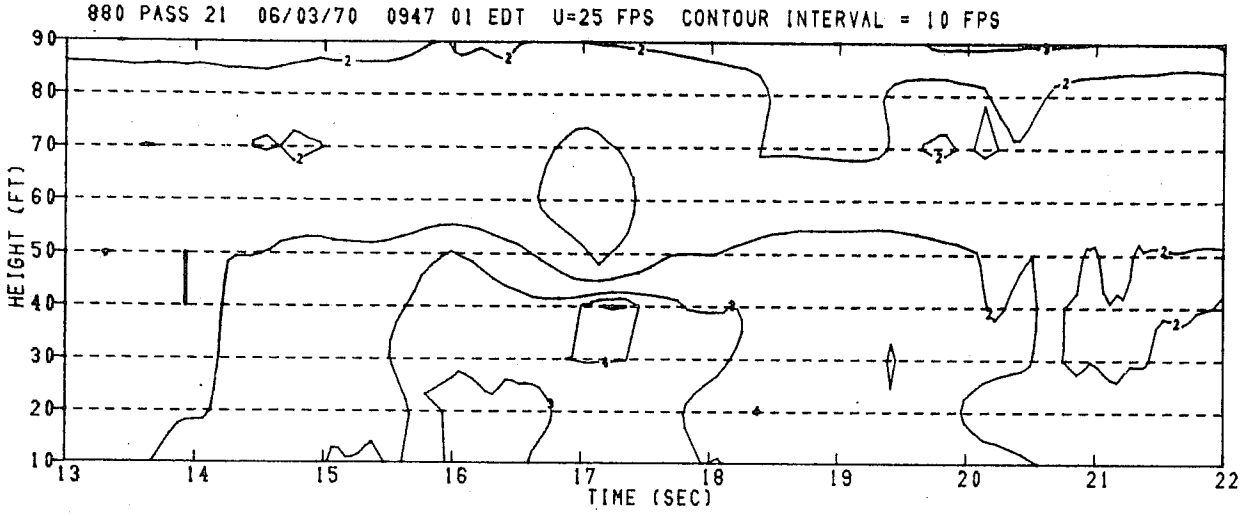
TIME (SEC)

880 PASS 20 06/03/70 0941 11 EDT U=27 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 21 06/03/70 0947 01 EDT U=25 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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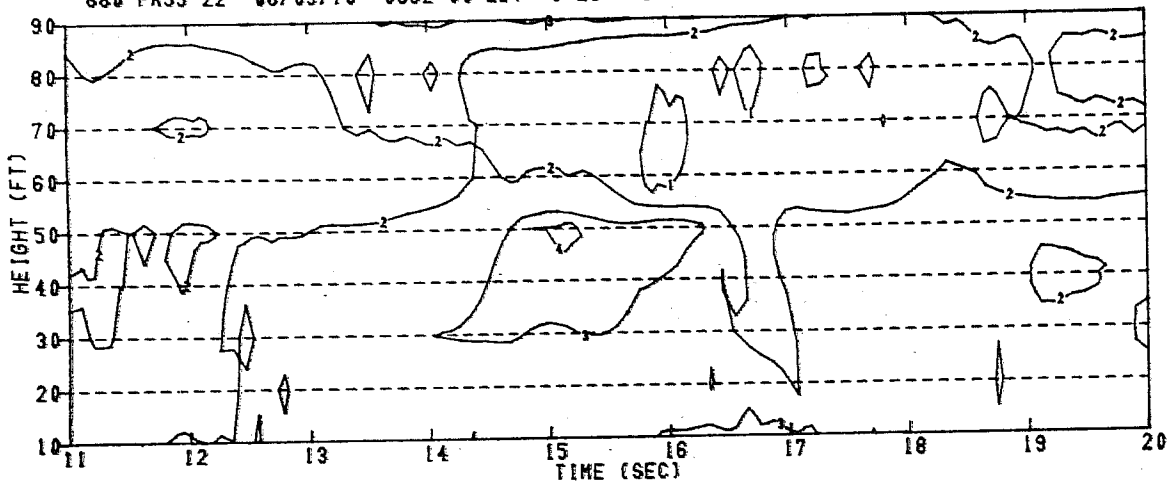
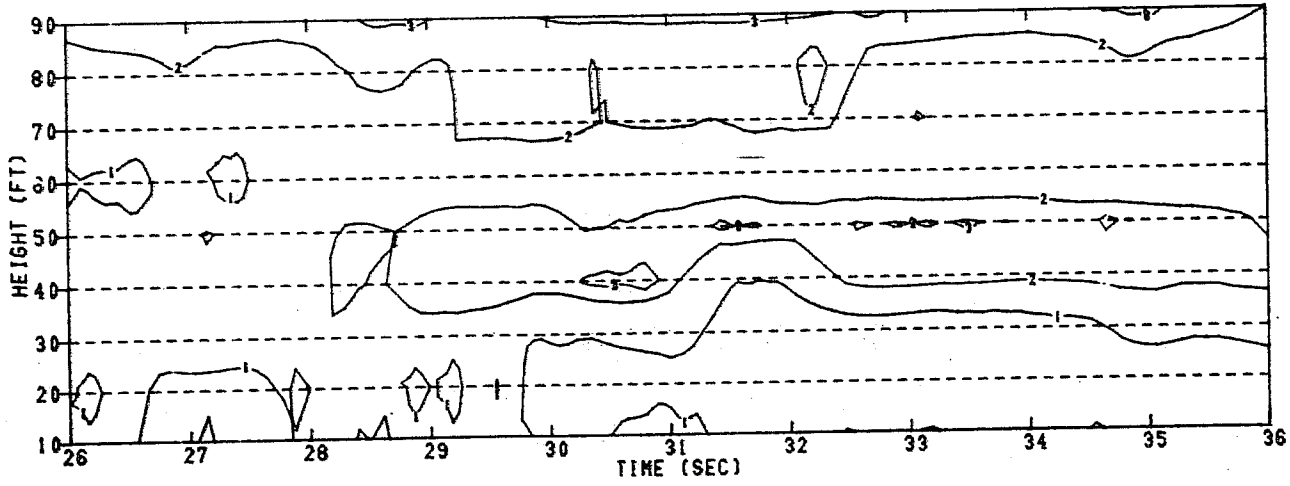
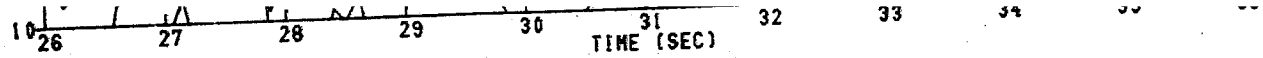
TIME (SEC)

880 PASS 22 06/03/70 0952 00 EDT U=23 FPS CONTOUR INTERVAL = 10 FPS



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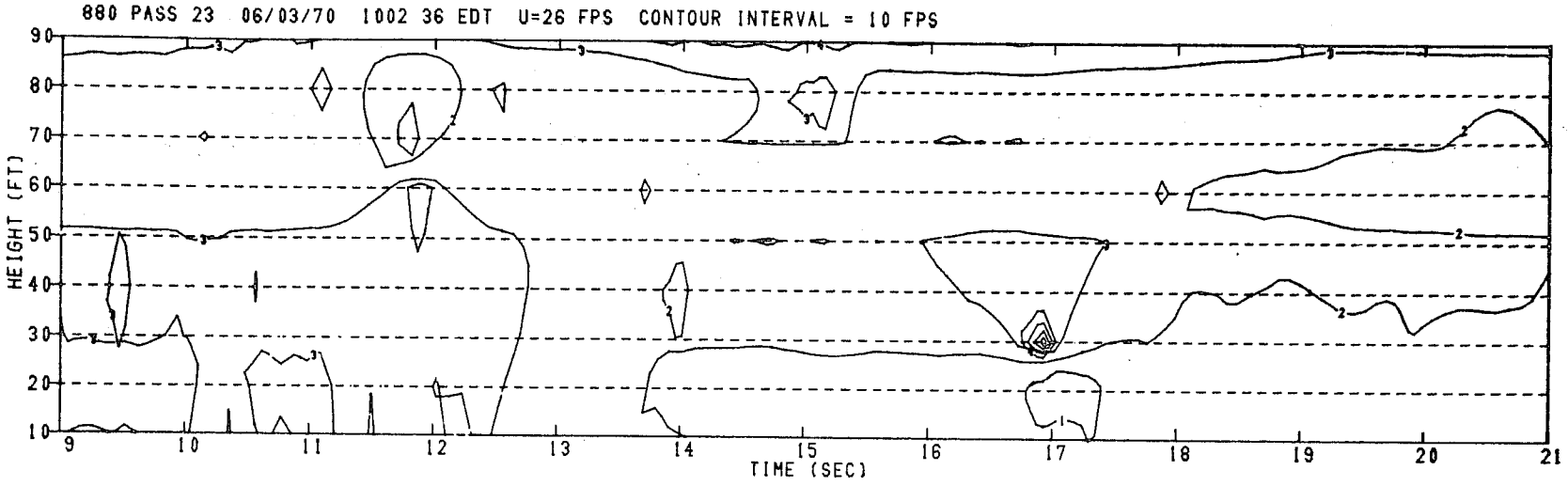
TIME (SEC)


880 PASS 23 06/03/70 1002 36 EDT U=26 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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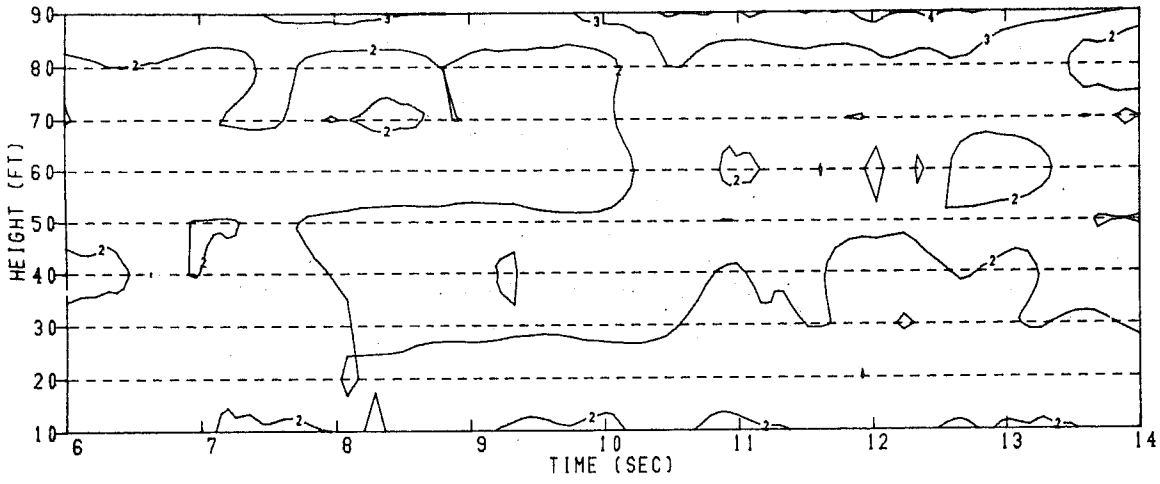
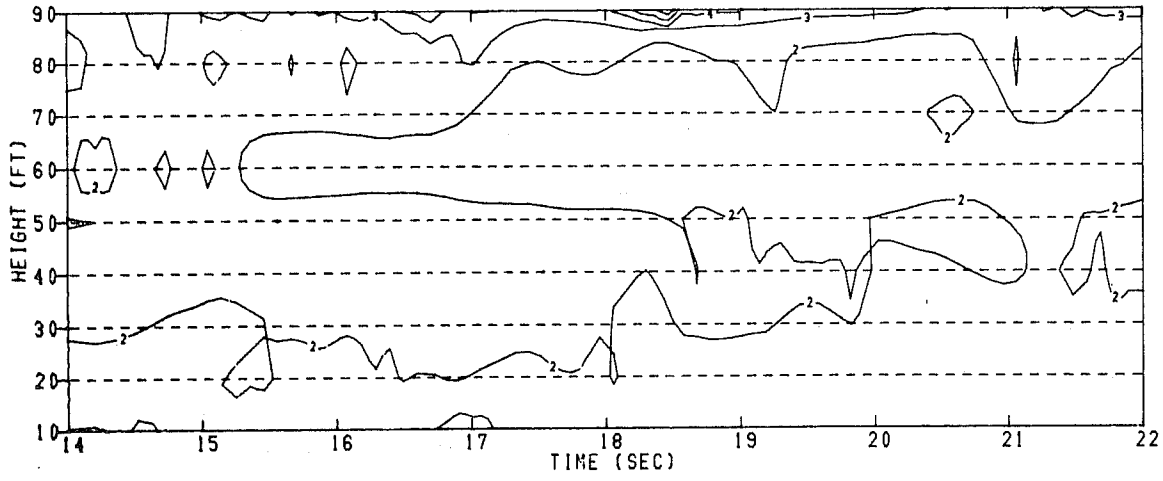
TIME (SEC)

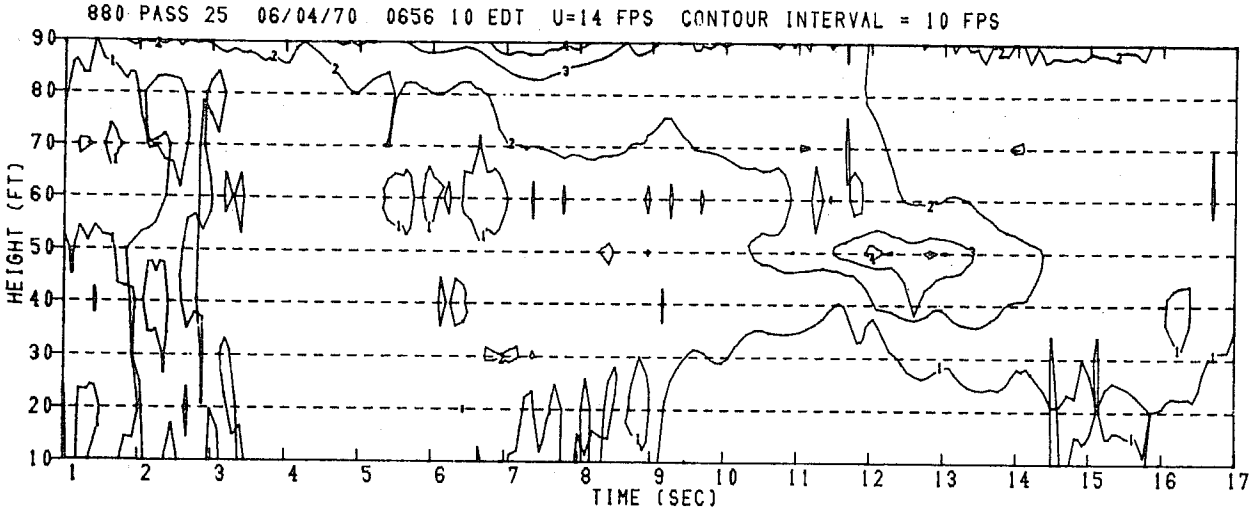
880 PASS 24 06/03/70 1008 15 EDT U=26 FPS CONTOUR INTERVAL = 10 FPS





880 PASS 25 06/04/70 0656 10 EDT

TIME (SEC)


880 PASS 25 06/04/70 0656 10 EDT U=14 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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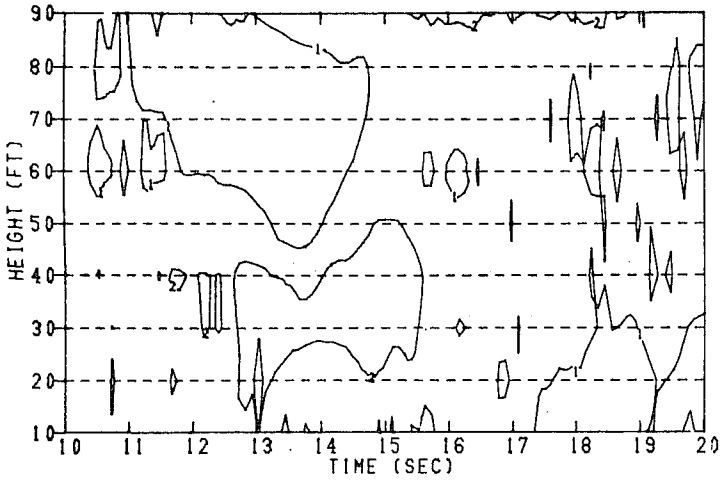
TIME (SEC)

880 PASS 26 06/04/70 0704 47 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 27 06/04/70 0712 38 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS

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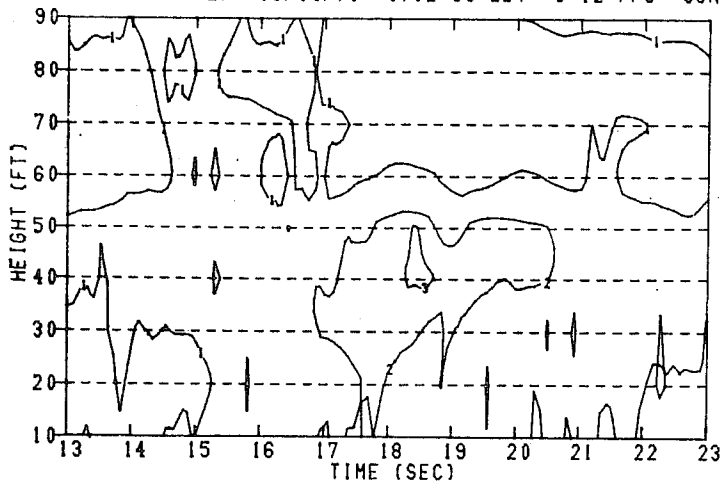
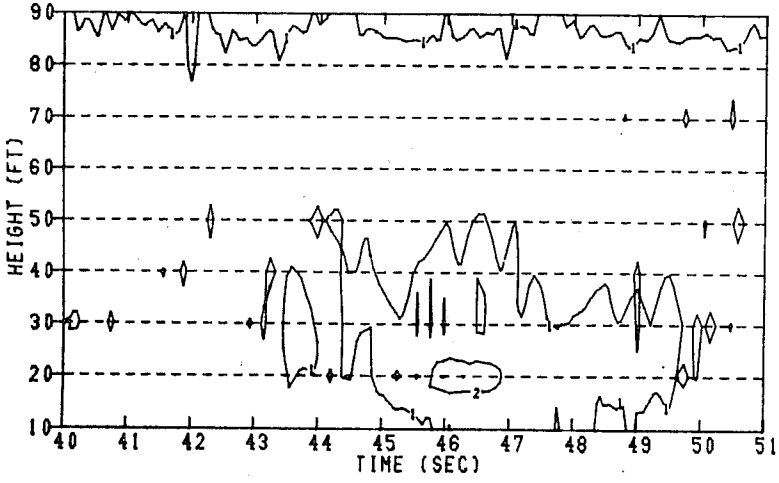
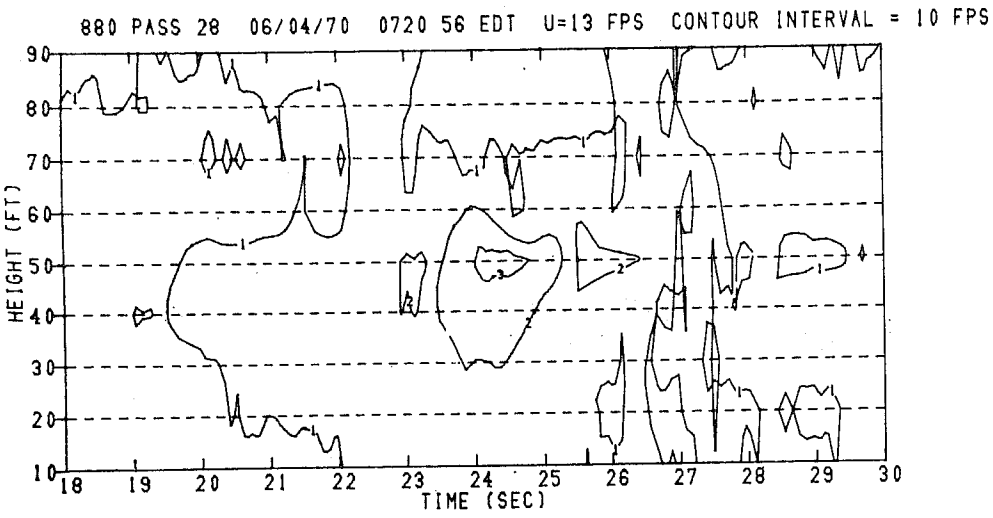
880 PASS 27 06/04/70 0712 38 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS






880 PASS 28 06/04/70 0720 56 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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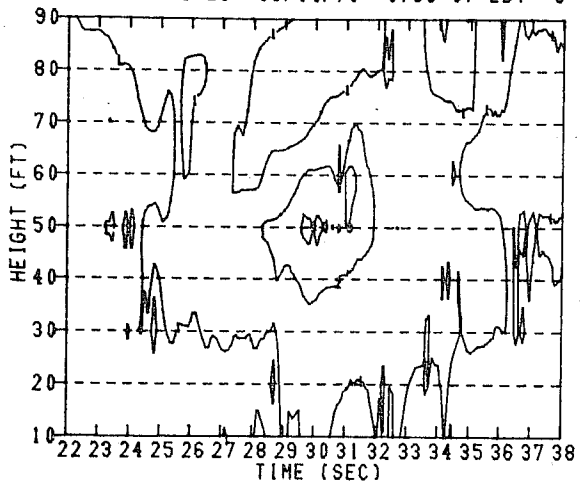
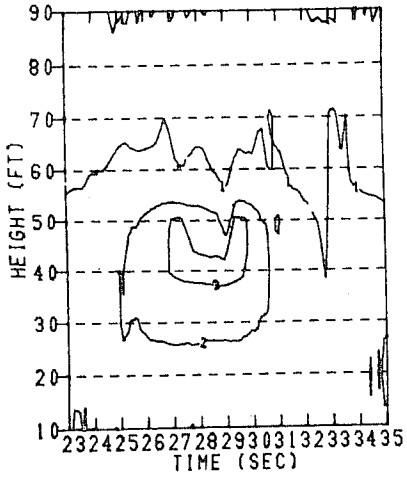
TIME (SEC)

880 PASS 29 06/04/70 0733 07 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 33 06/04/70 0813 55 EDT U=05 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 36 06/04/70 1101 05 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS

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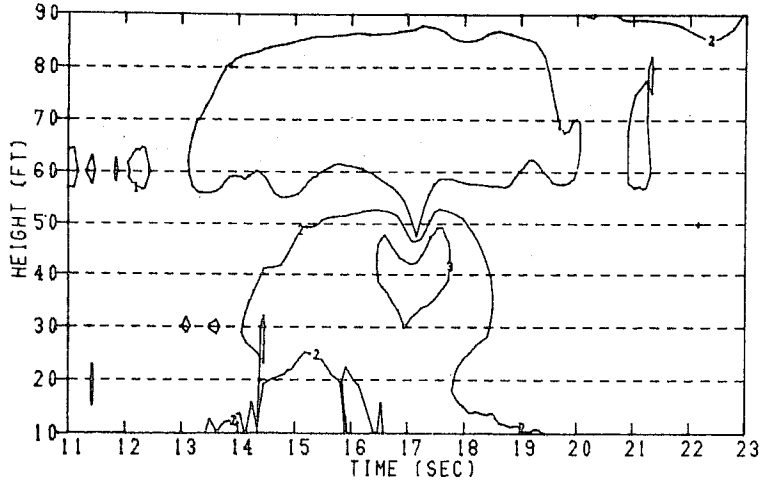
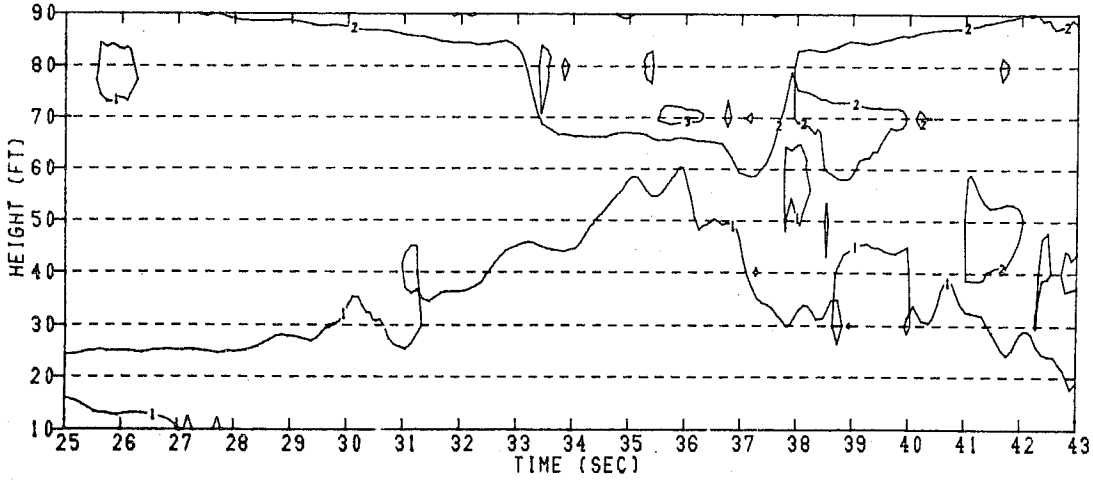
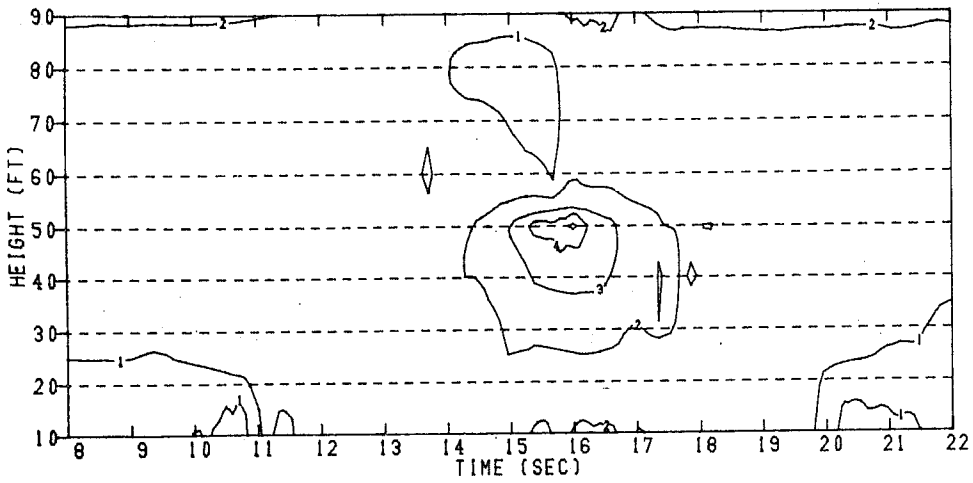
880 PASS 36 06/04/70 1101 05 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS



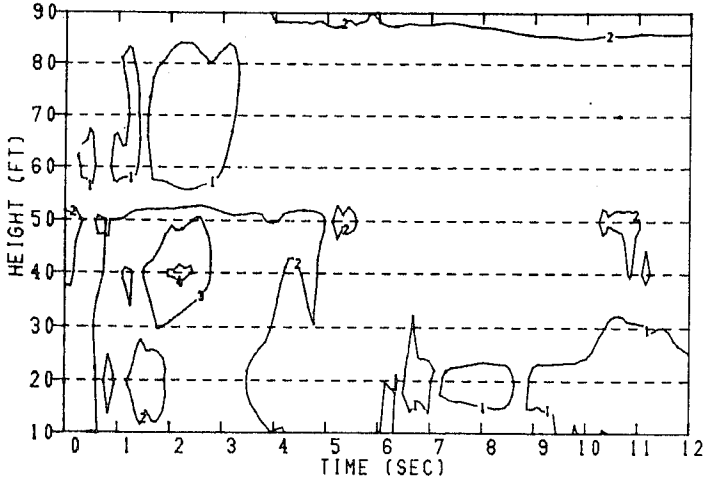


880 PASS 37 06/04/70 1109 30 EDT U=12 FPS CONTOUR INTERVAL = 10 FPS

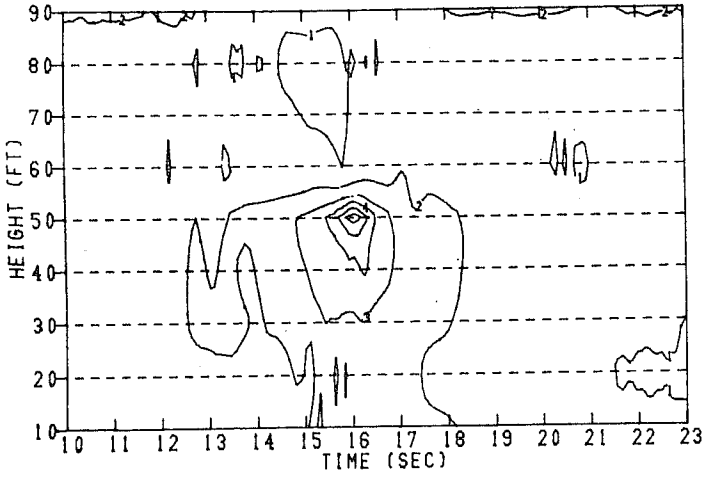


880 PASS 38 06/04/70 1116 22 EDT U=10 FPS CONTOUR INTERVAL

880 PASS 38 06/04/70 1116 22 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS



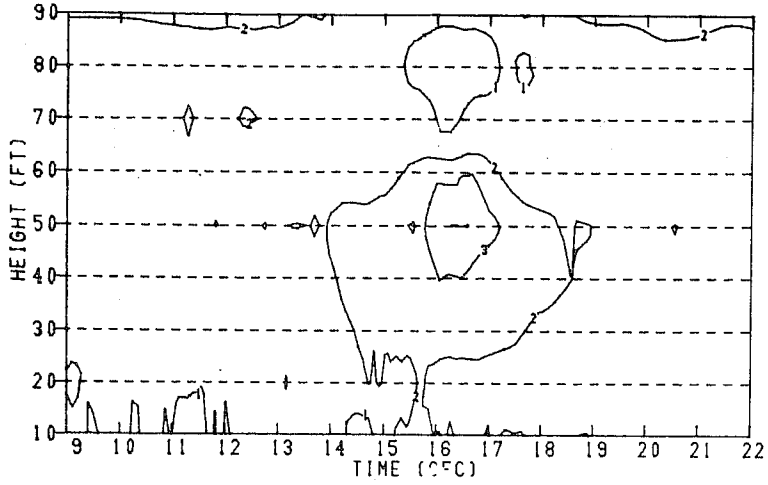
880 PASS 39 06/04/70 1123 13 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS

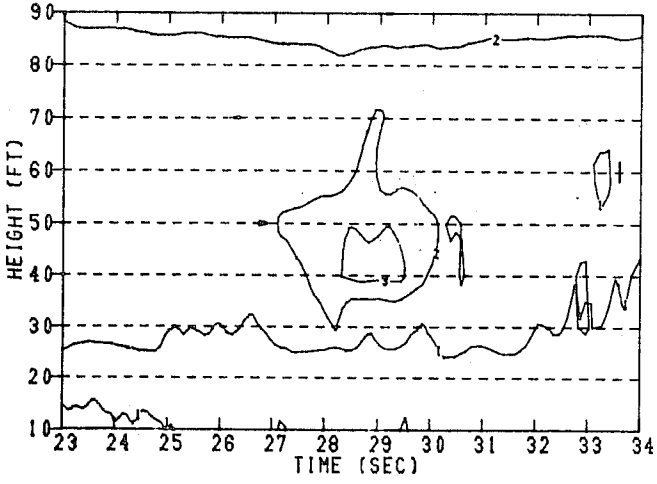


880 PASS 40 06/04/70 1132 49 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS

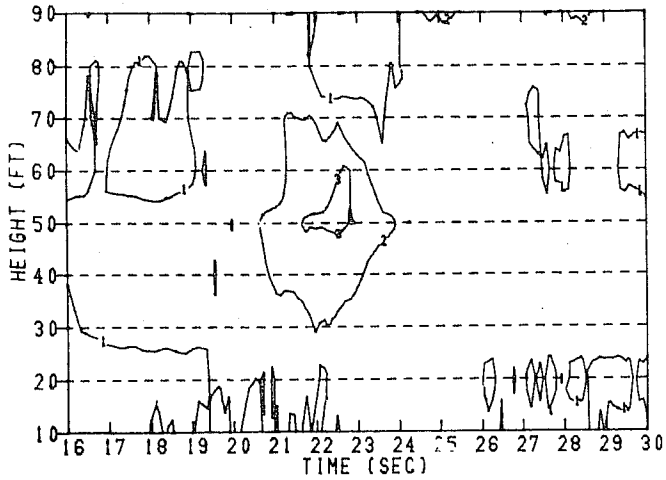
90

880 PASS 40 06/04/70 1132 49 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS

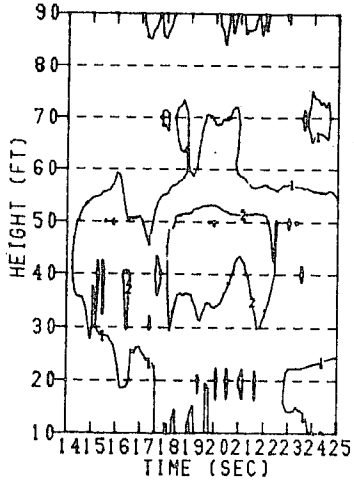




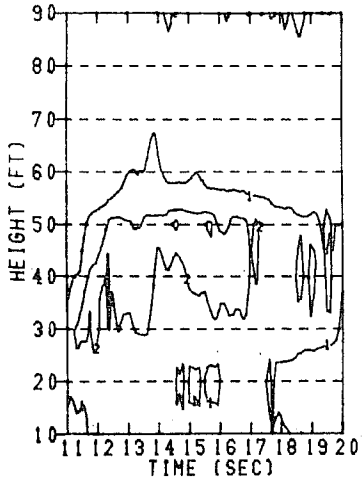
880 PASS 41 06/04/70 1141 33 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS



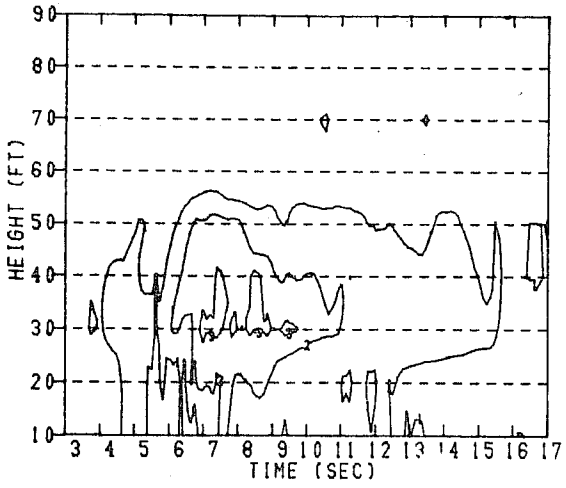
880 PASS 42 06/05/70 0802 32 EDT U=05 FPS CONTOUR INTERVAL = 10 FPS



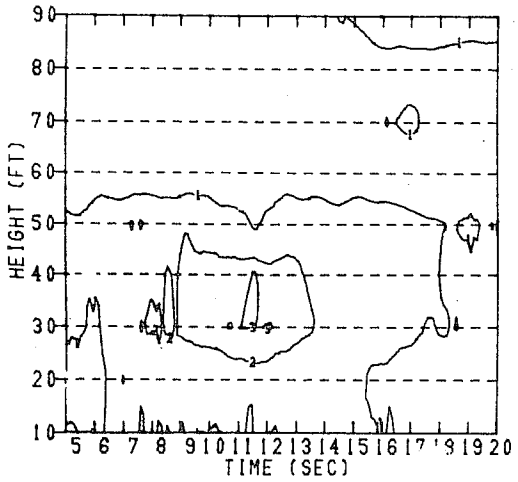
880 PASS 44 06/05/70 0814 26 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



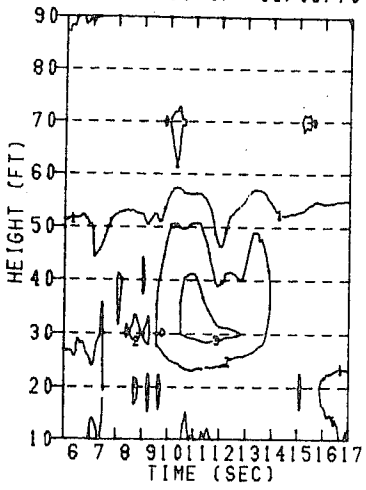
880 PASS 45 06/05/70 0819 09 EDT U=07 FPS CONTOUR INTERVAL = 10 FPS



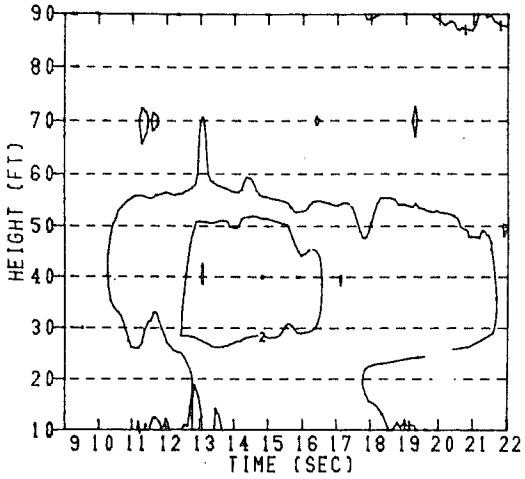
880 PASS 46 06/05/70 0833 49 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



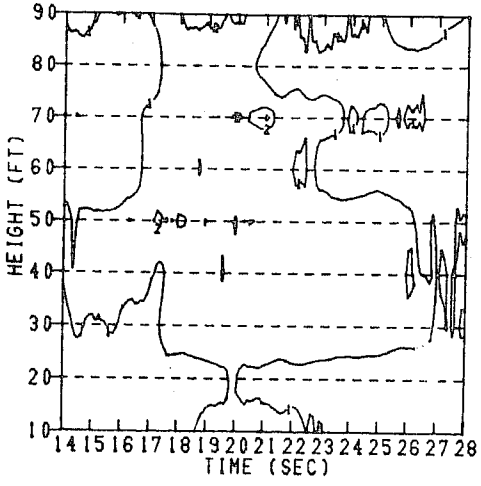
880 PASS 47 06/05/70 0838 08 EDT U=05 FPS CONTOUR INTERVAL = 10 FPS



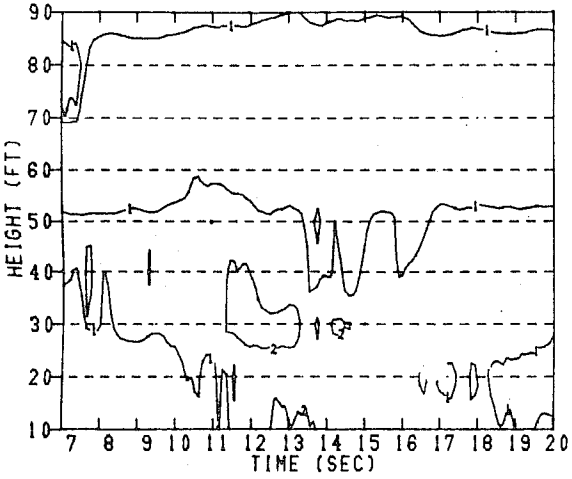
880 PASS 48 06/05/70 0842 14 EDT U=07 FPS CONTOUR INTERVAL = 10 FPS



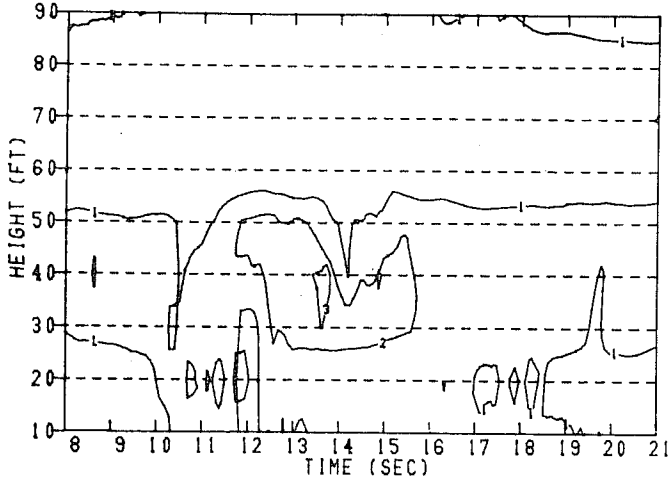
880 PASS 49 06/05/70 0846 59 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



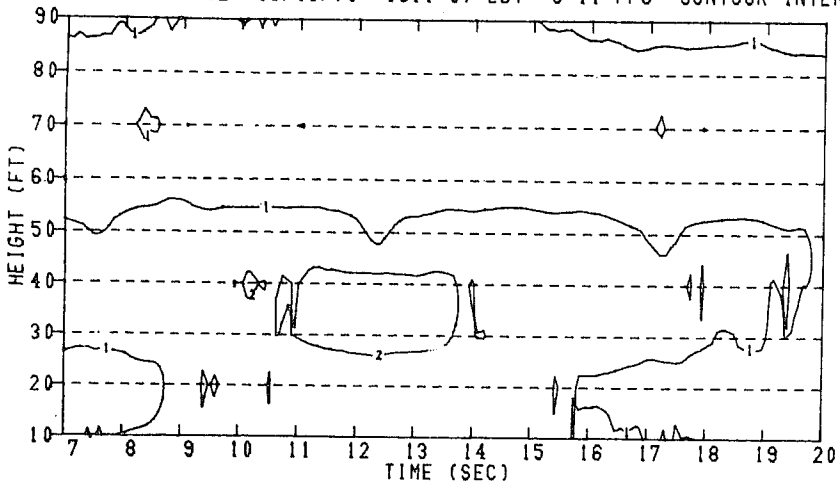
880 PASS 50 06/05/70 0859 59 EDT U=07 FPS CONTOUR INTERVAL = 10 FPS



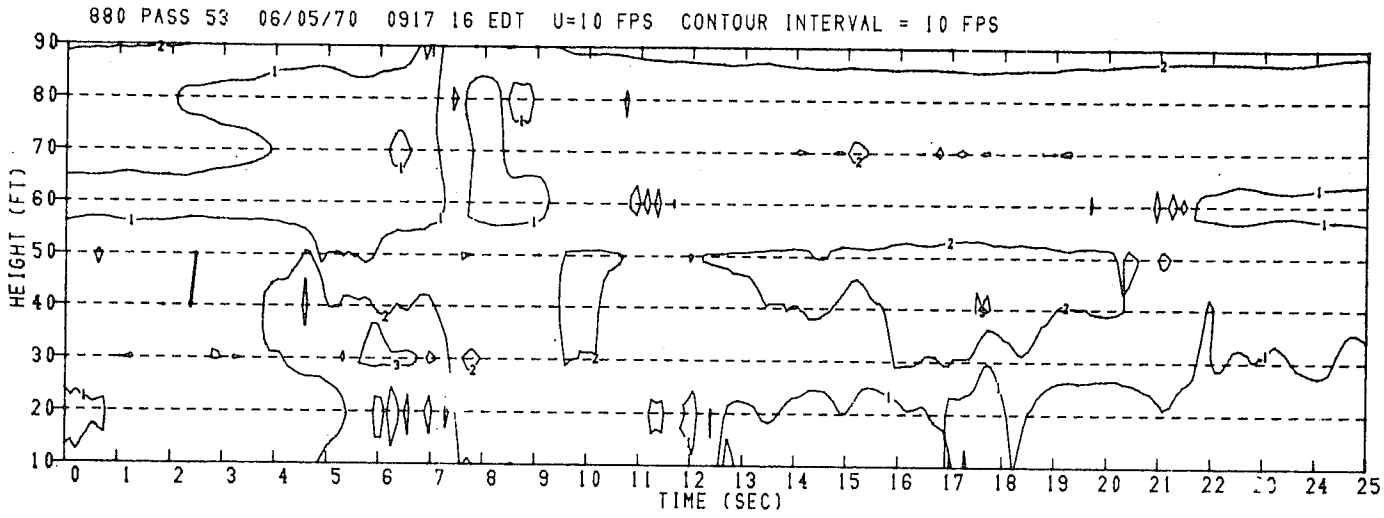
880 PASS 51 06/05/70 0906 28 EDT U=0: FPS CONTOUR INTERVAL = 10 FPS



880 PASS 52 06/05/70 0911 57 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 53 06/05/70 0917 16 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS


880 PASS 53 06/05/70 0917 16 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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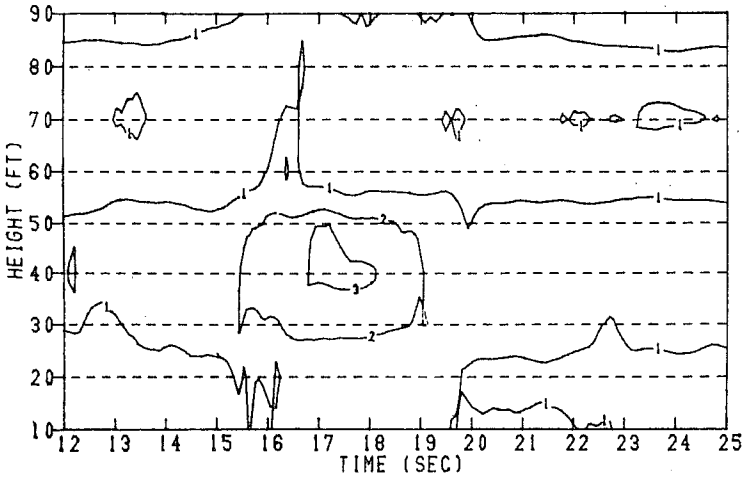
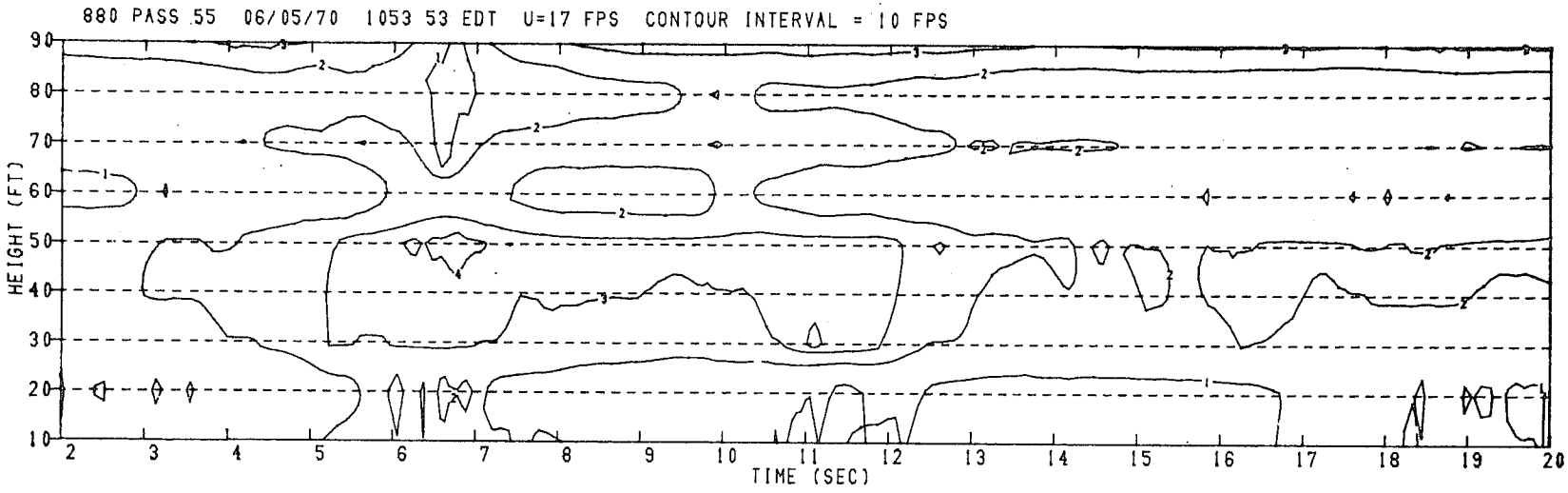
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
TIME (SEC)

880 PASS 54 06/05/70 1046 36 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 55 06/05/70 1053 53 EDT U=17 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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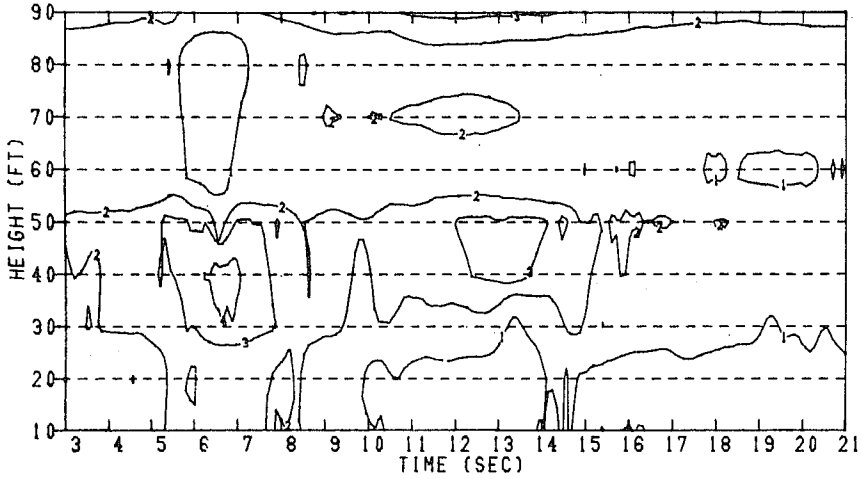
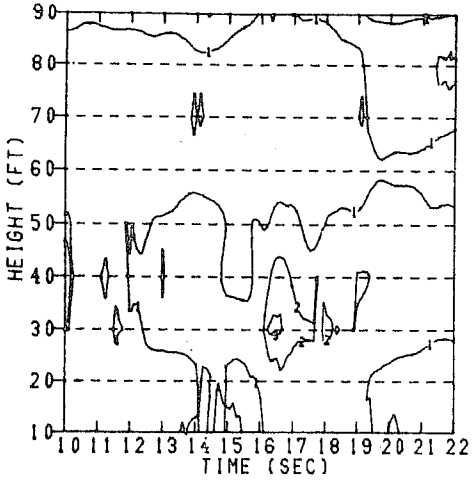
TIME (SEC)

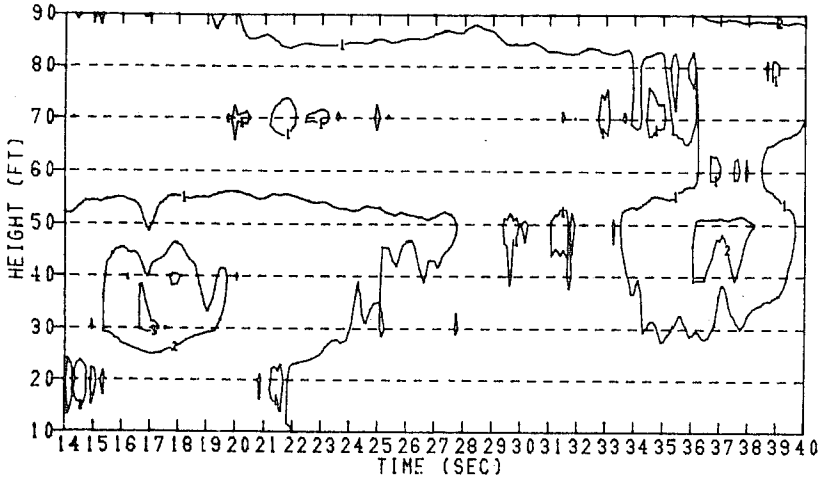
880 PASS 56 06/05/70 1058 19 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS



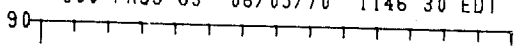
880 PASS 59 06/05/70 1122 36 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



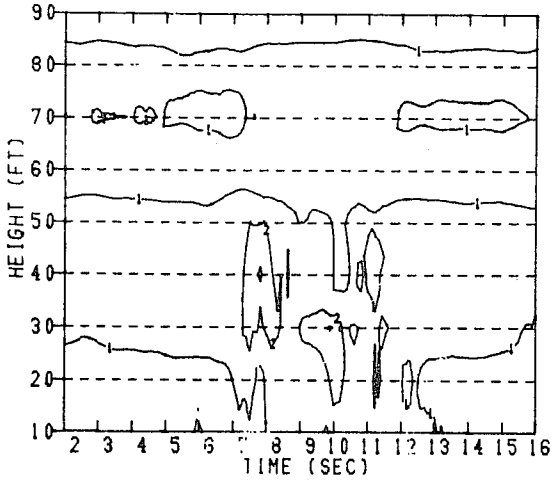
880 PASS 60 06/05/70 1127 07 EDT U=05 FPS CONTOUR INTERVAL = 10 FPS



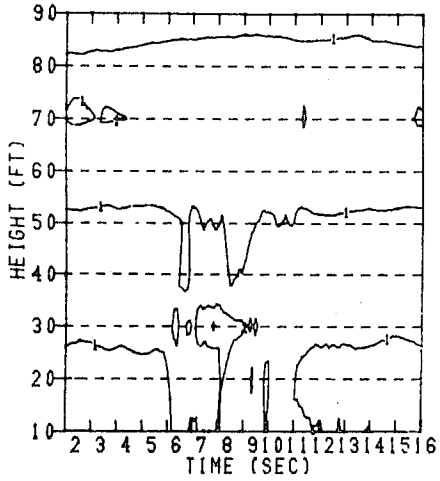
880 PASS 63 06/05/70 1146 30 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS

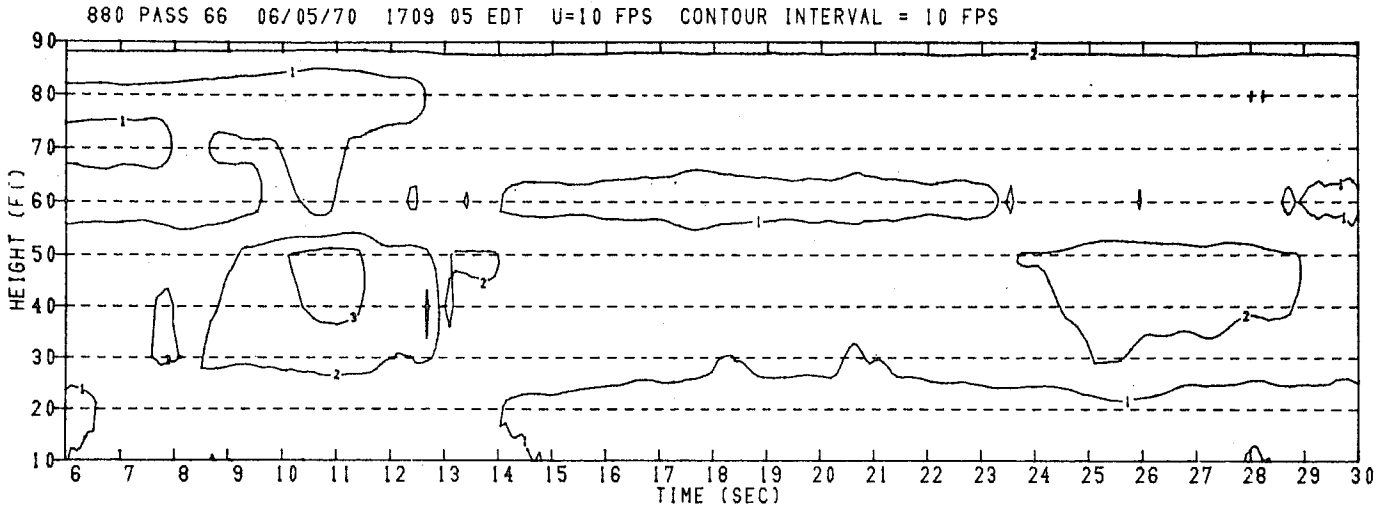


880 PASS 63 06/05/70 1146 30 EDT U=06 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 64 06/05/70 1150 59 EDT U=05 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 66 06/05/70 1709 05 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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40
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20
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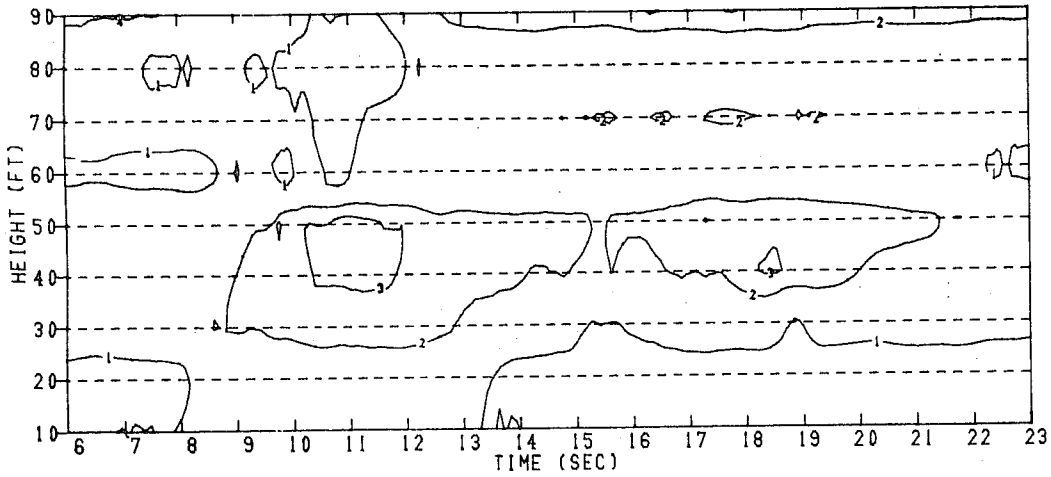
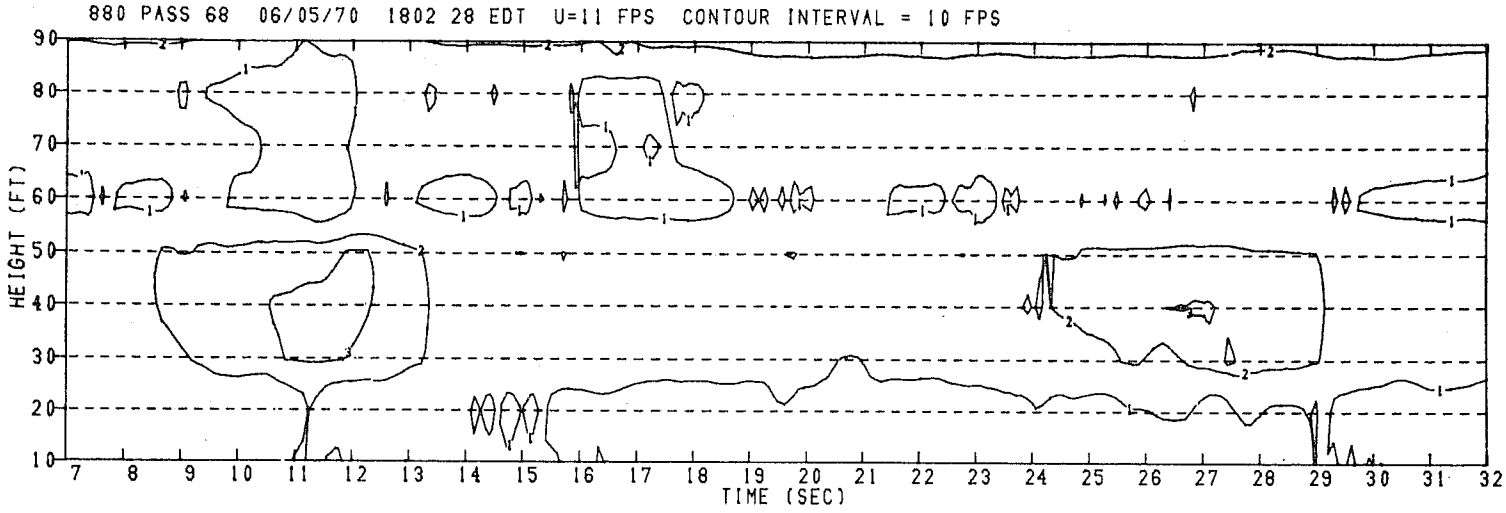
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
TIME (SEC)

880 PASS 67 06/05/70 1757 09 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 68 06/05/70 1802 28 EDT U=11 FPS CONTOUR INTERV


880 PASS 68 06/05/70 1802 28 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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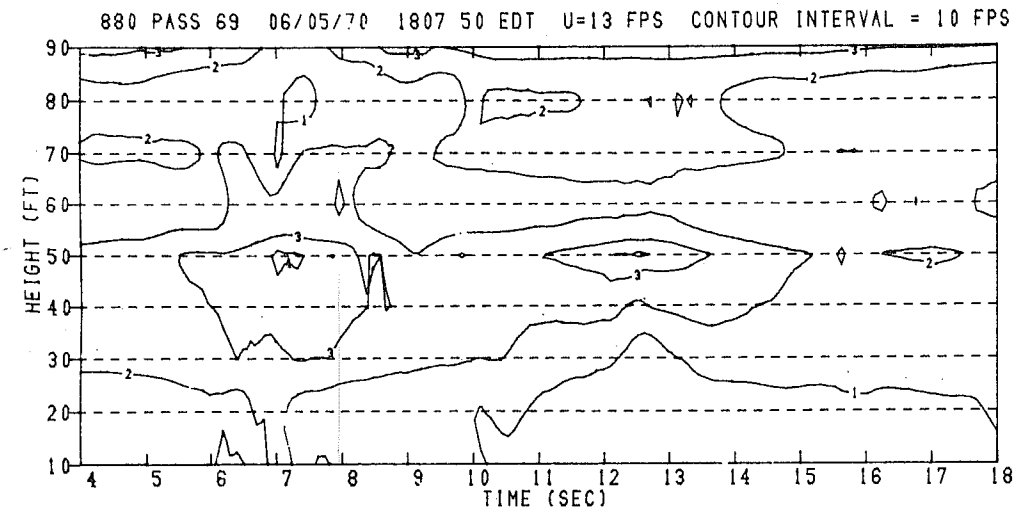
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
TIME (SEC)


880 PASS 69 06/05/70 1807 50 EDT U=13 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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11
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14
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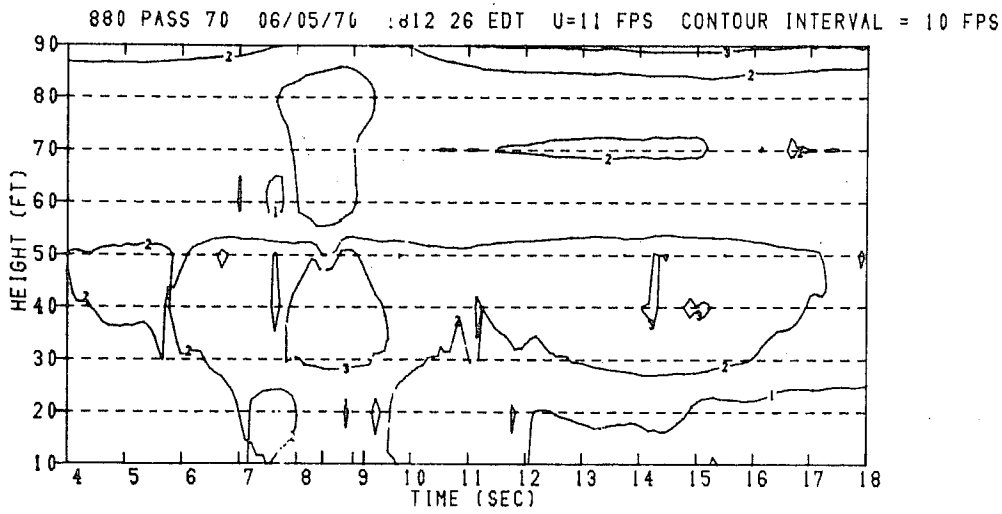
18
TIME (SEC)


880 PASS 70 06/05/76 :812 26 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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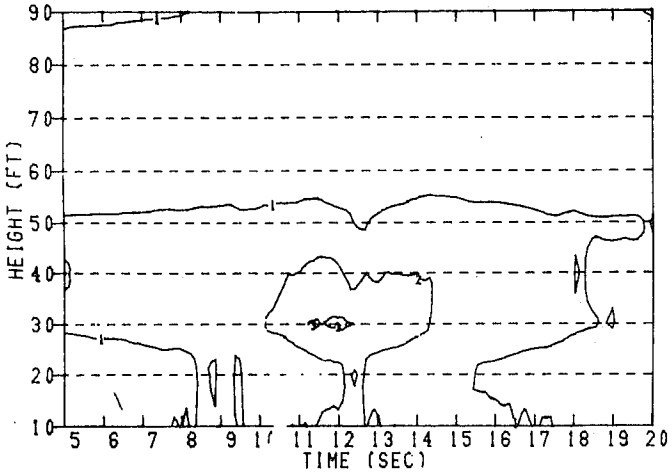
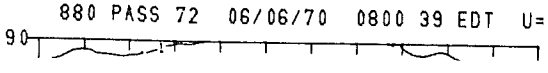
18
TIME (SEC)

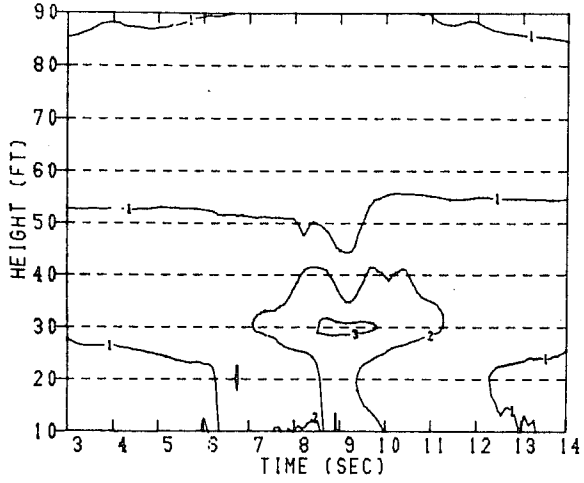
880 PASS 71 06/06/70 0748 55 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS

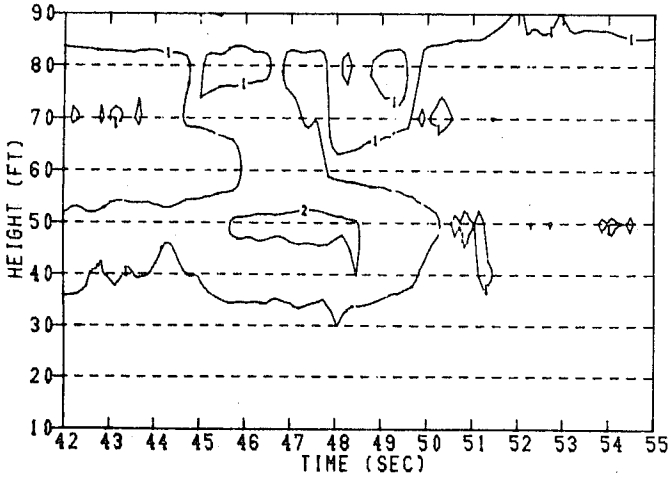


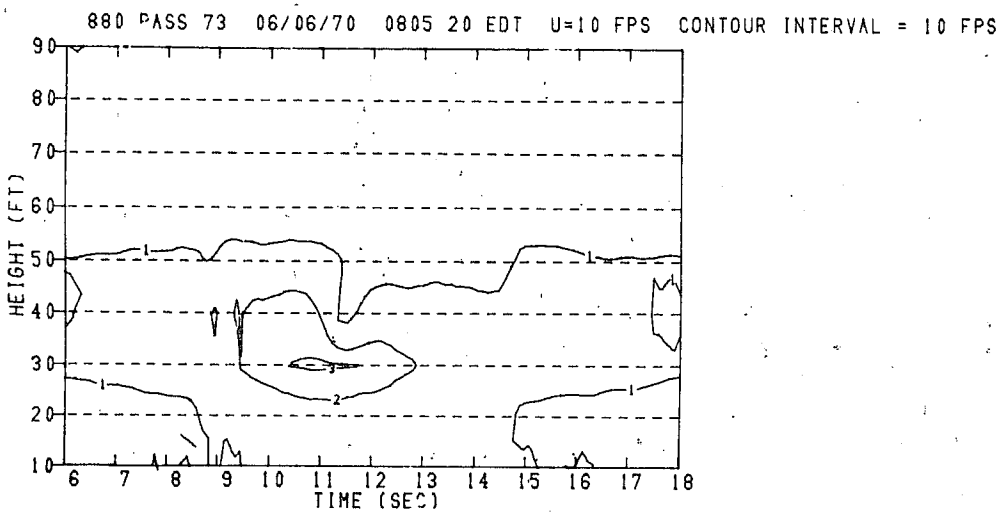
880 PASS 72 06/06/70 0800 39 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS



880 PASS 72 06/06/70 0800 39 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS






880 PASS 73 06/06/70 0805 20 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
90
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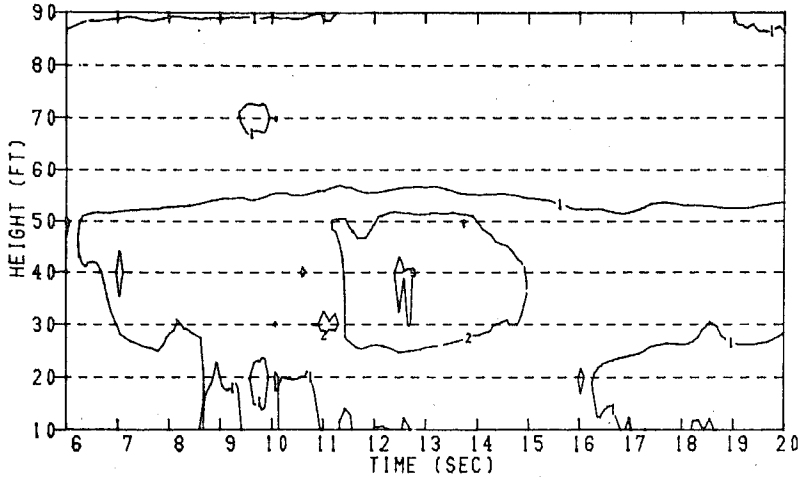
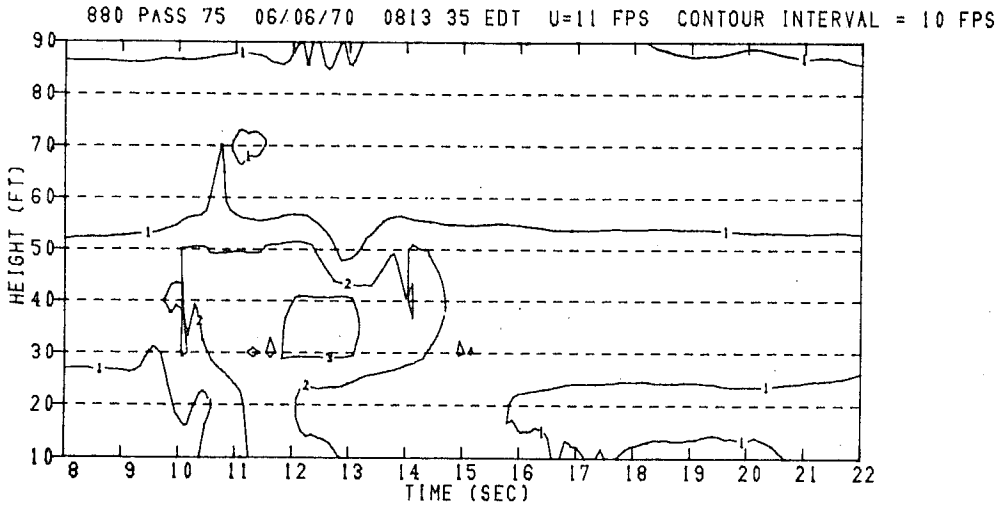
30
20
10
6 7 8 9 10 11 12 13 14 15 16 17 18
TIME (SEC)
1
2
3

880 PASS 74 06/06/70 0809 32 EDT U=10 FPS CONTOUR INTERVAL = 10 FPS




880 PASS 75 06/06/70 0813 35 EDT U=11 FPS CONTOUR INTERVAL = 10 FPS
HEIGHT (FT)
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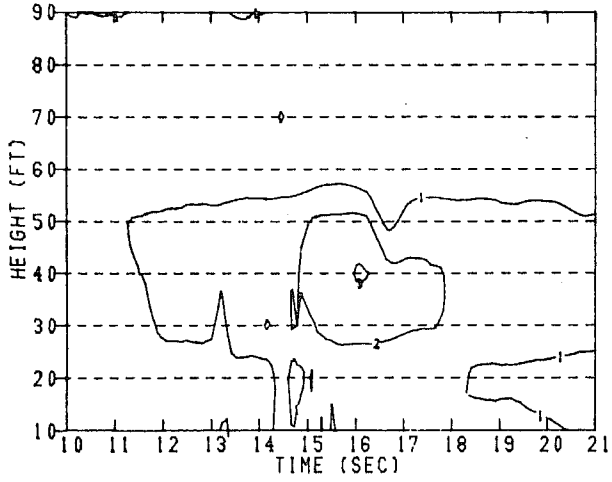
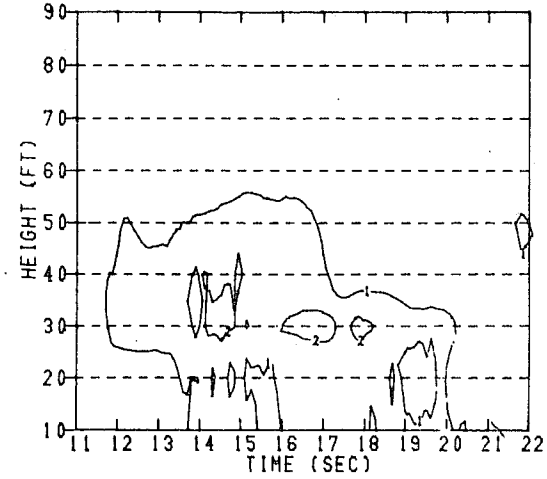
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
TIME (SEC)

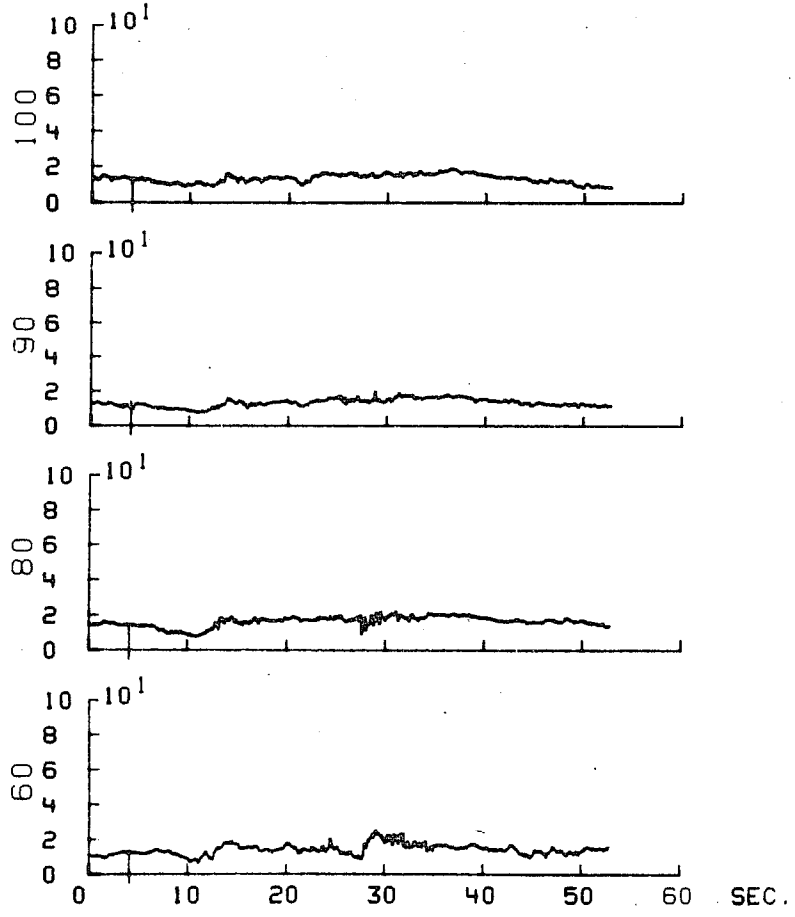
880 PASS 84 06/06/70 1045 35 EDT U=09 FPS CONTOUR INTERVAL = 10 FPS



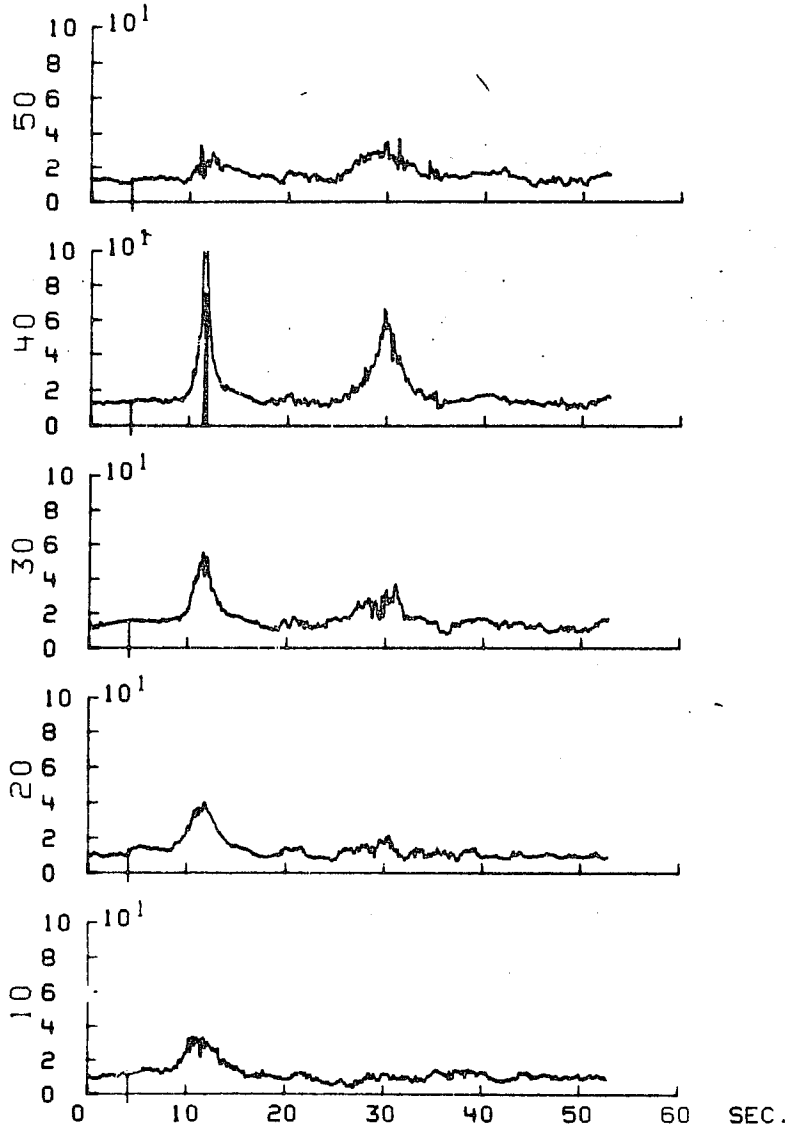
880 PASS 85 06/06/70 1049 38 EDT U=08 FPS CONTOUR INTERVAL = 10 FPS

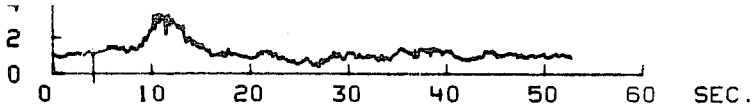


727 PASS 08 05/27/70 0746 08 EDT U=16 FPS

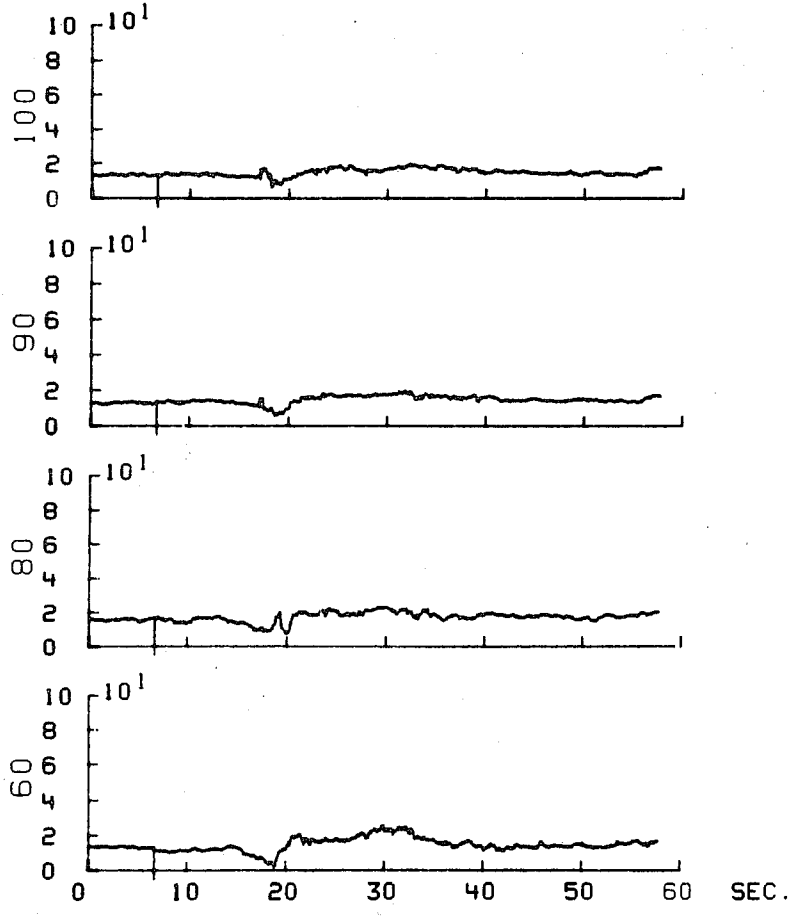


727 PASS 08 05/27/70 0746 08 EDT U=16 FPS

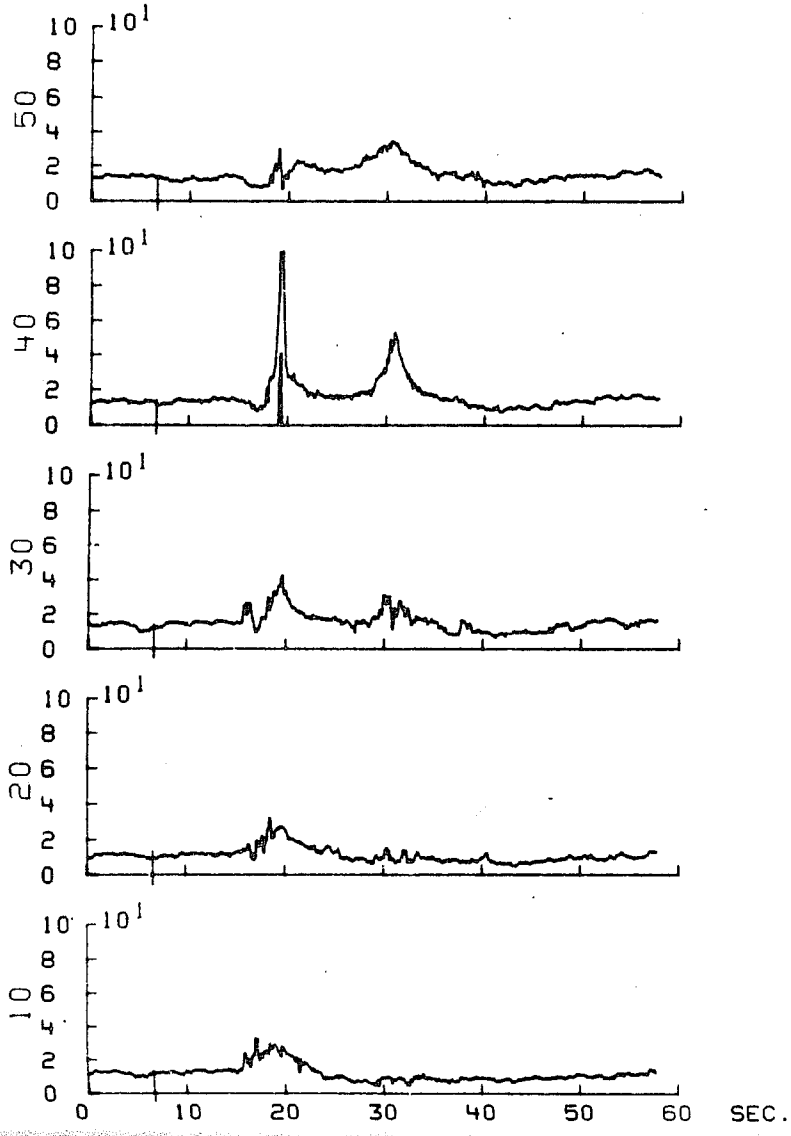


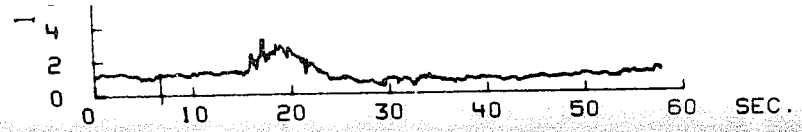


727 PASS 09 05/27/70 0758 44 EDT U=16 FPS

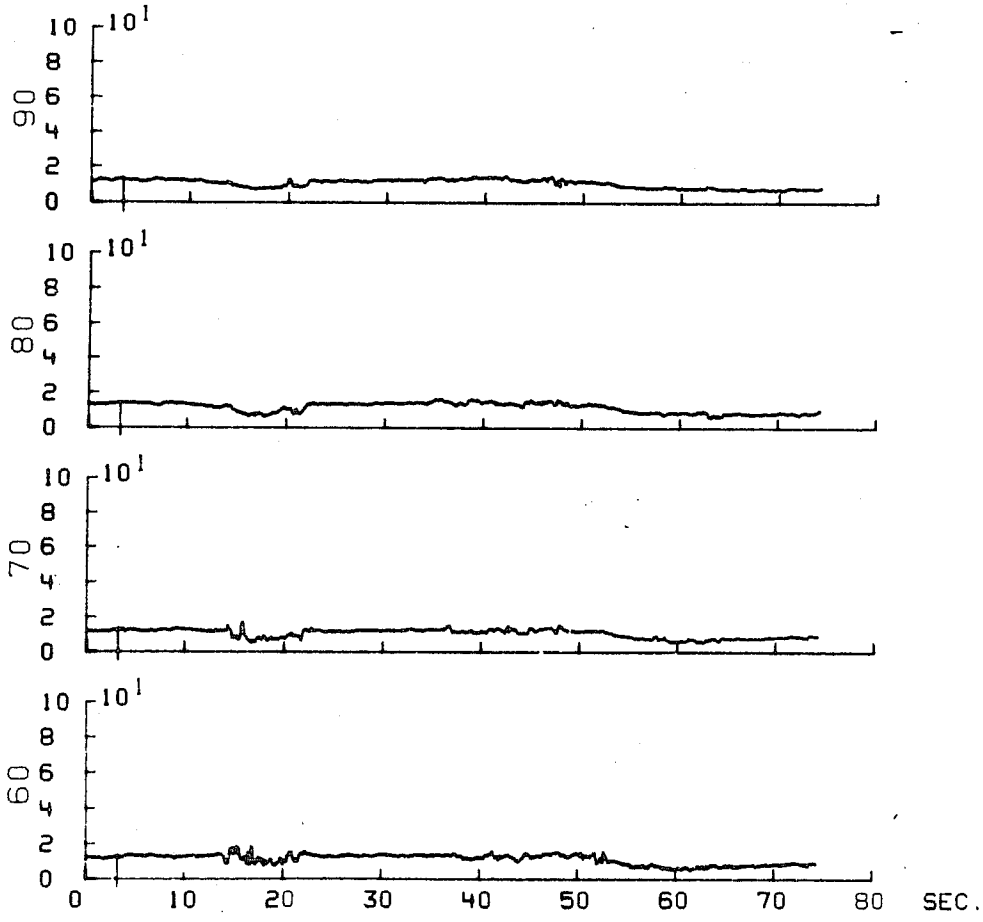


727 PASS 09 05/27/70 0758 44 EDT U=16 FPS

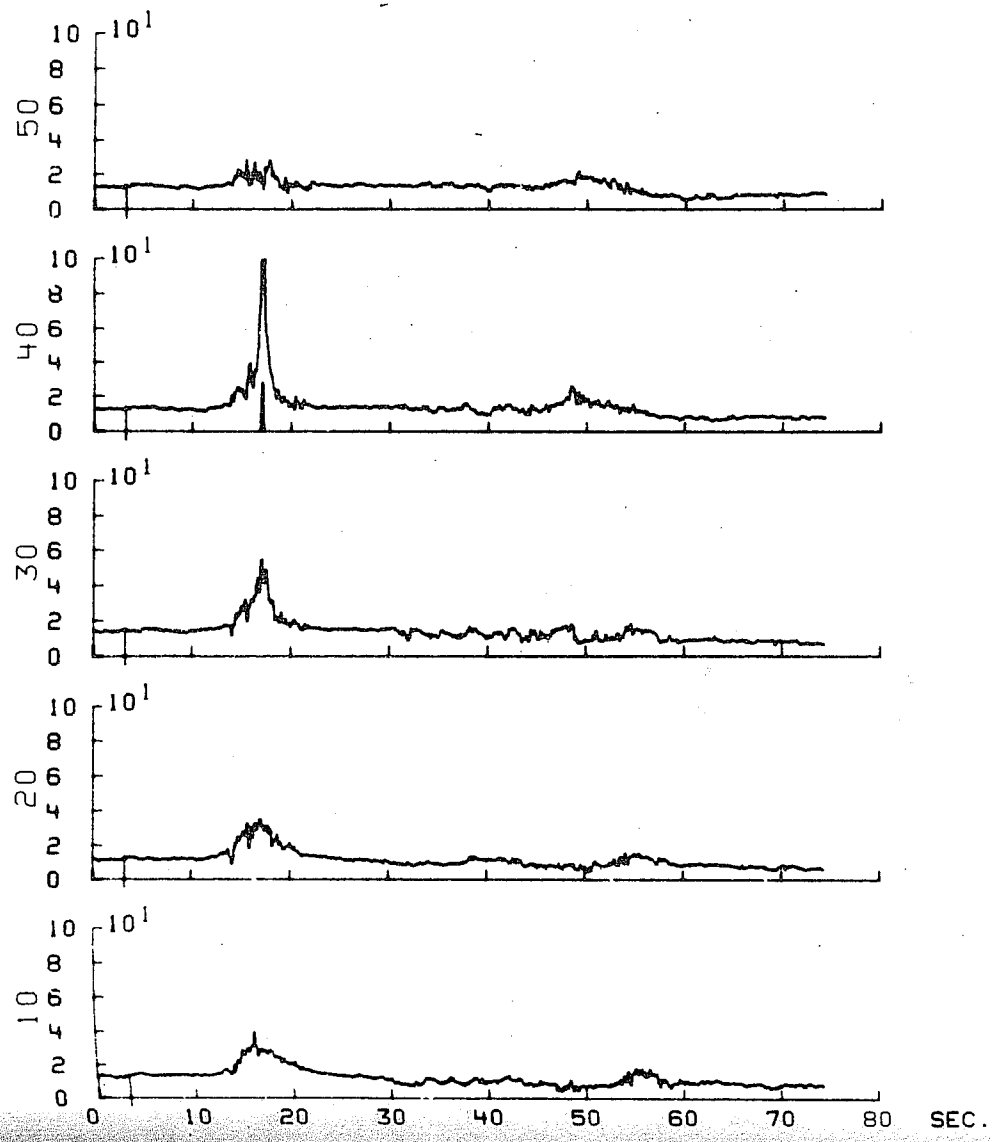


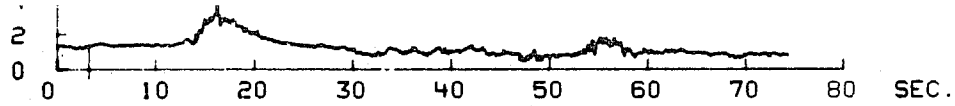


727 PASS 26 05/28/70 0829 23 EDT U=07 FPS

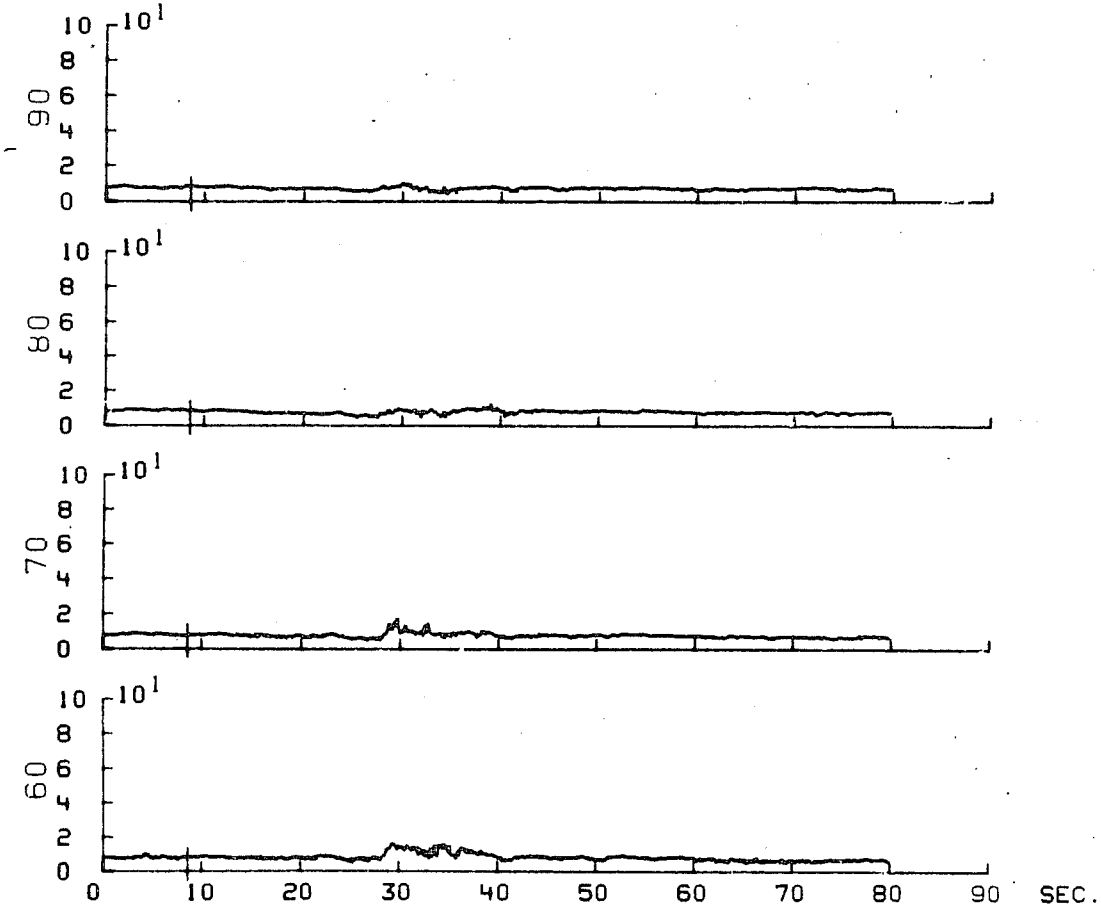


727 PASS 26 05/28/70 0829 23 EDT U=07 FPS





727 PASS 42 05/28/70 1149 14 EDT U=02 FPS



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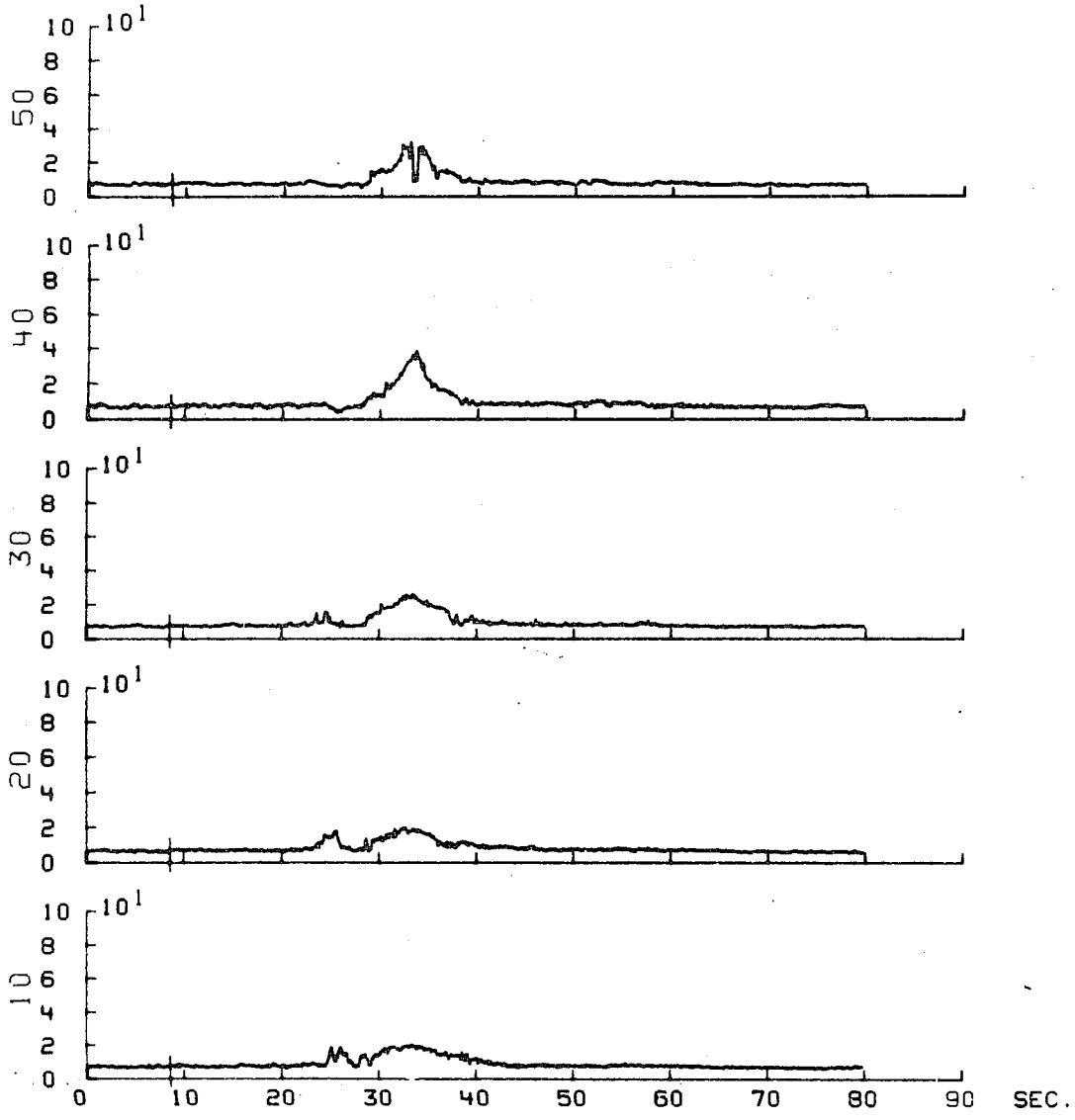

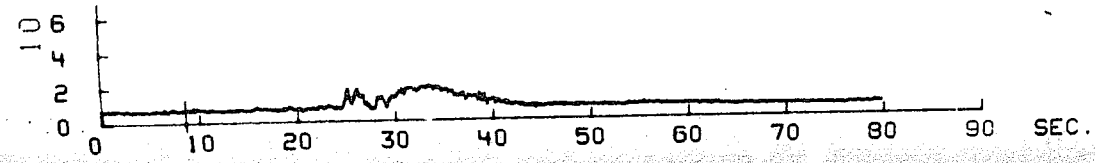

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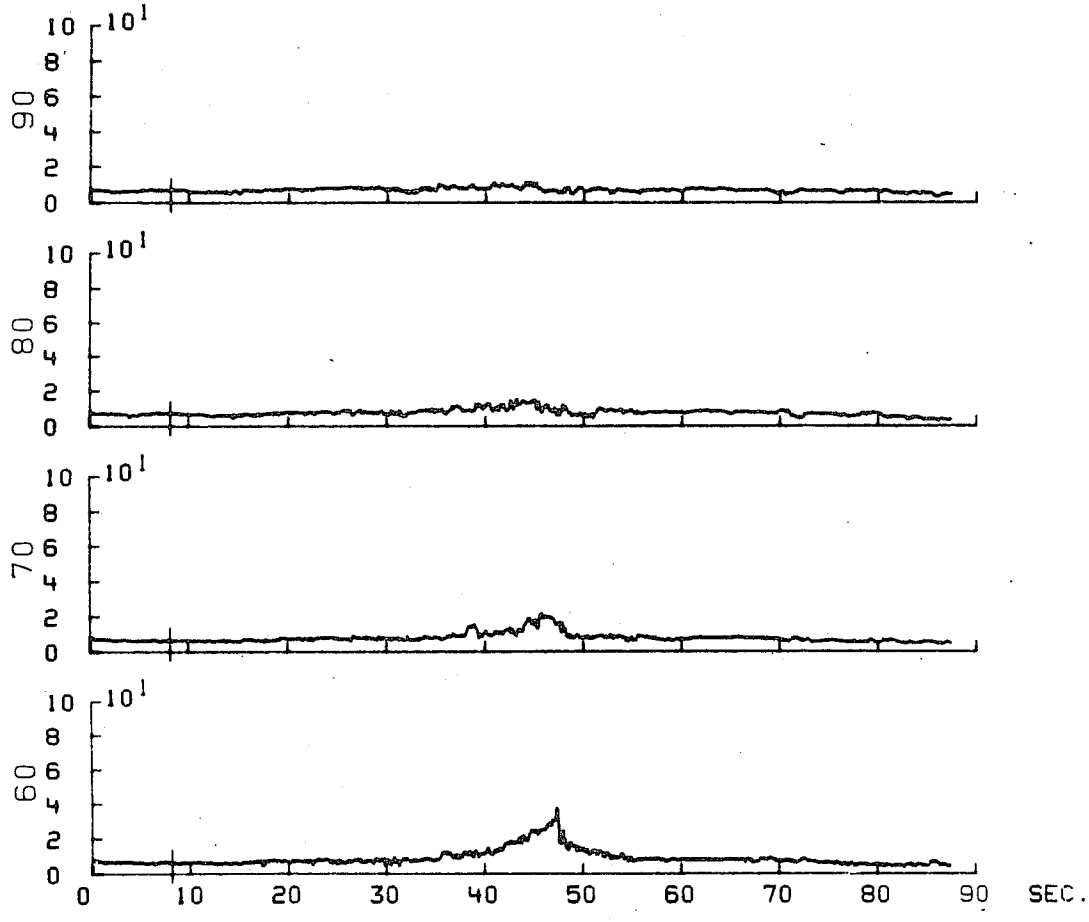

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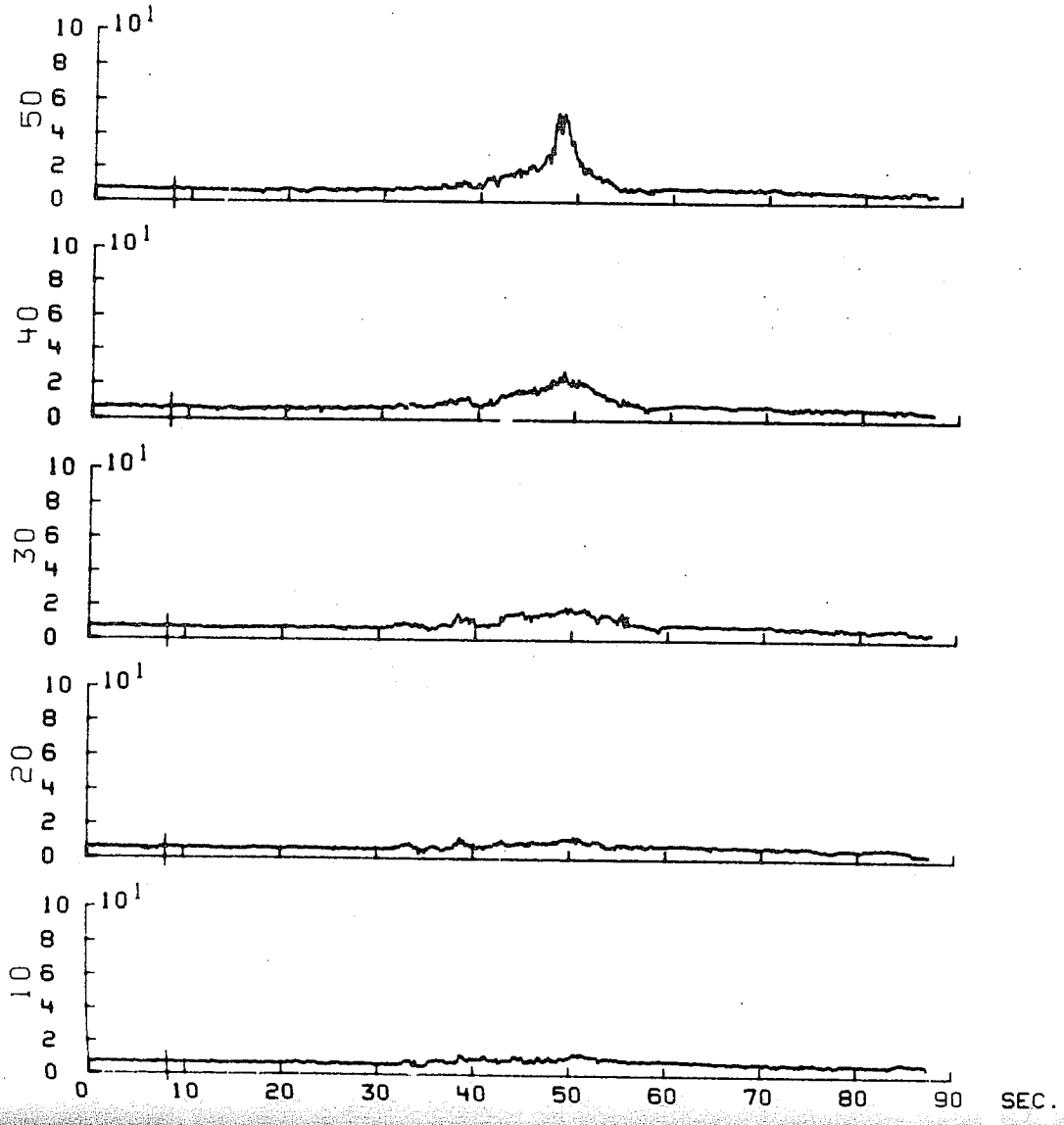

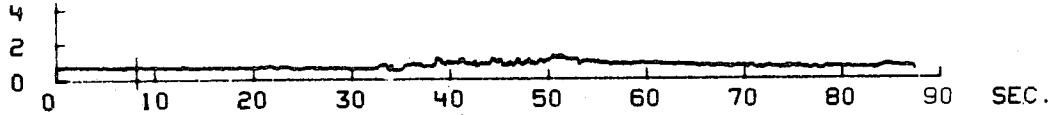

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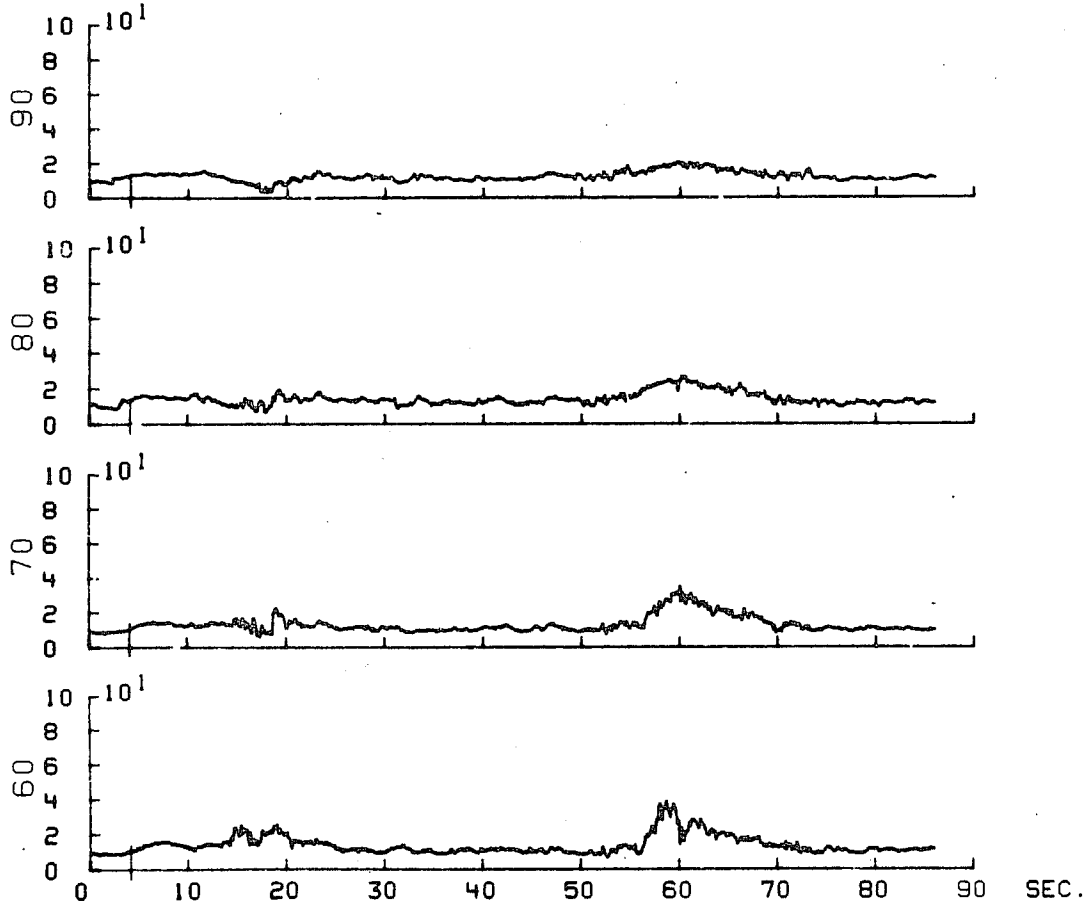

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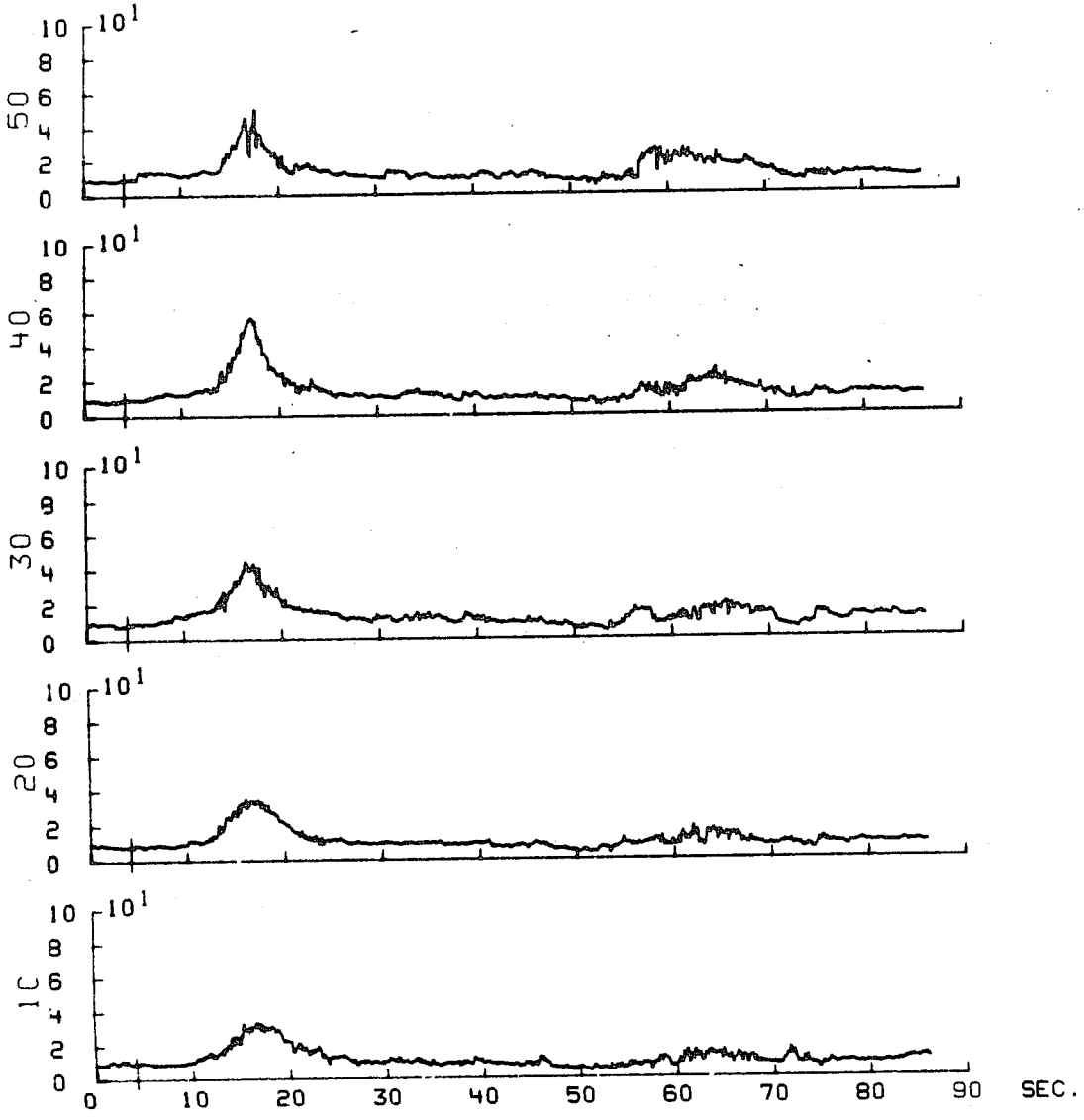
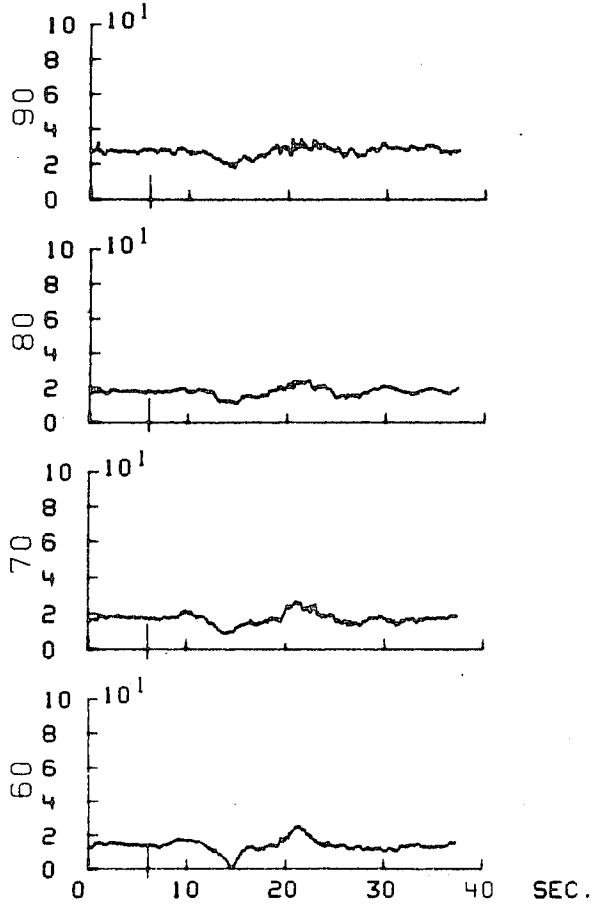


DC9 PASS 01 06/03/70 0648 00 EDT U=18 FPS



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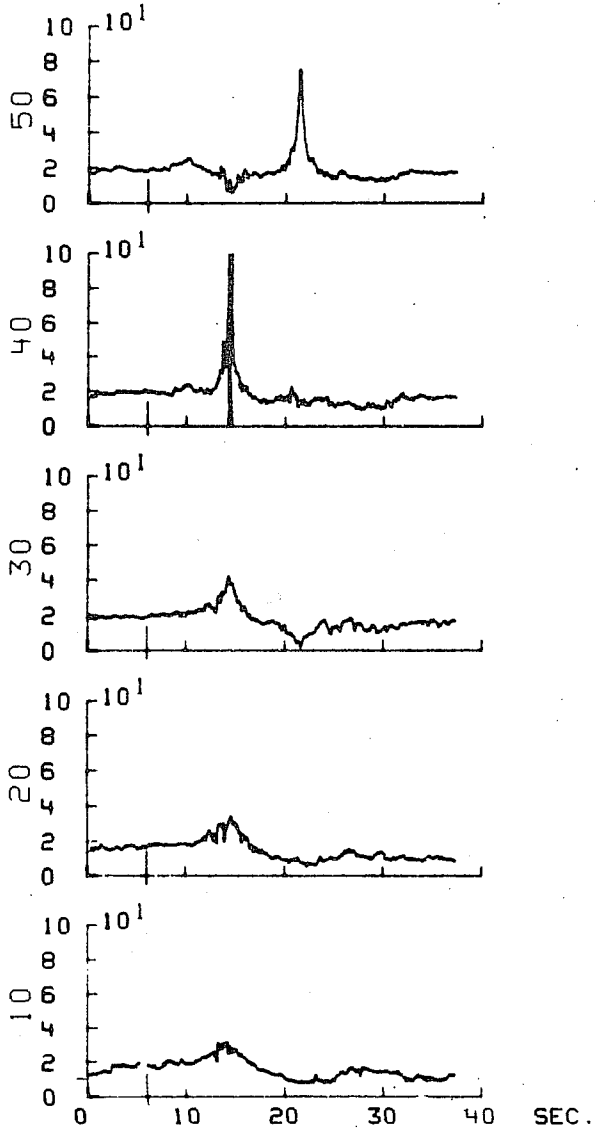

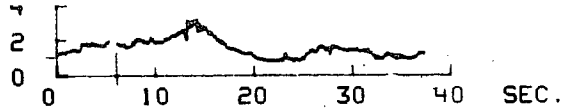

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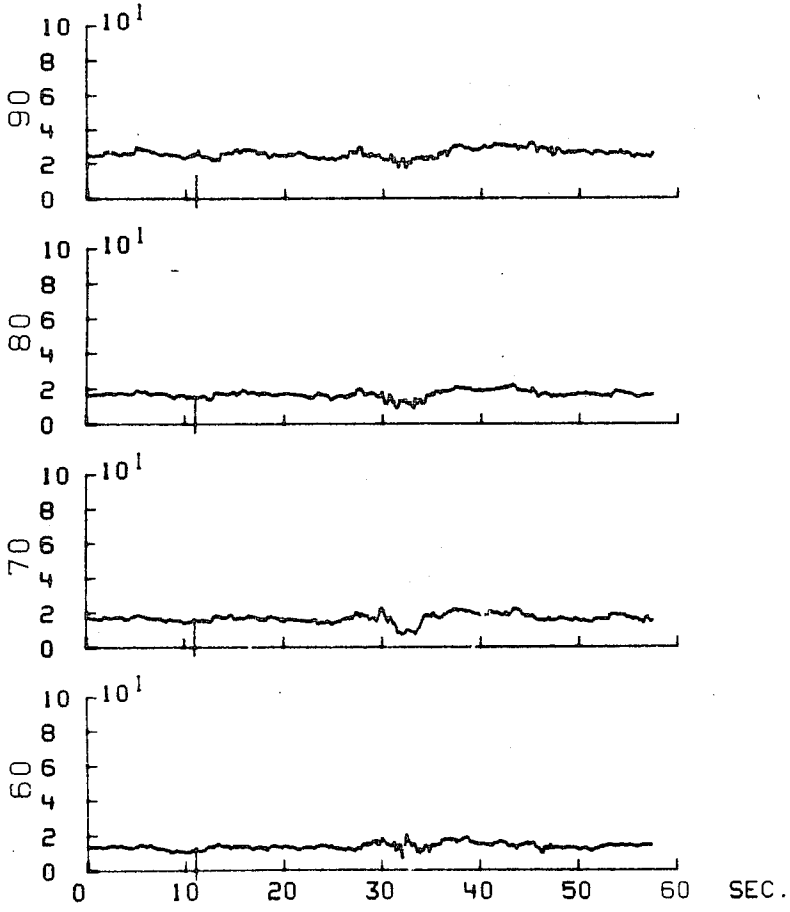

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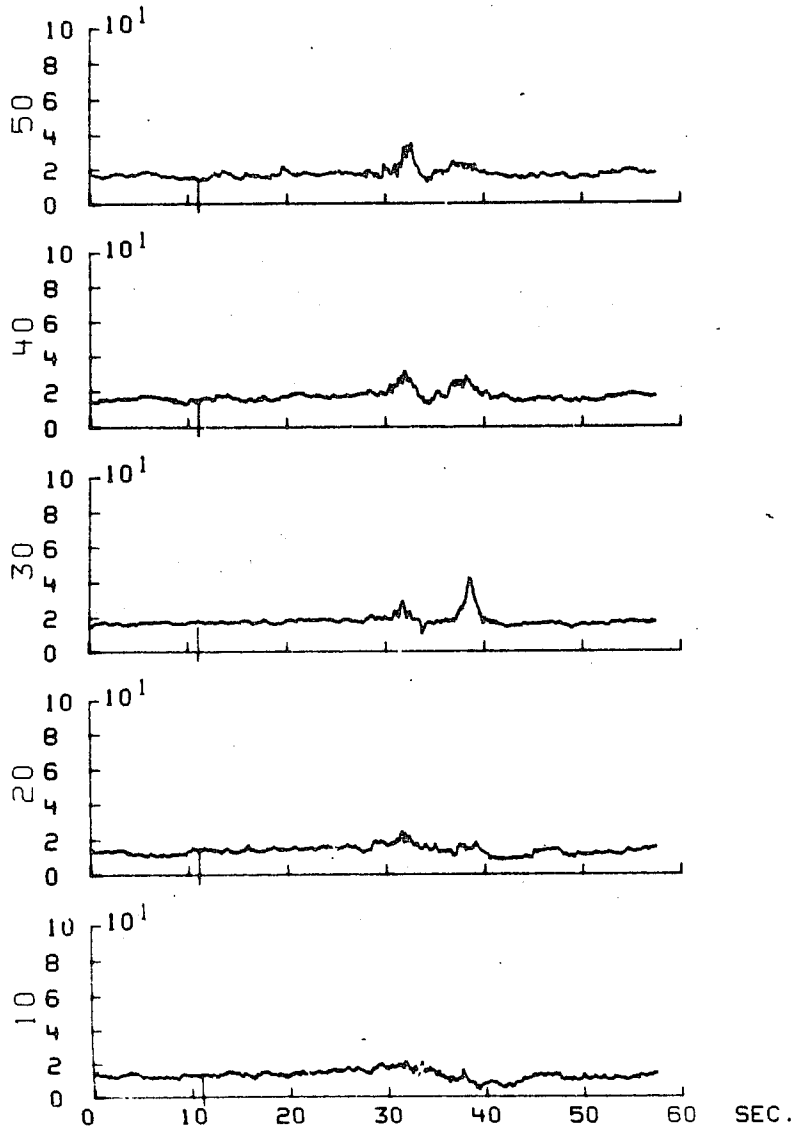

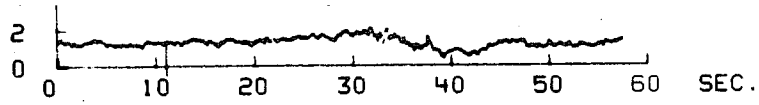

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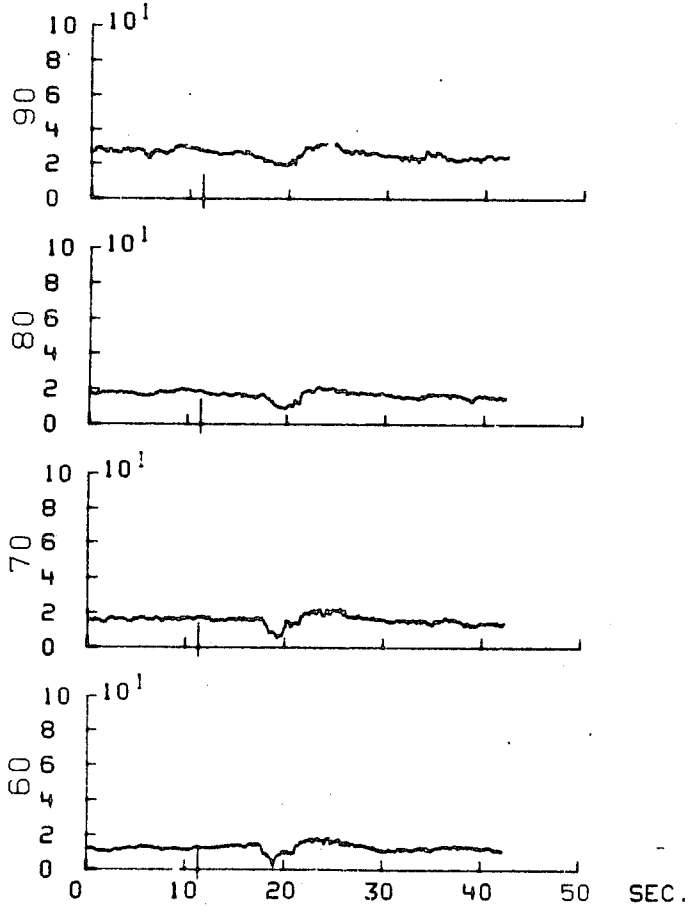

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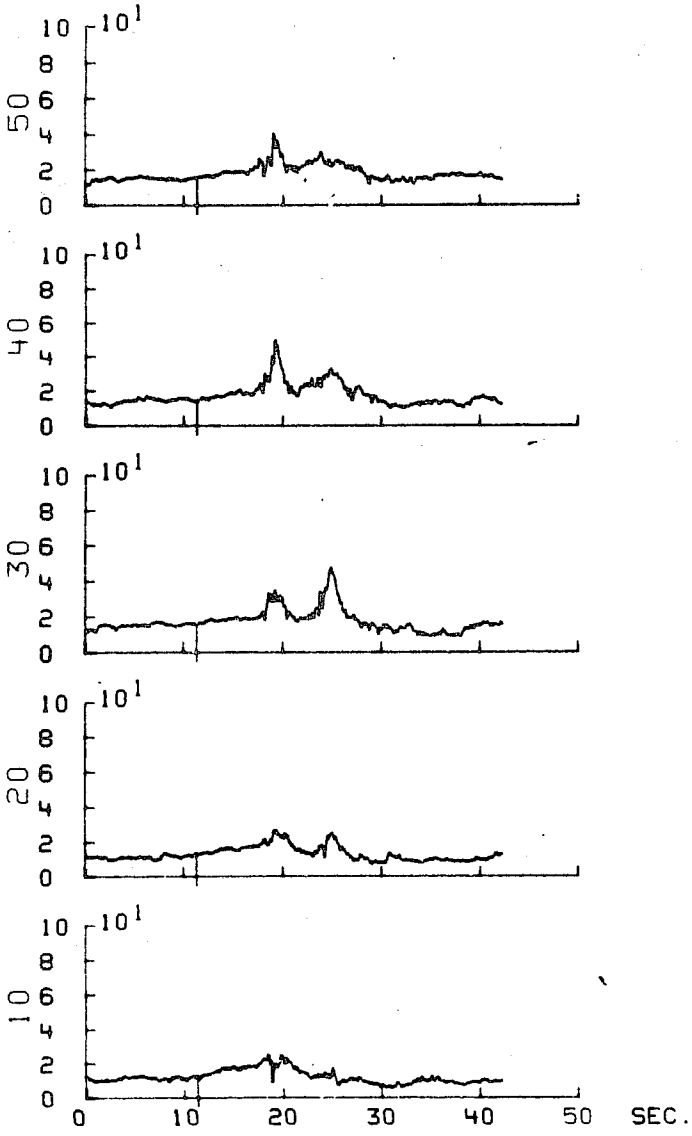

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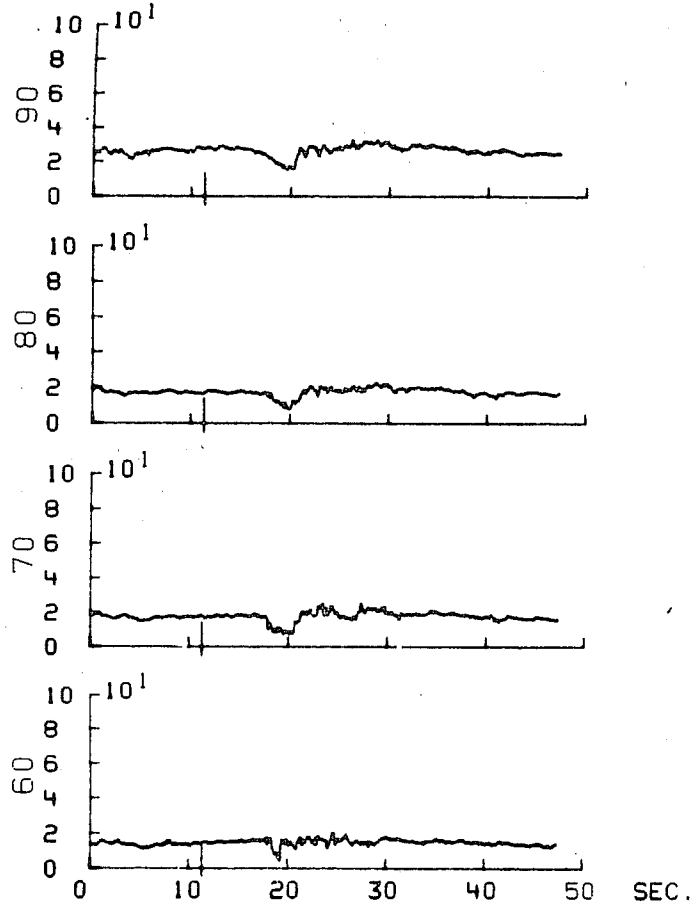

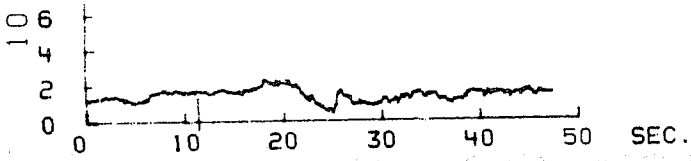

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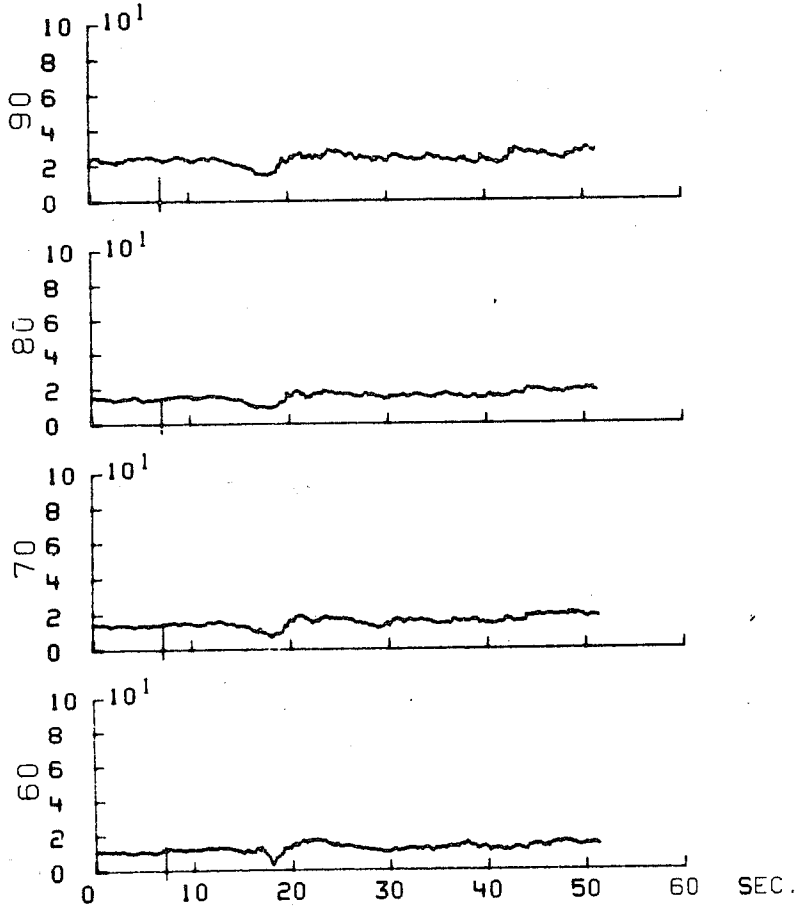

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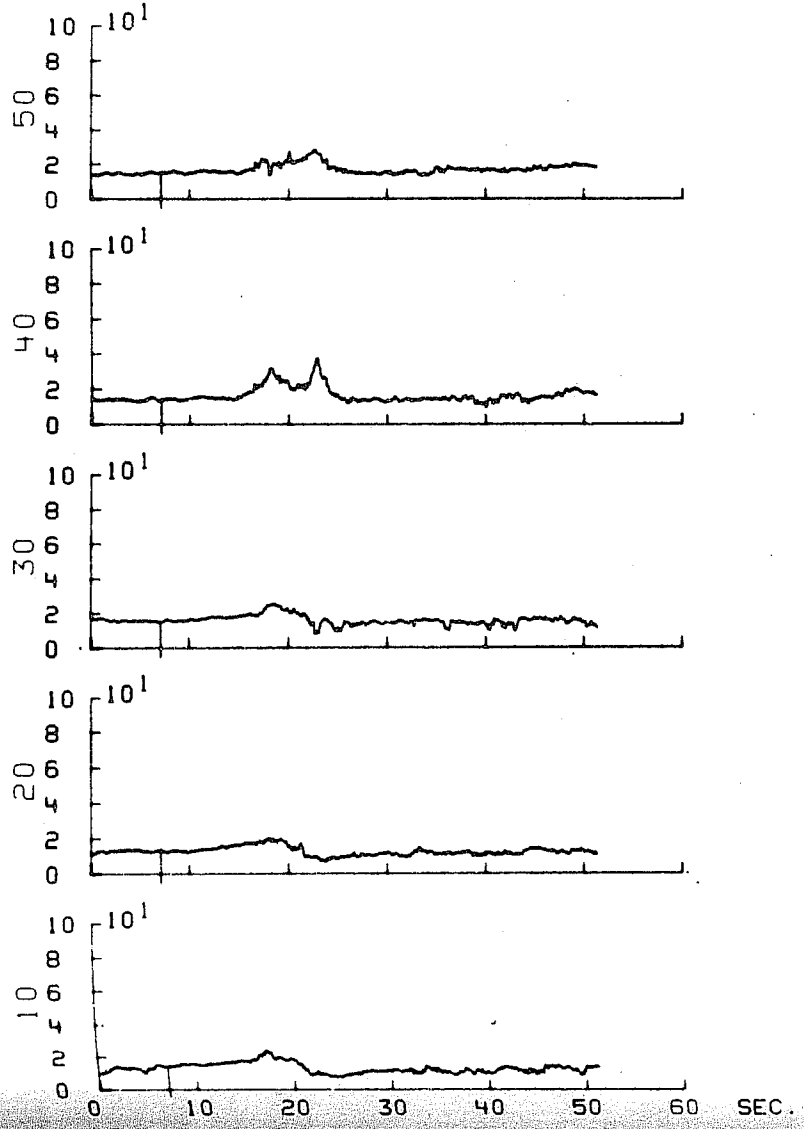
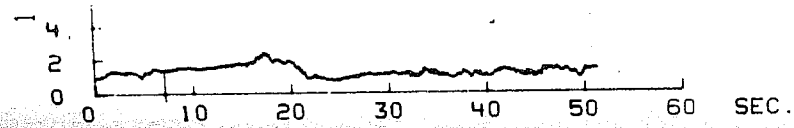
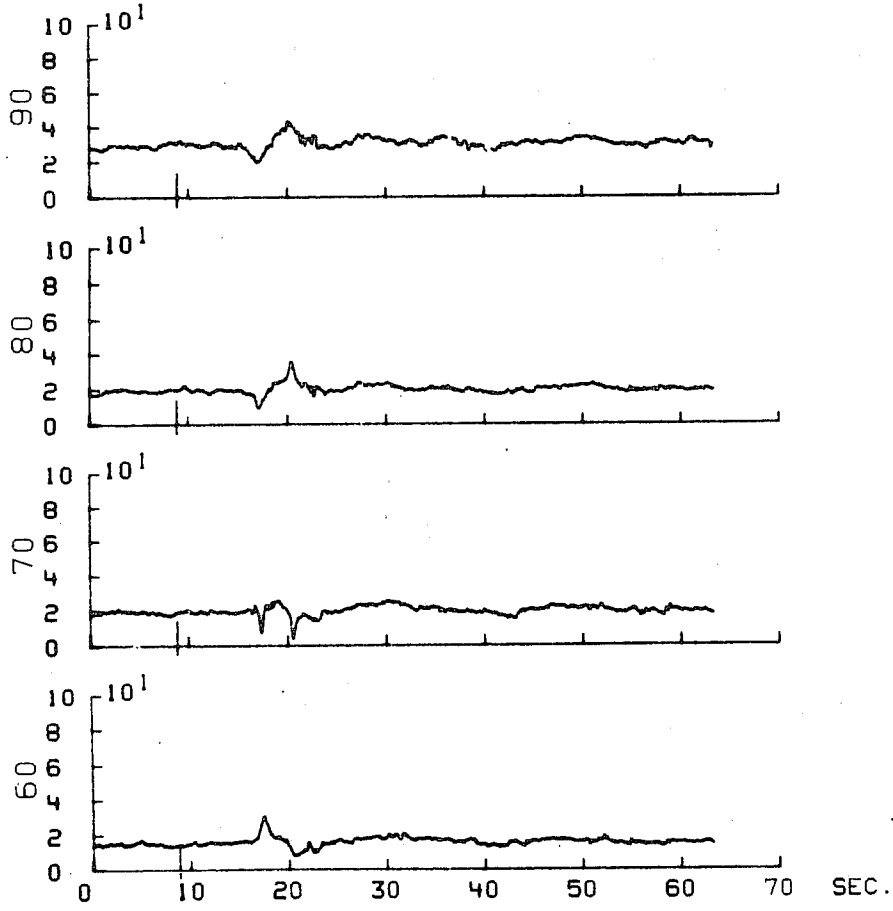




DC9 PASS 06 06/03/70 0714 49 EDT U=19 FPS



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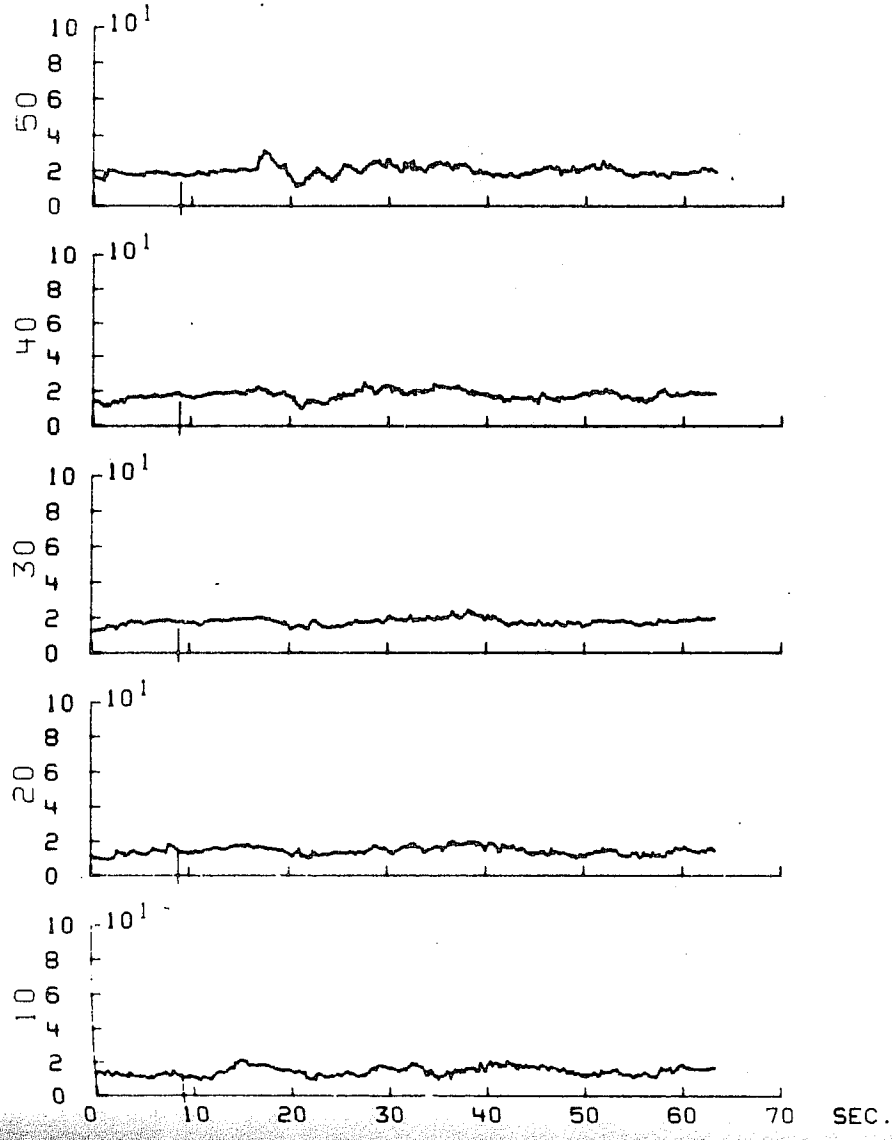

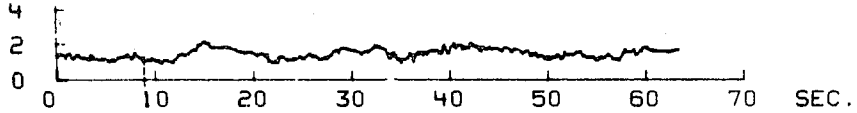

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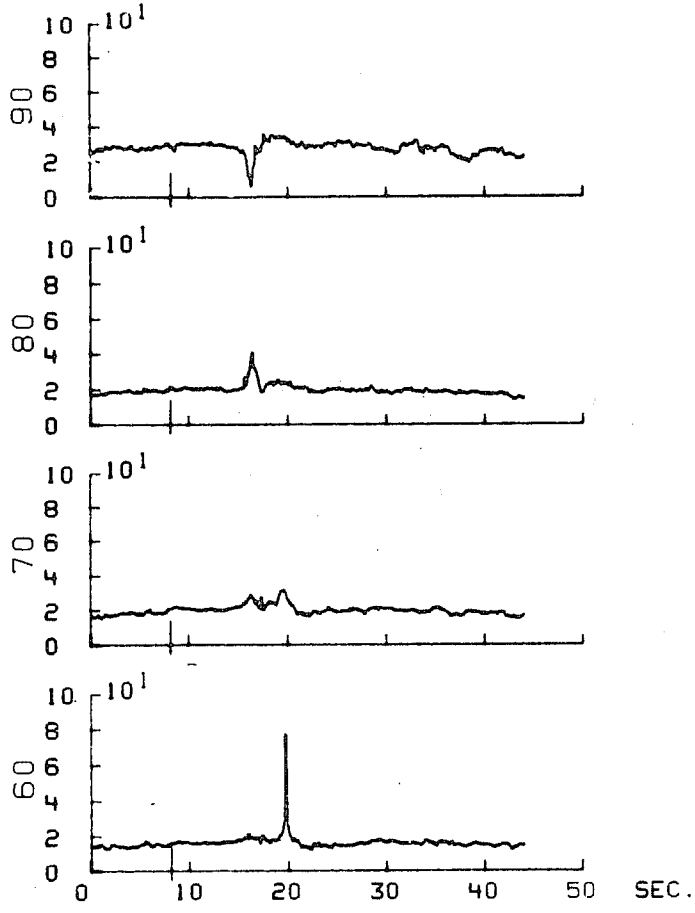

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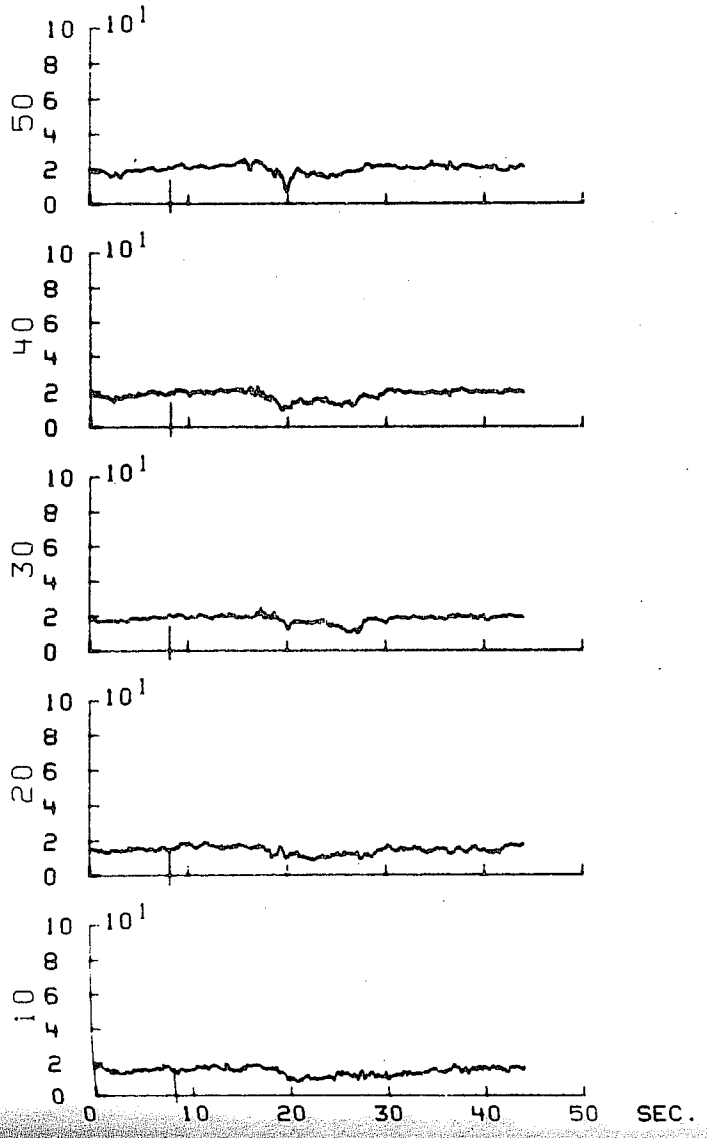

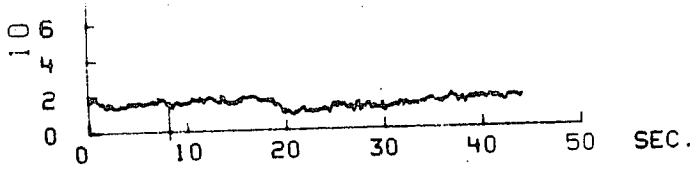

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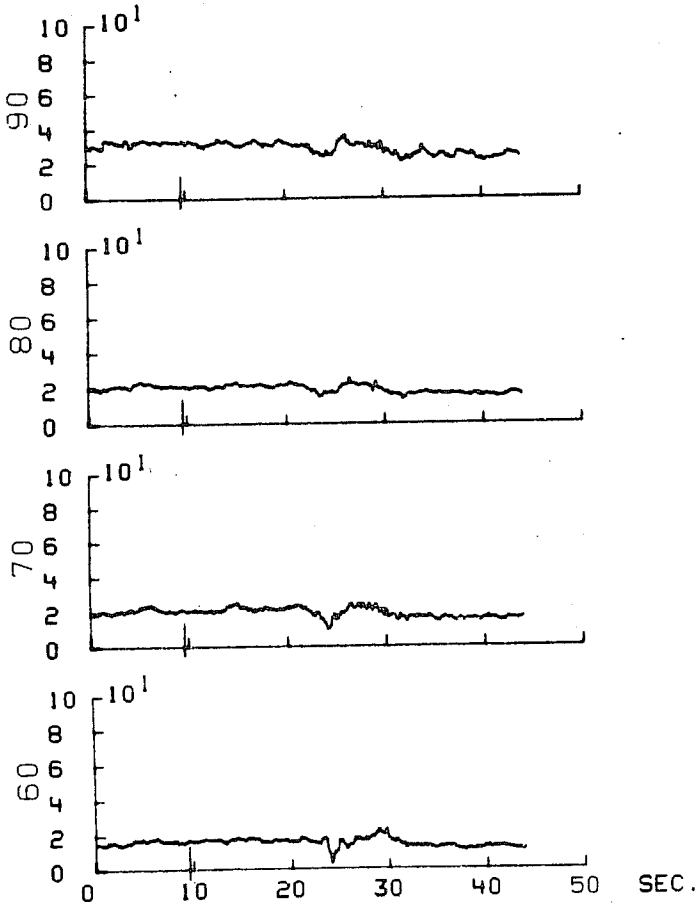

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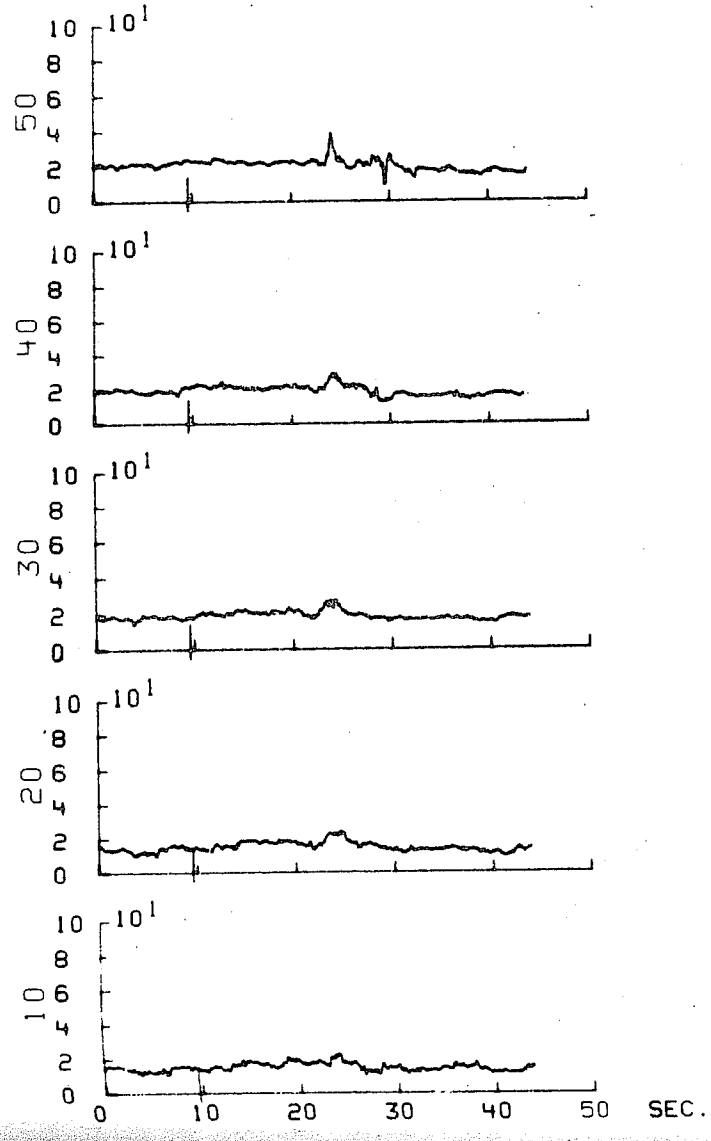

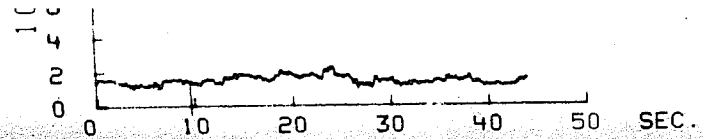

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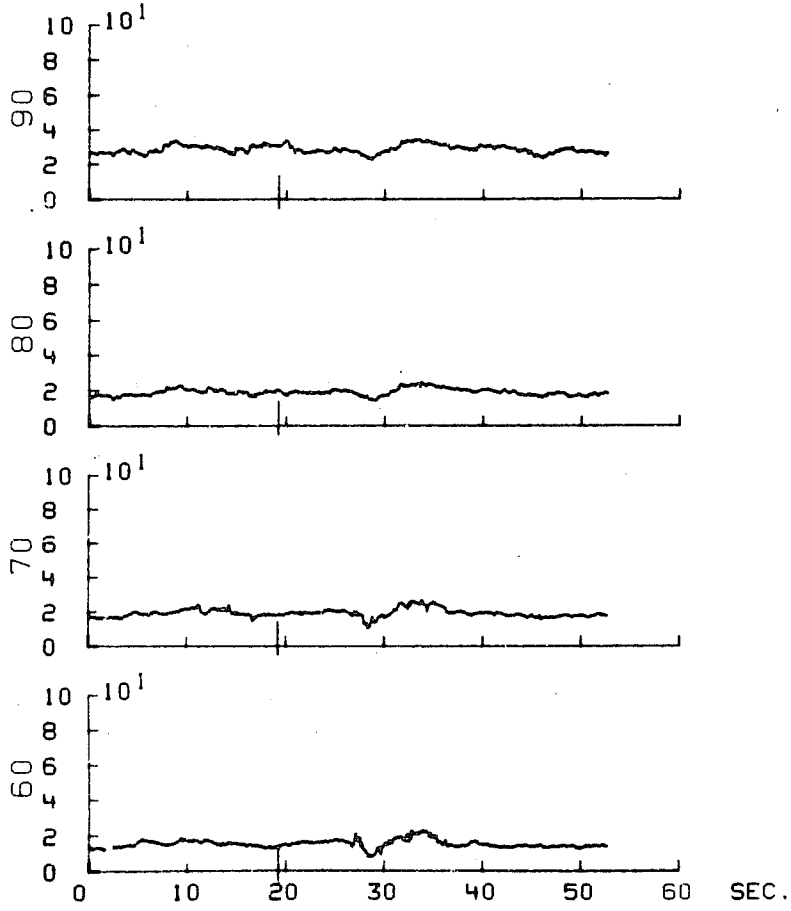

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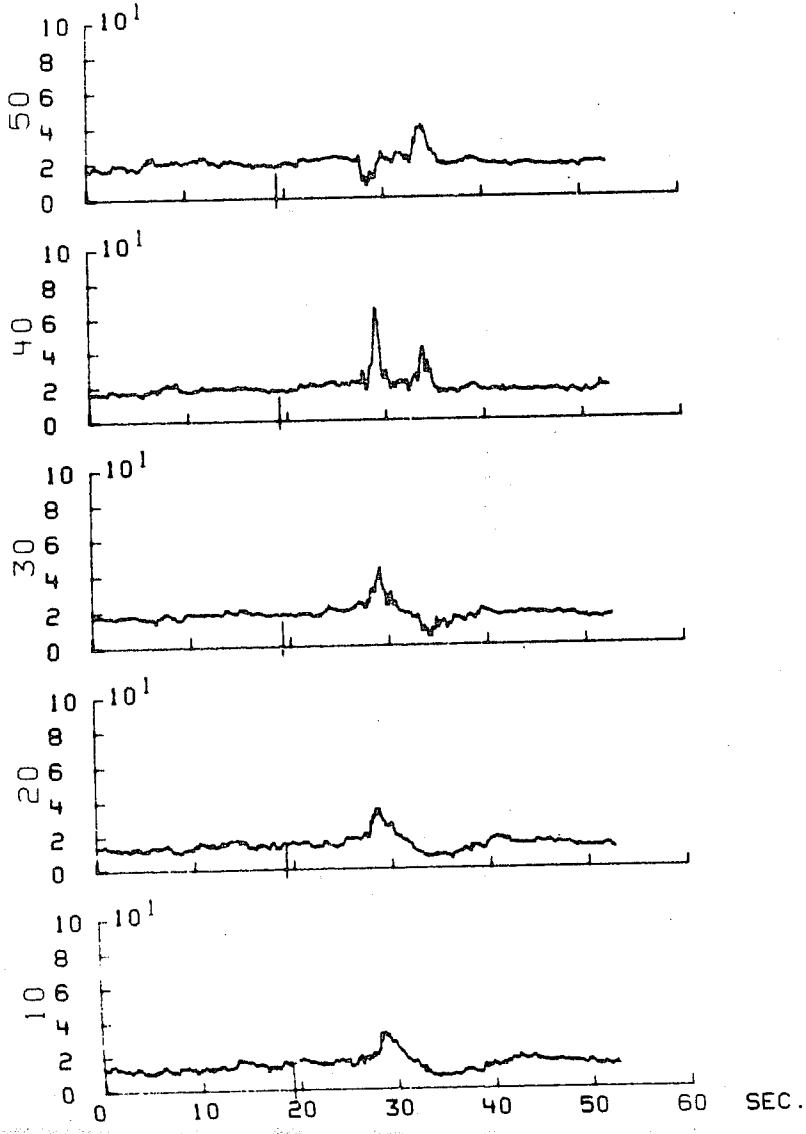

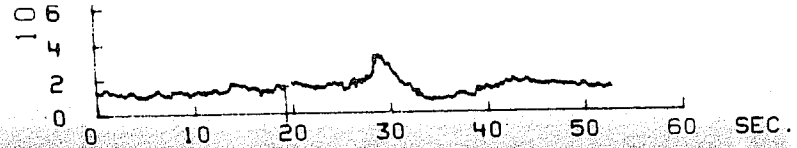

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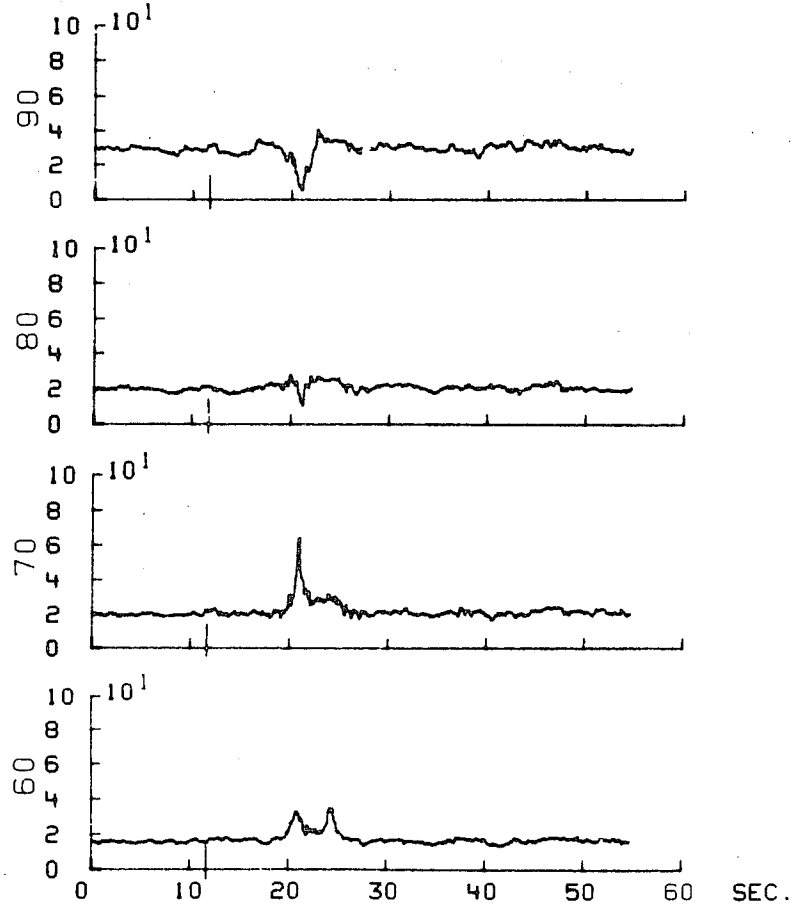

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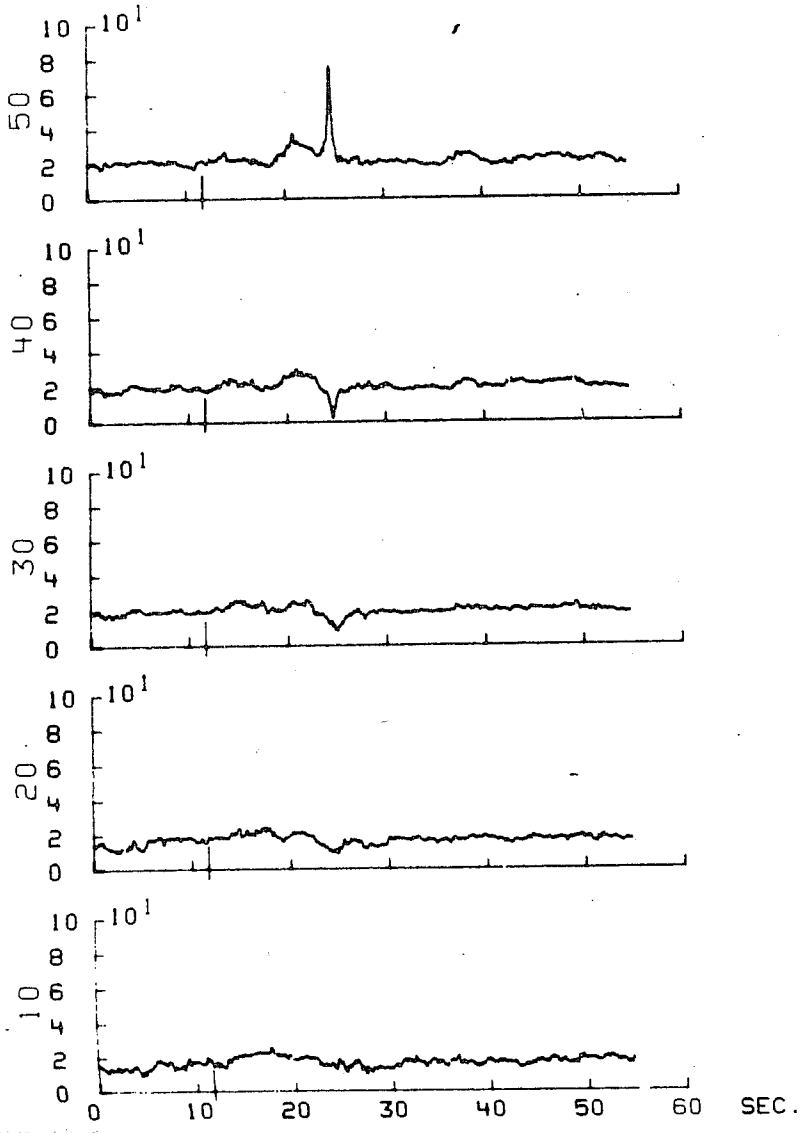

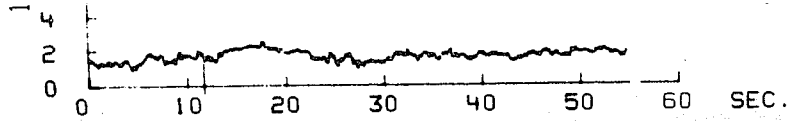

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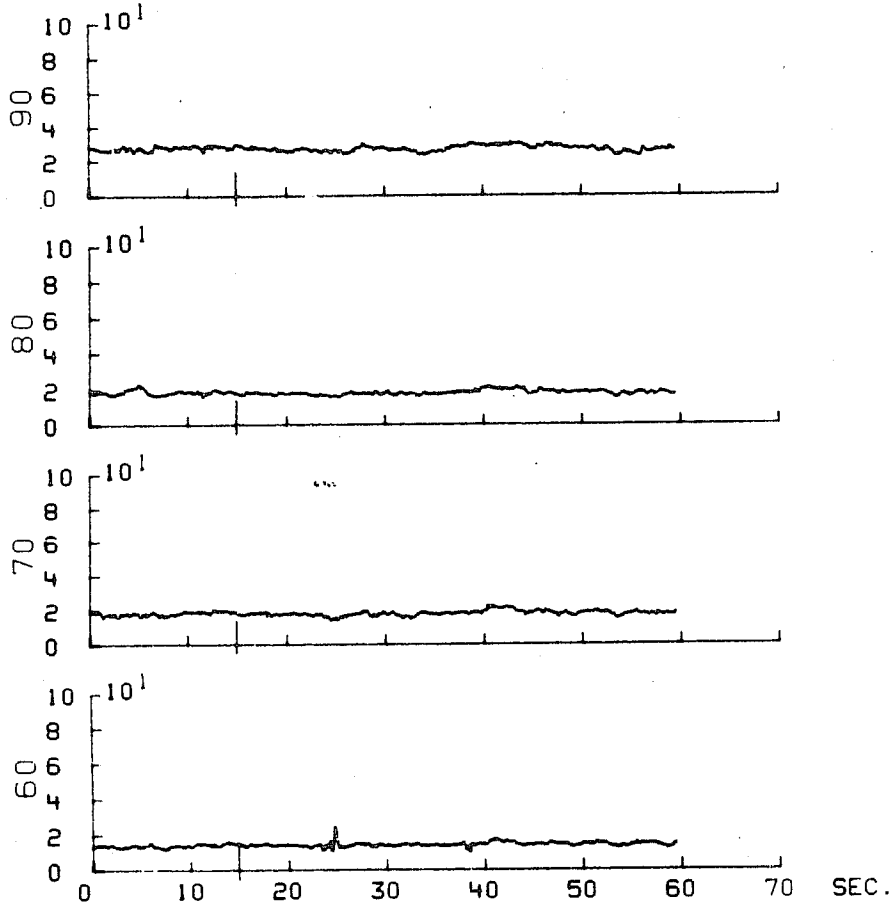

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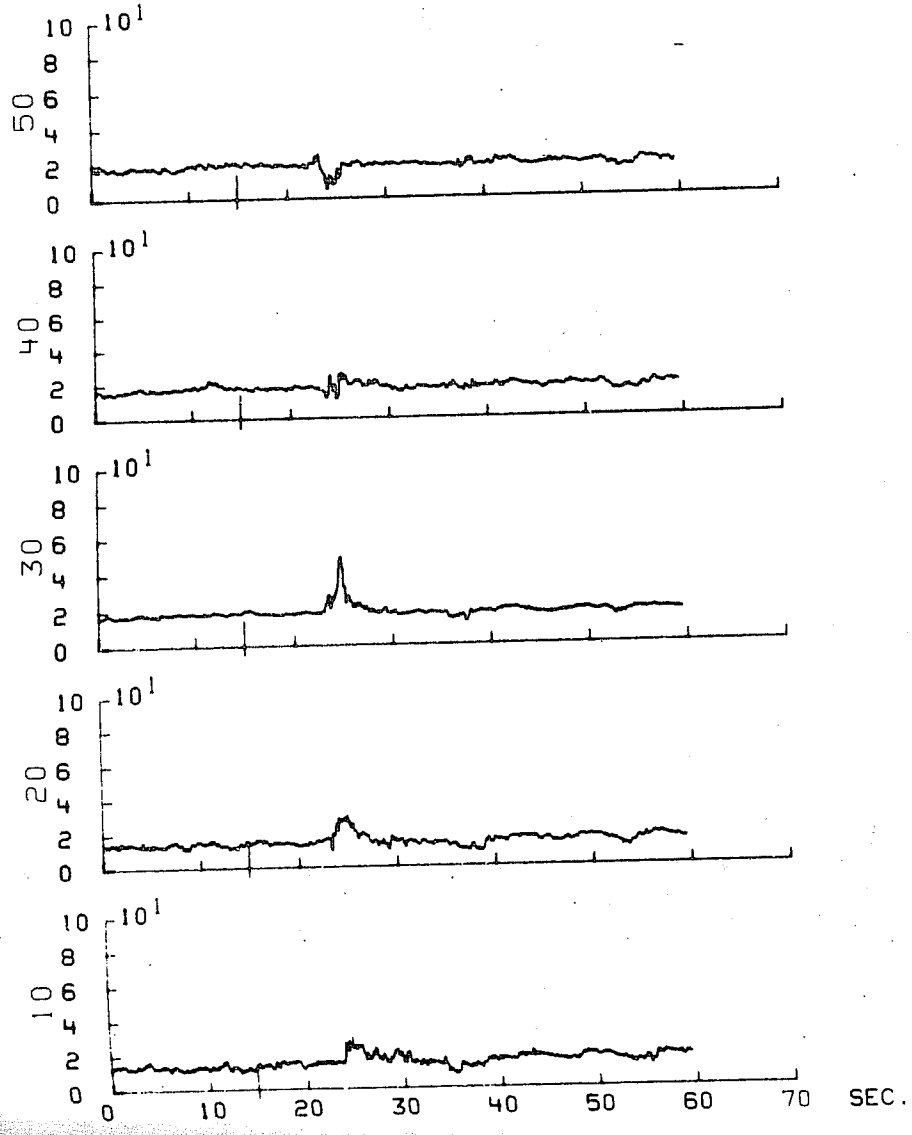

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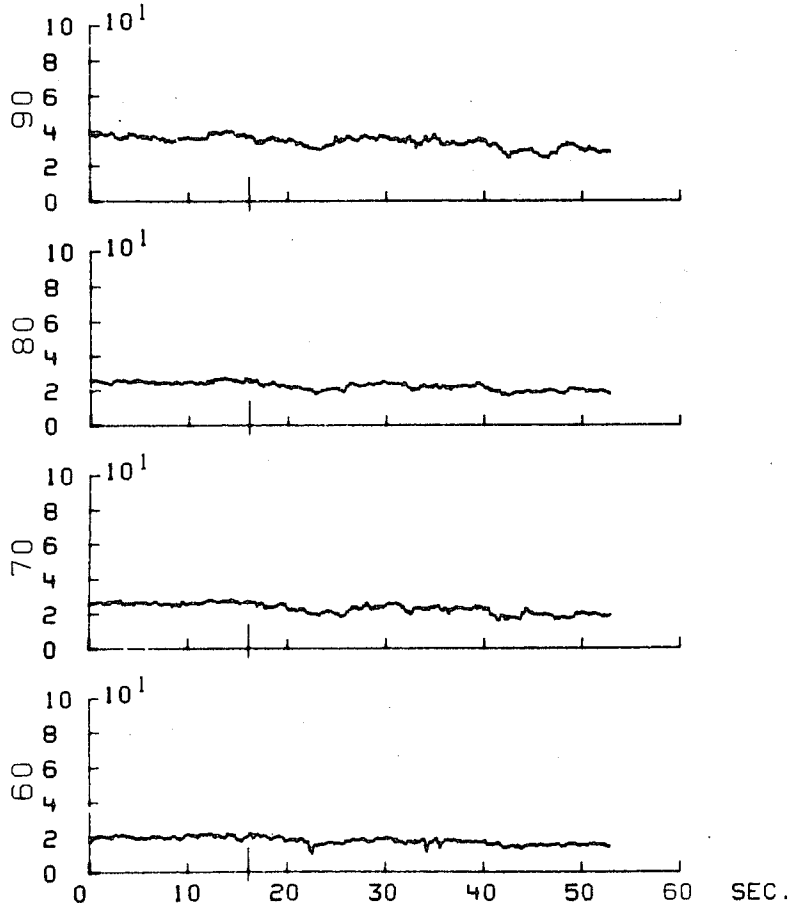

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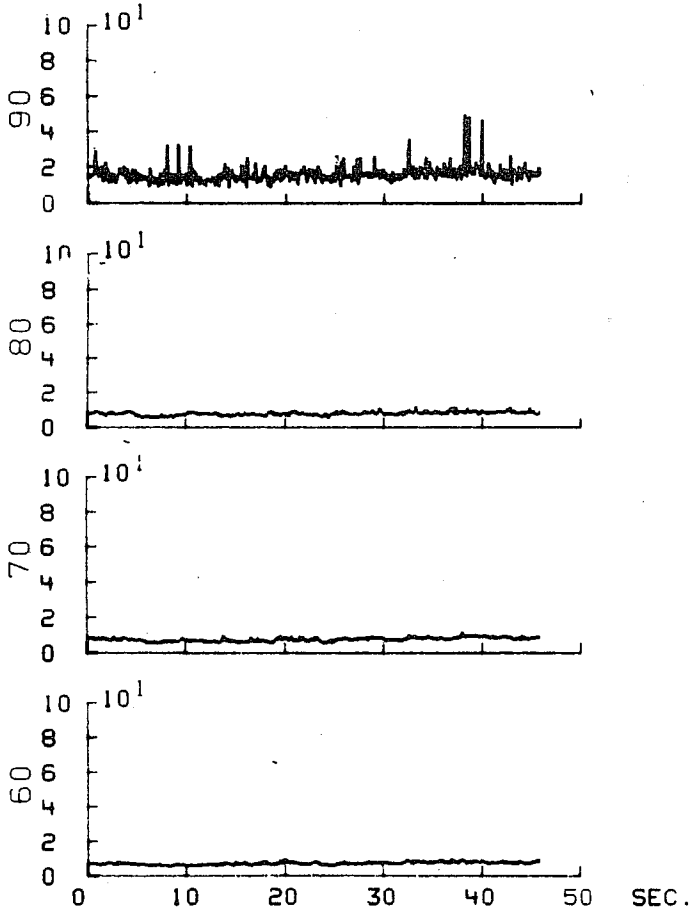

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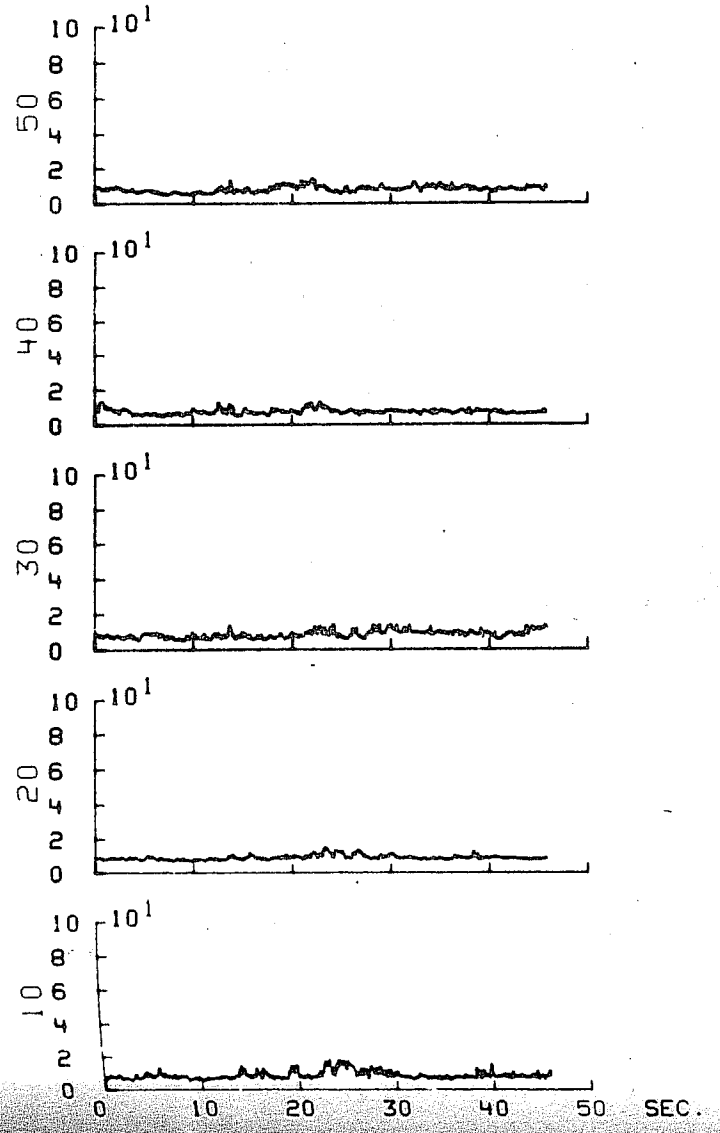

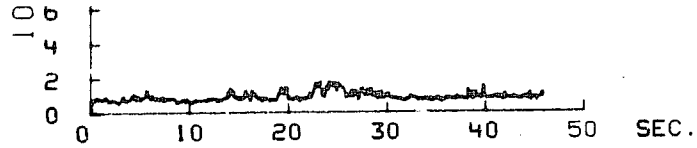

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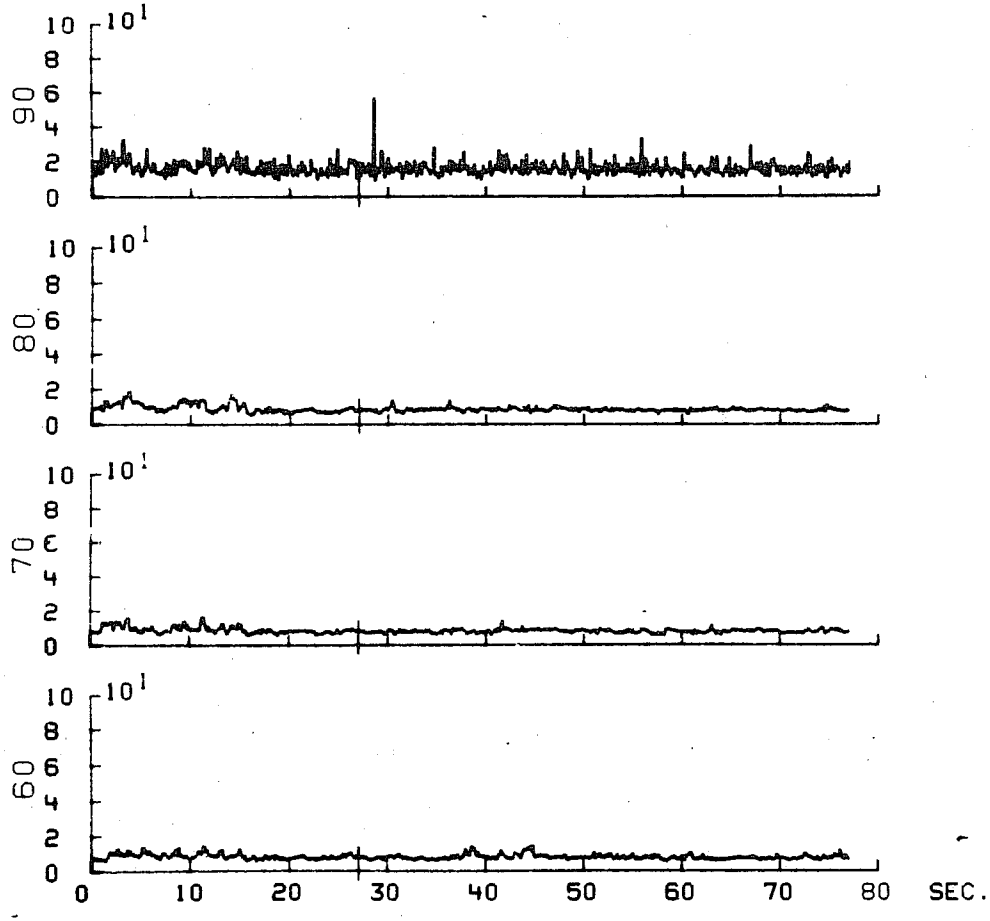

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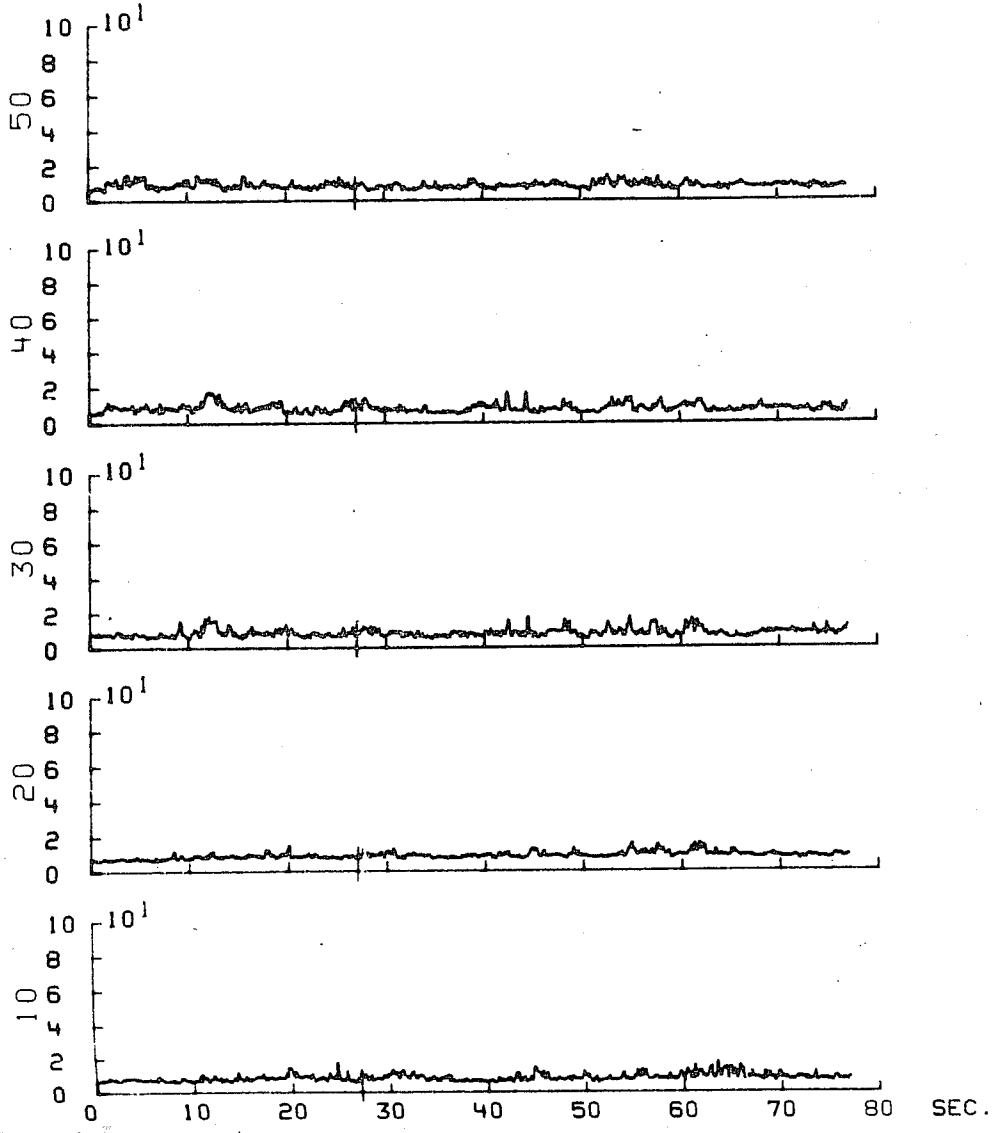

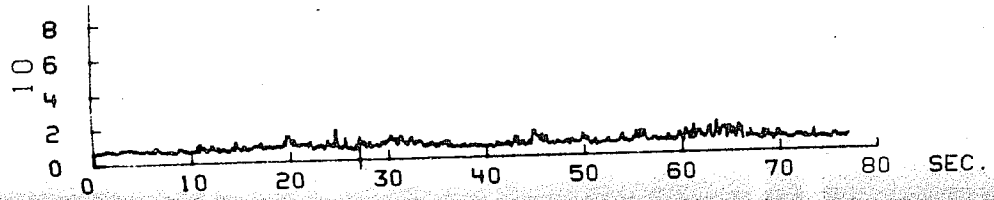

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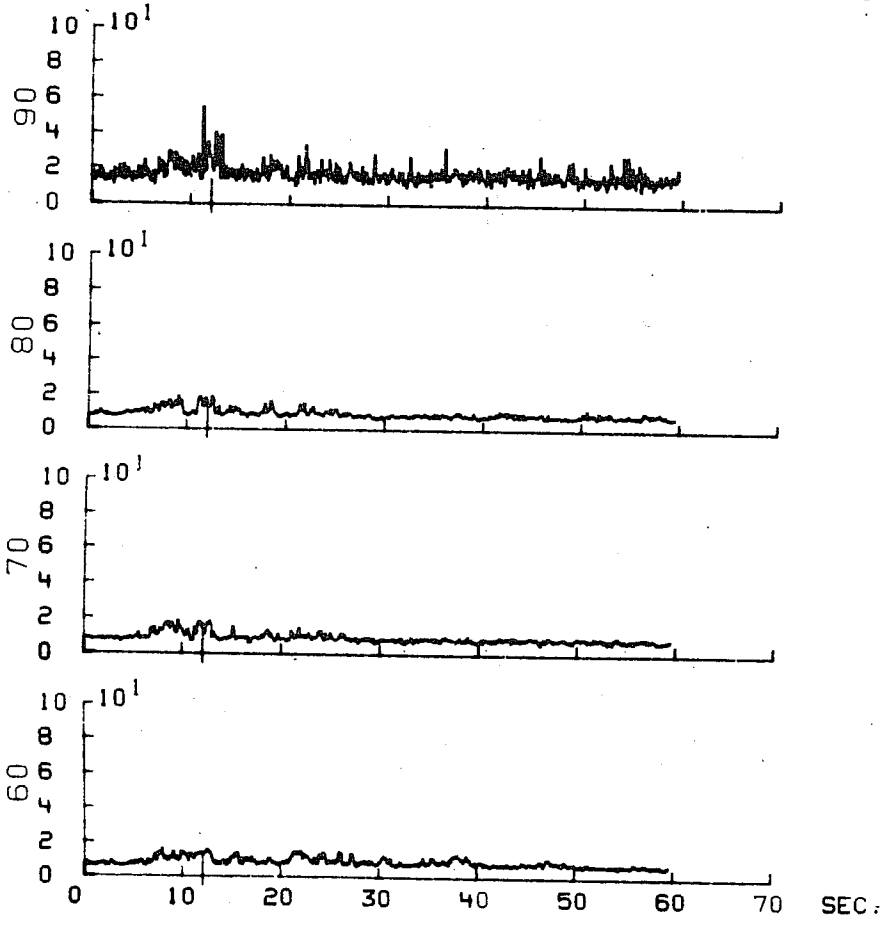

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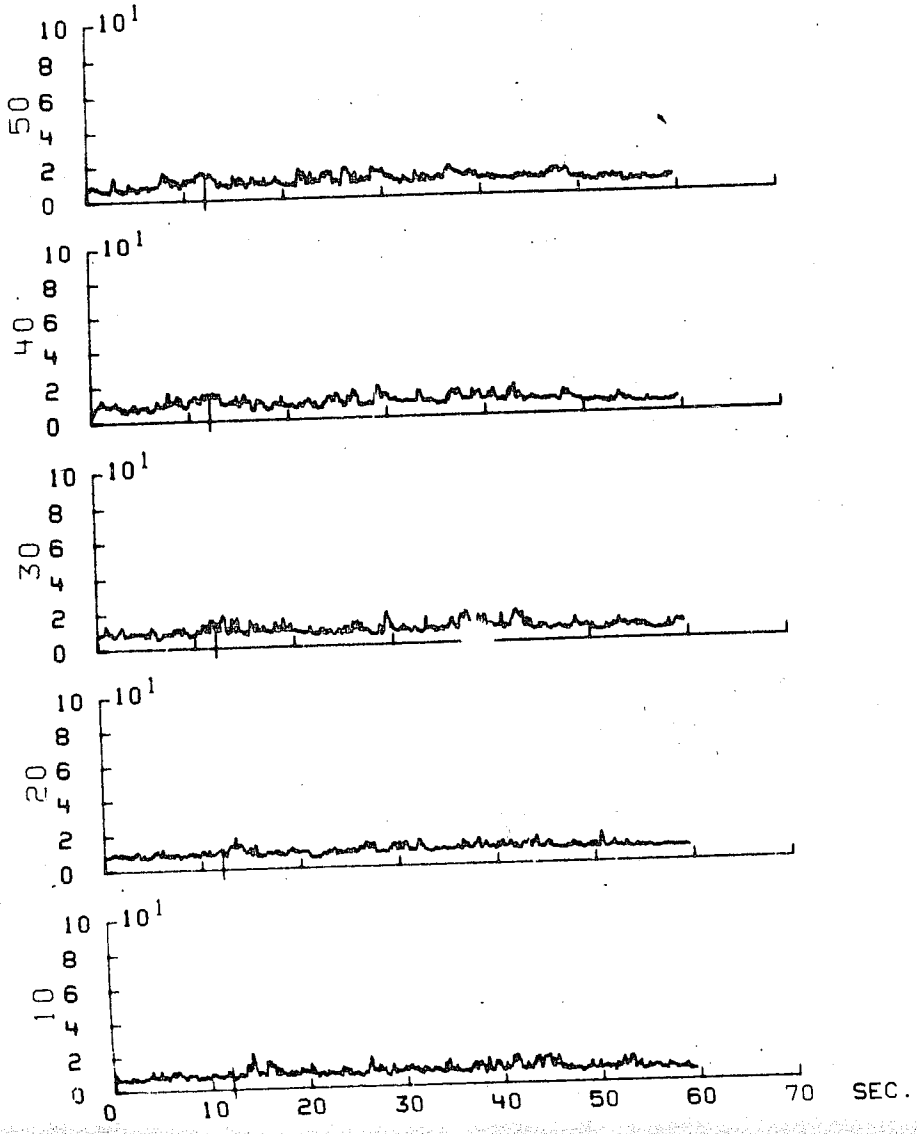

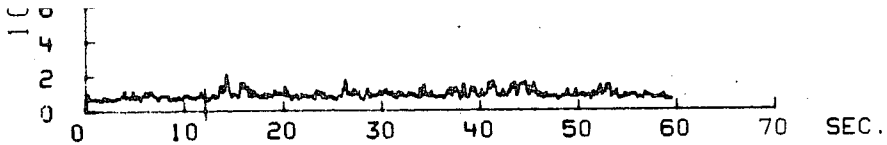

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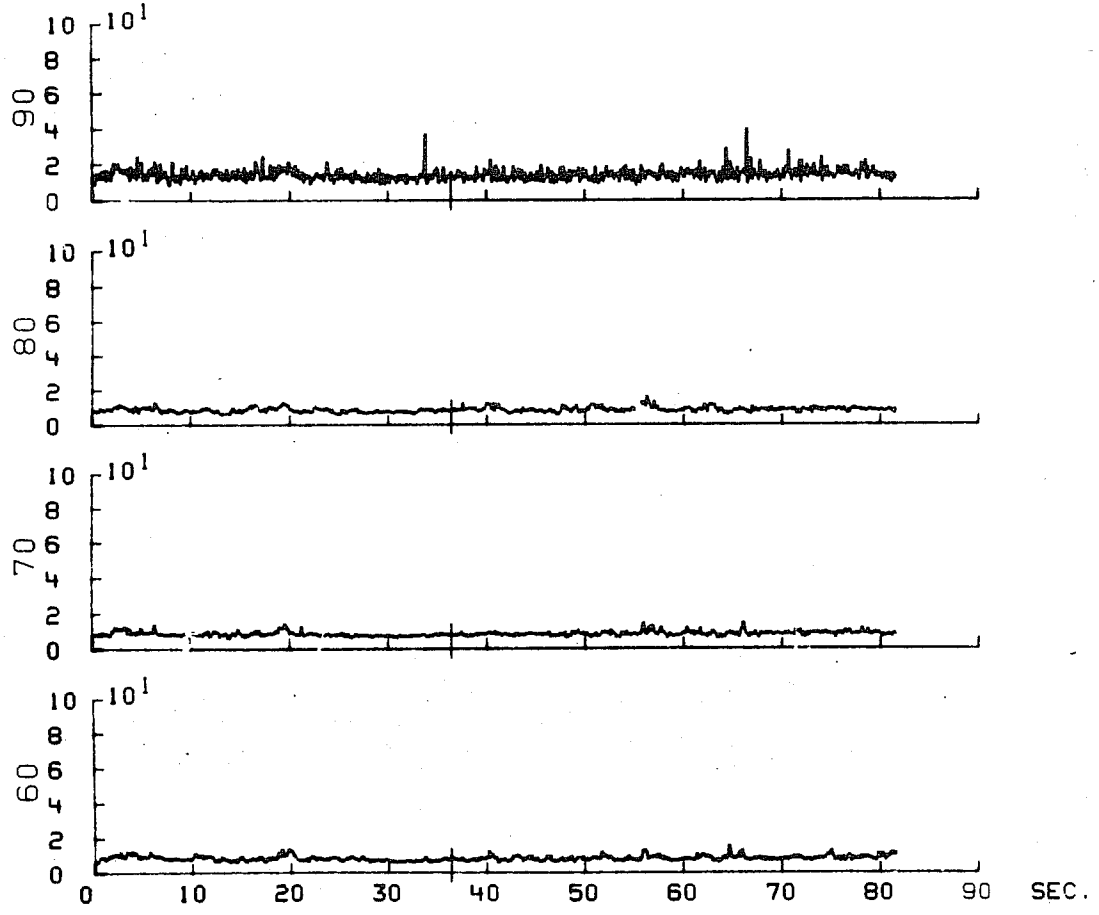

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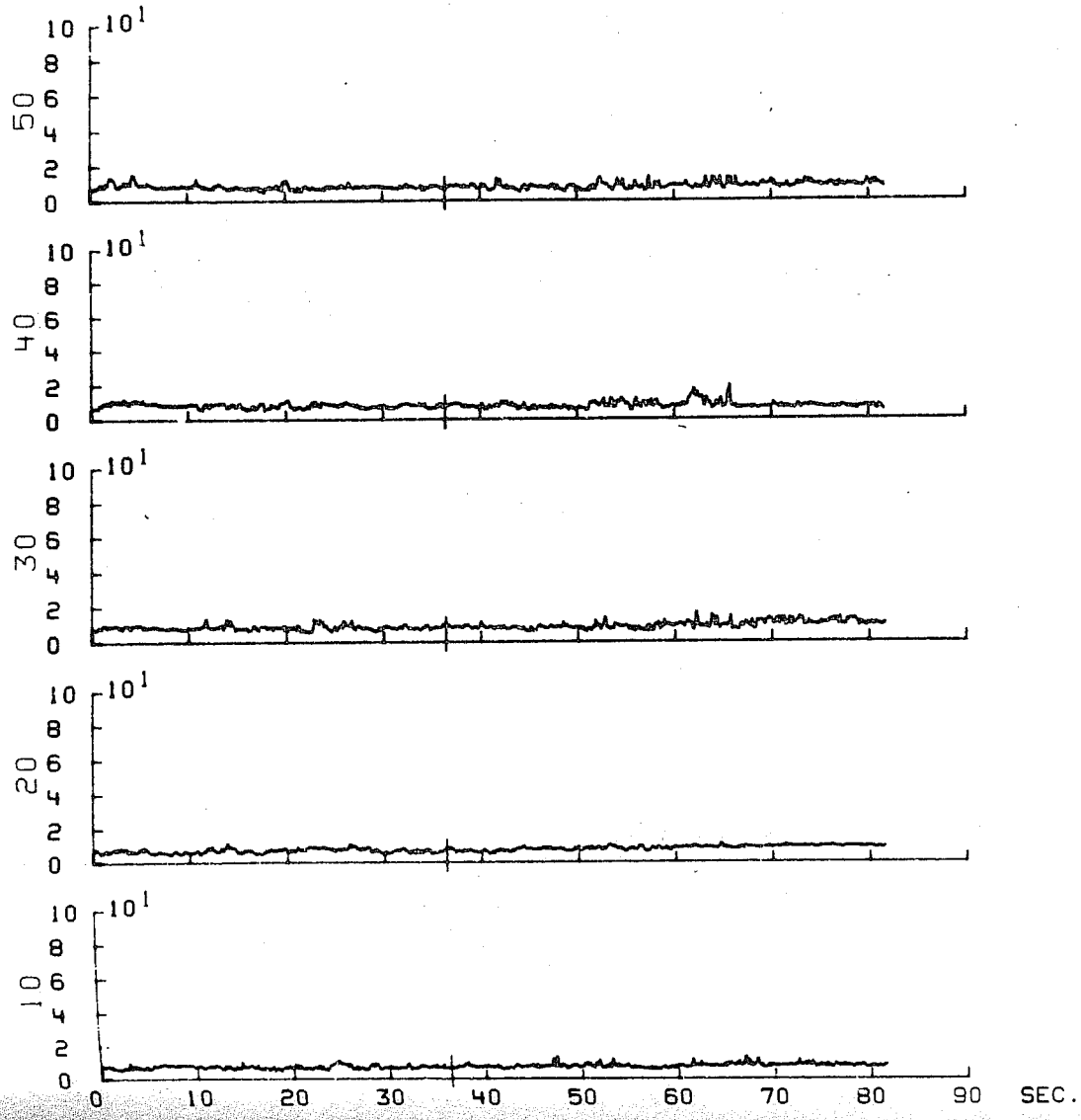

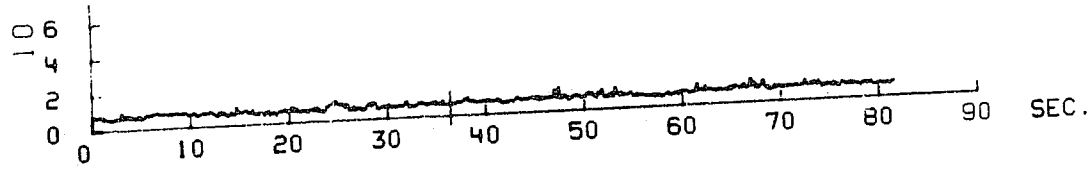

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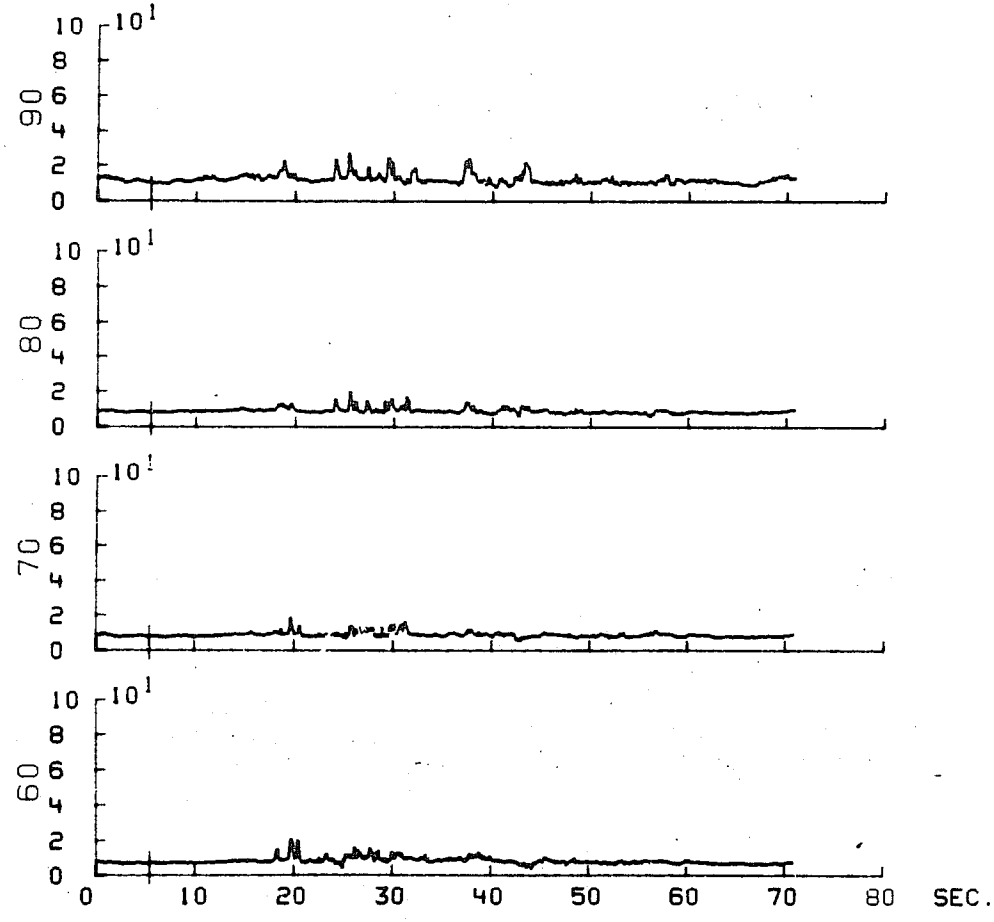

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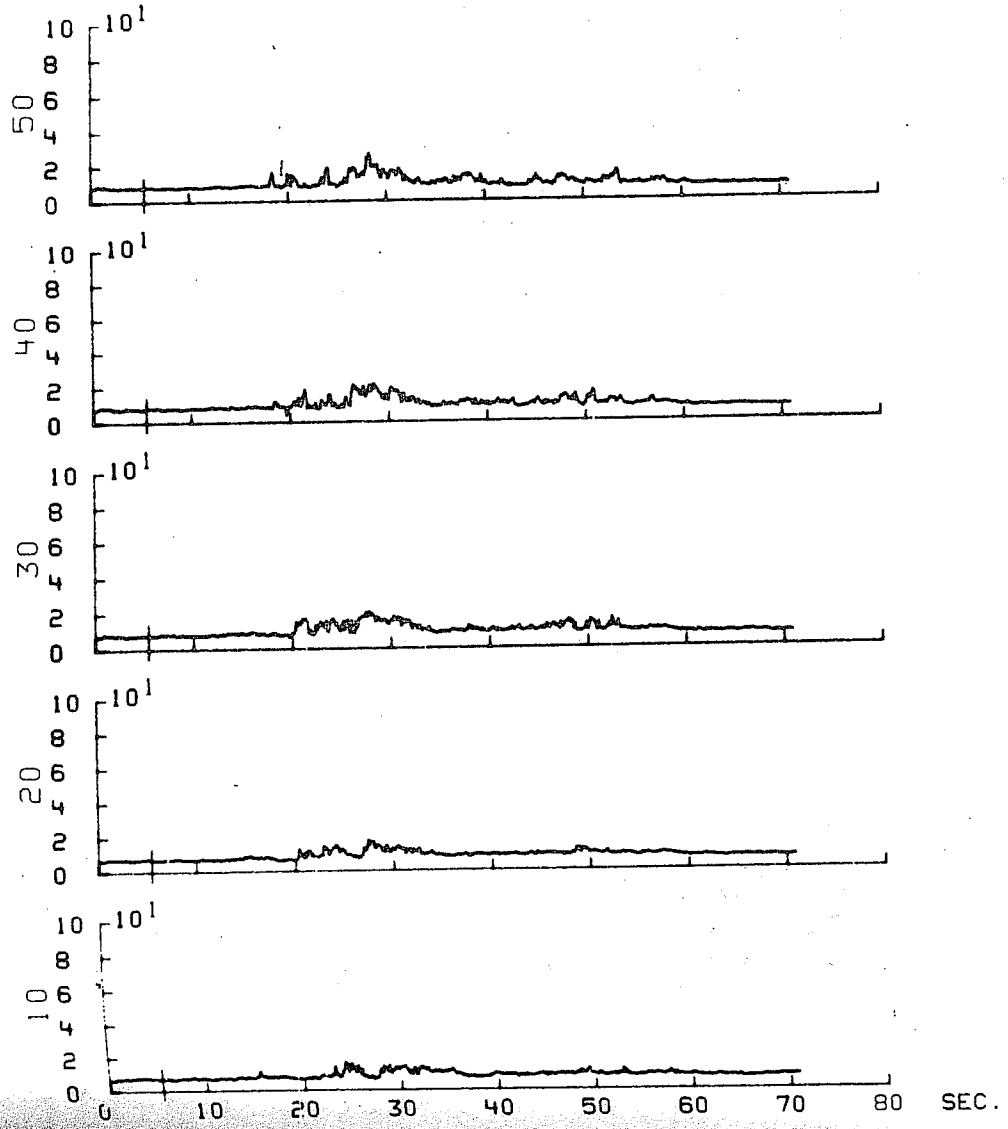

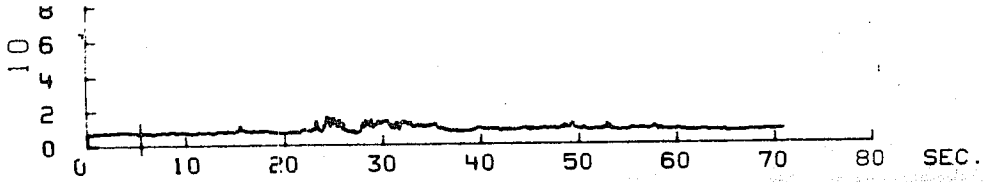

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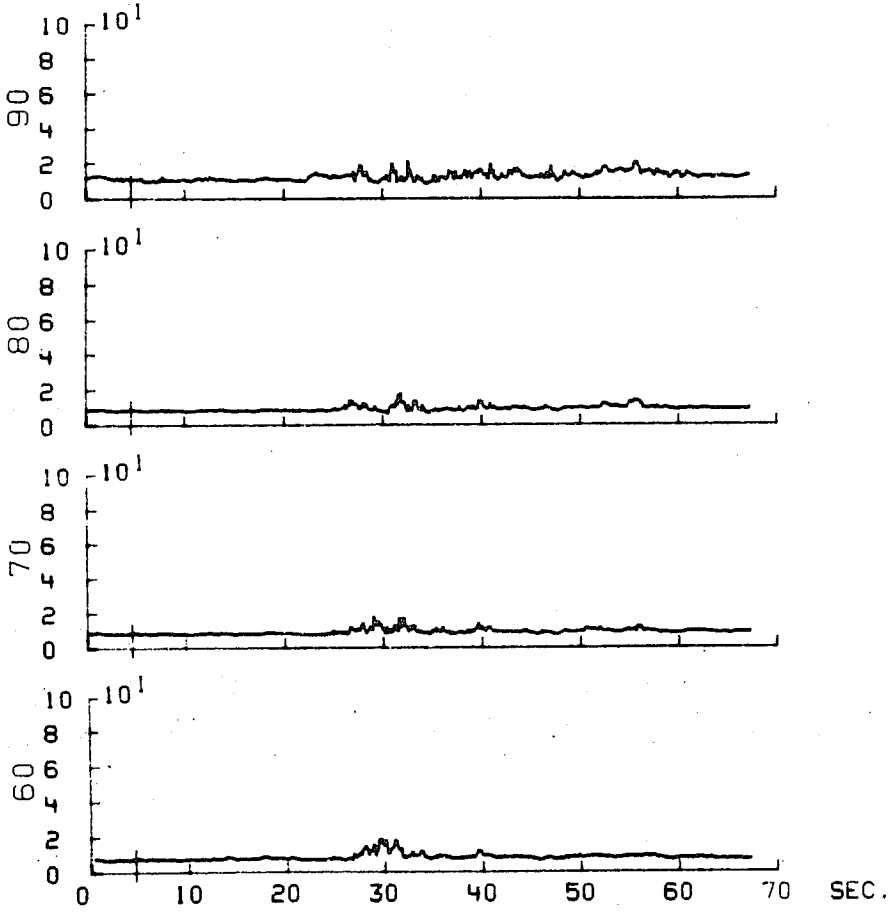

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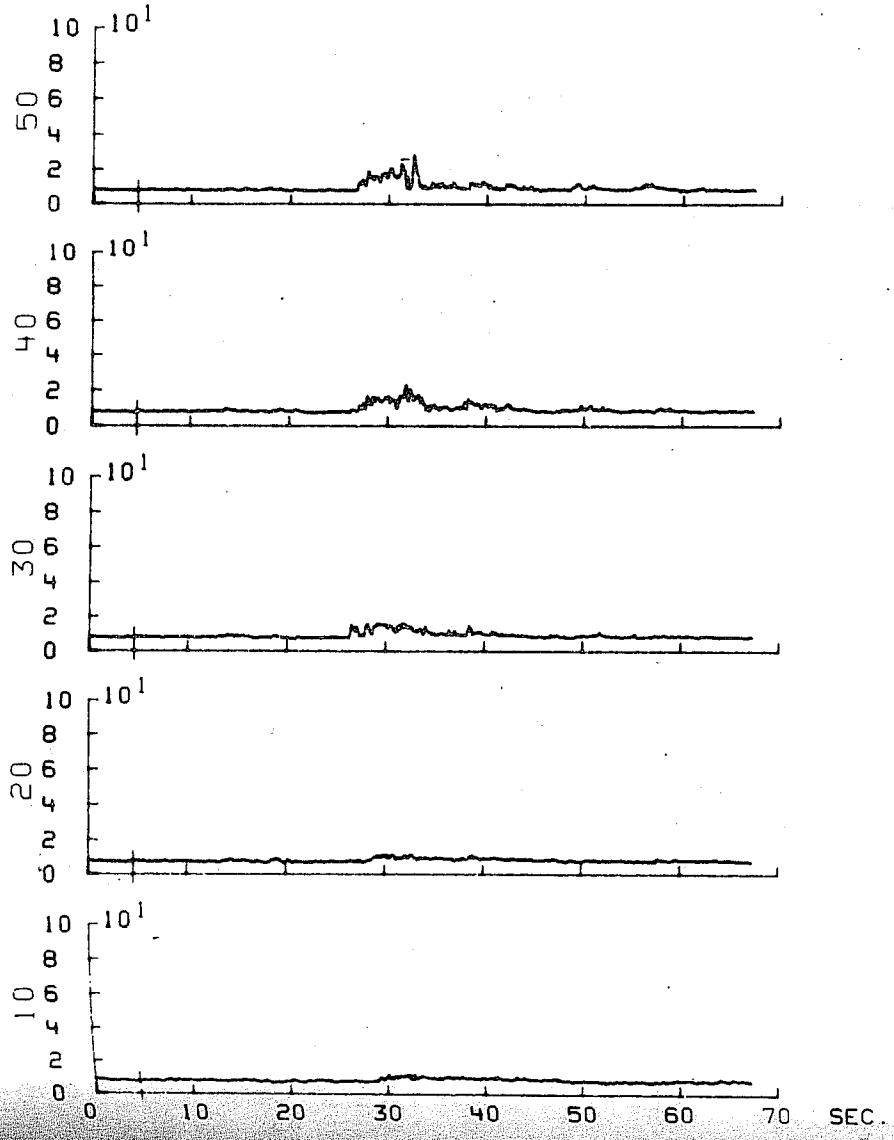

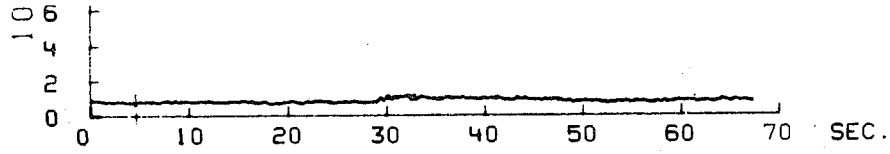

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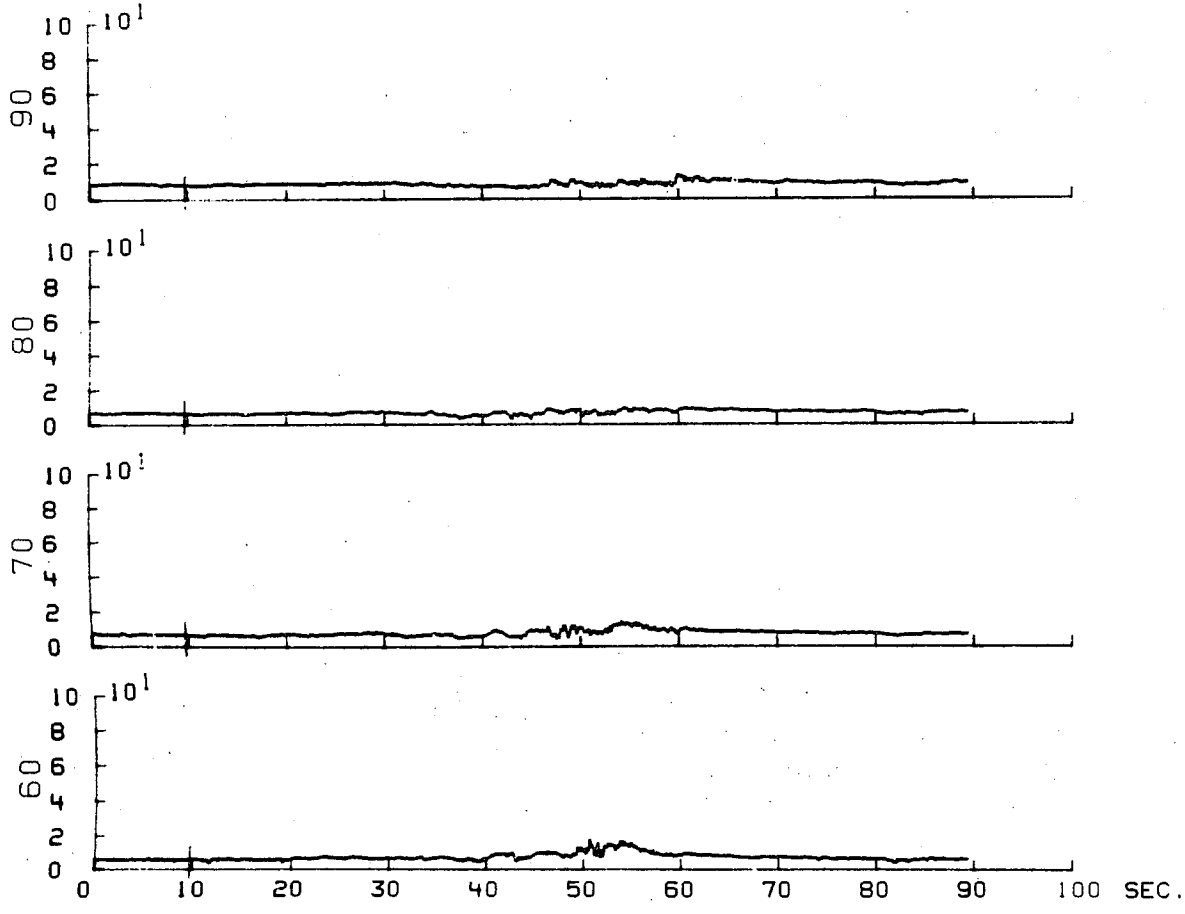

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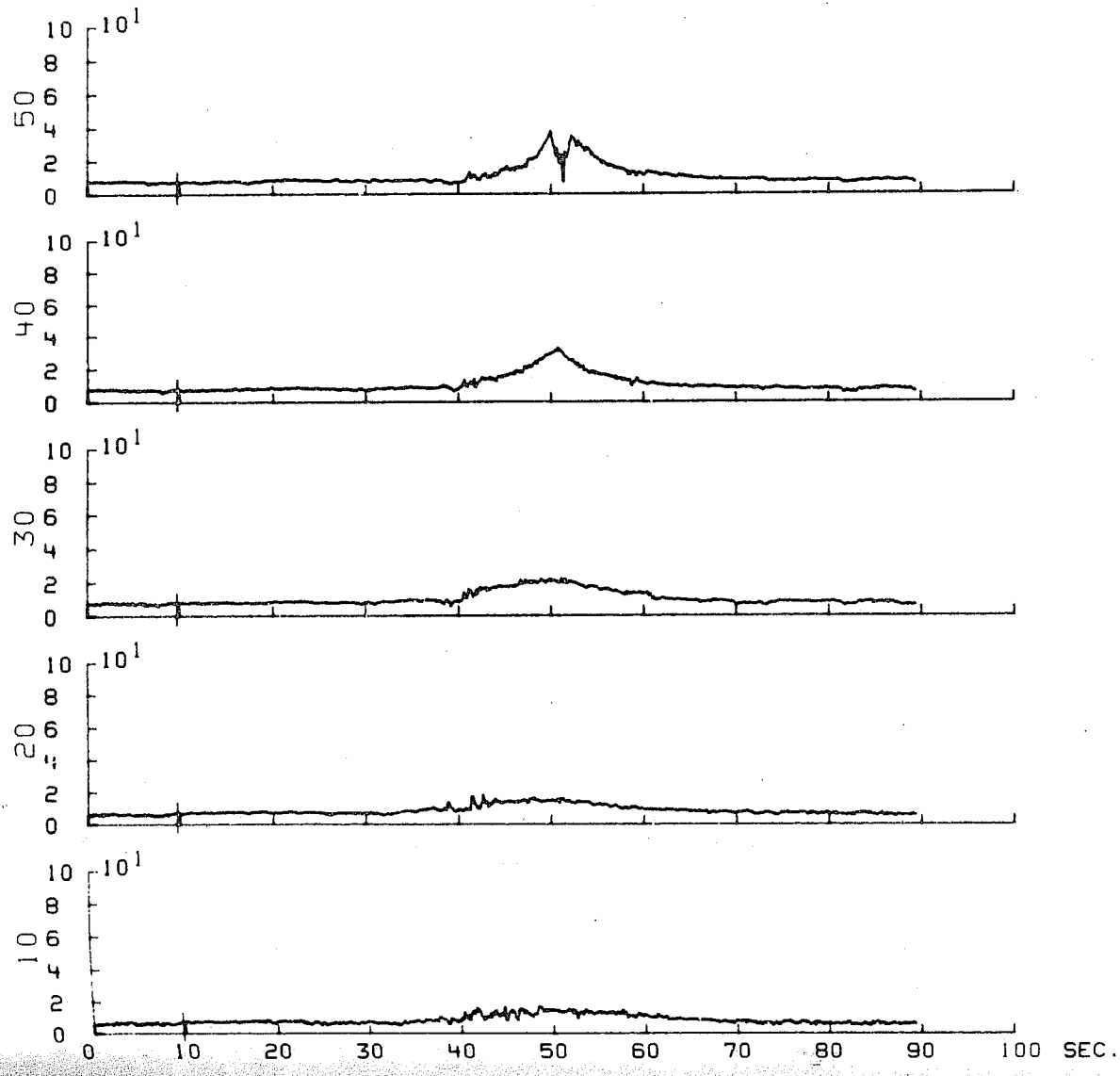

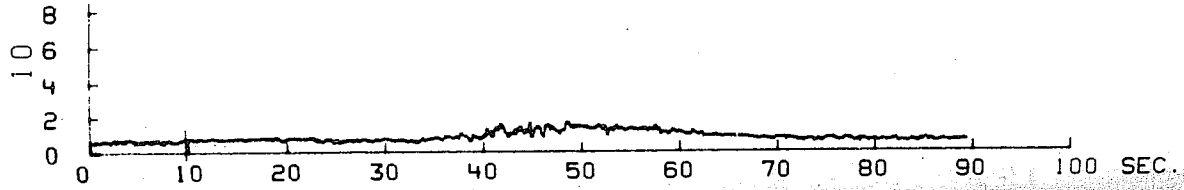

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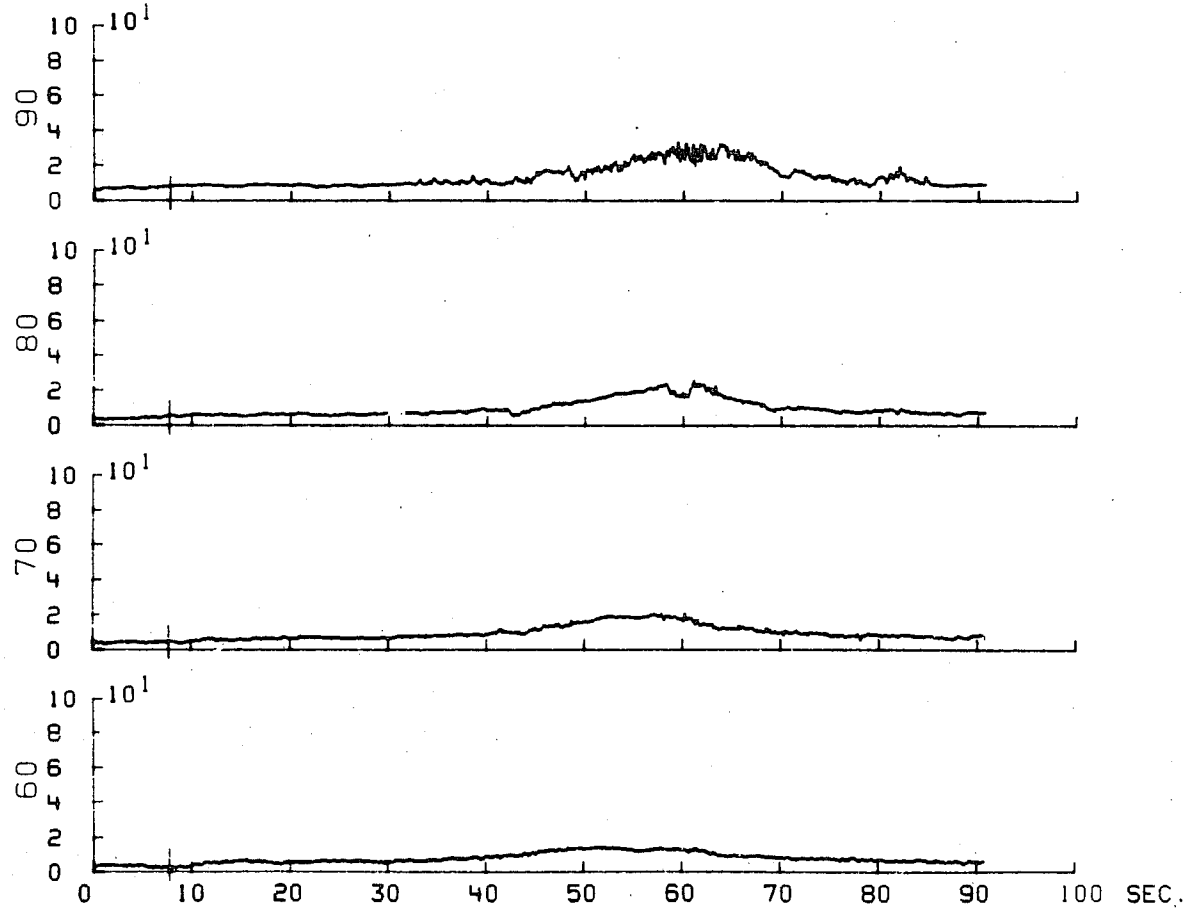

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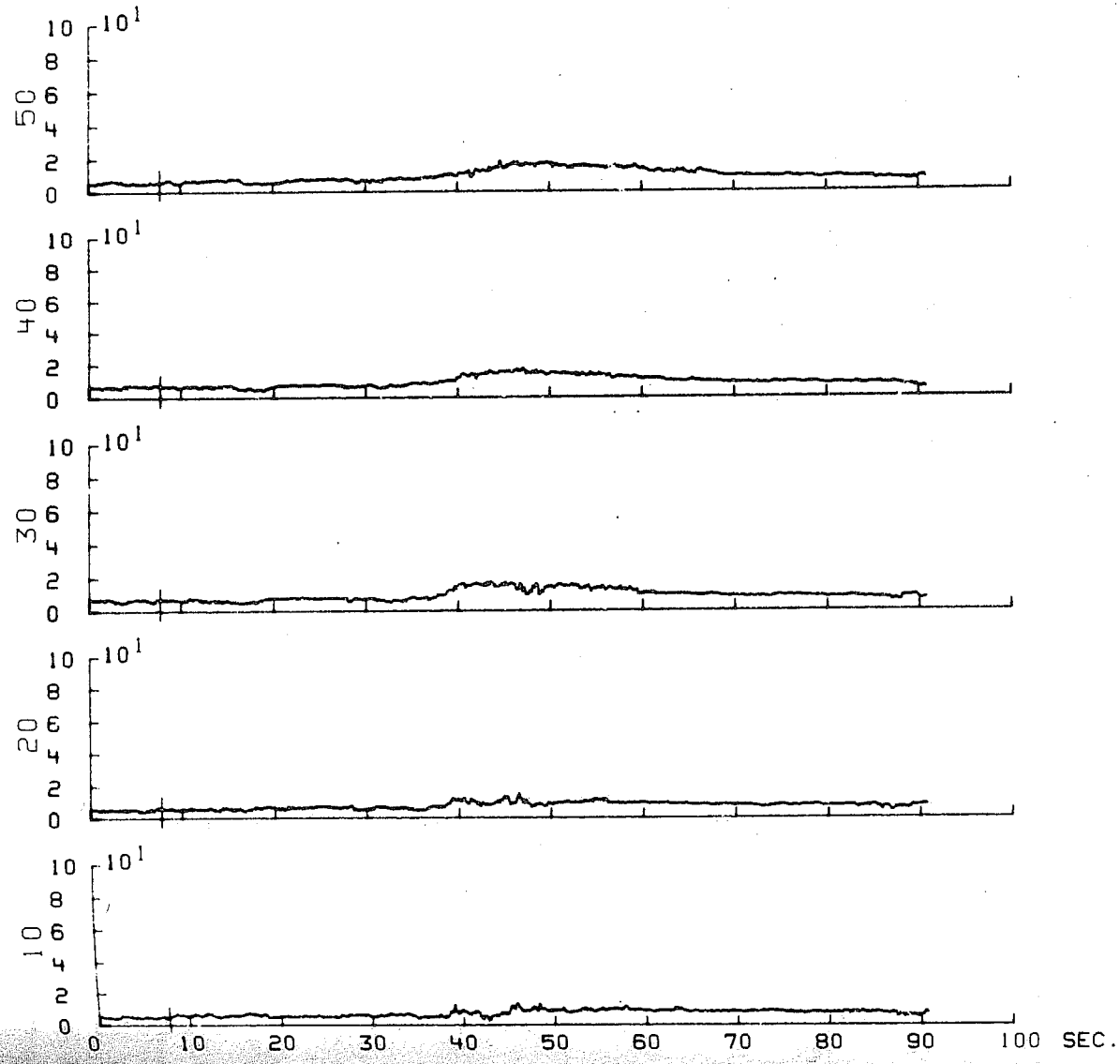
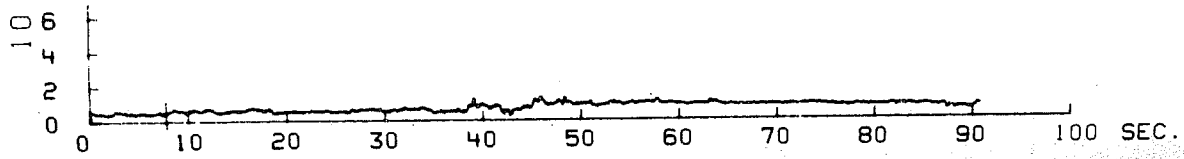
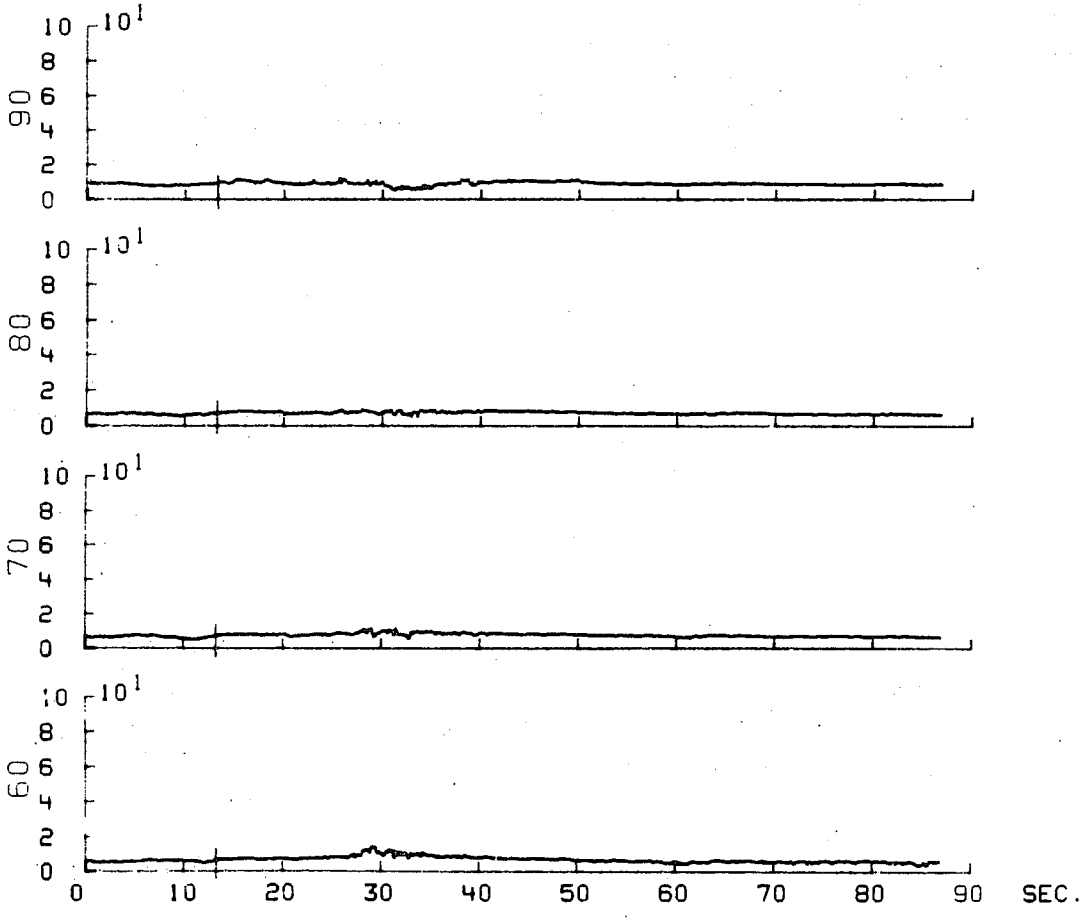




880 PASS 34 06/04/70 0822 19 EDT U=03 FPS



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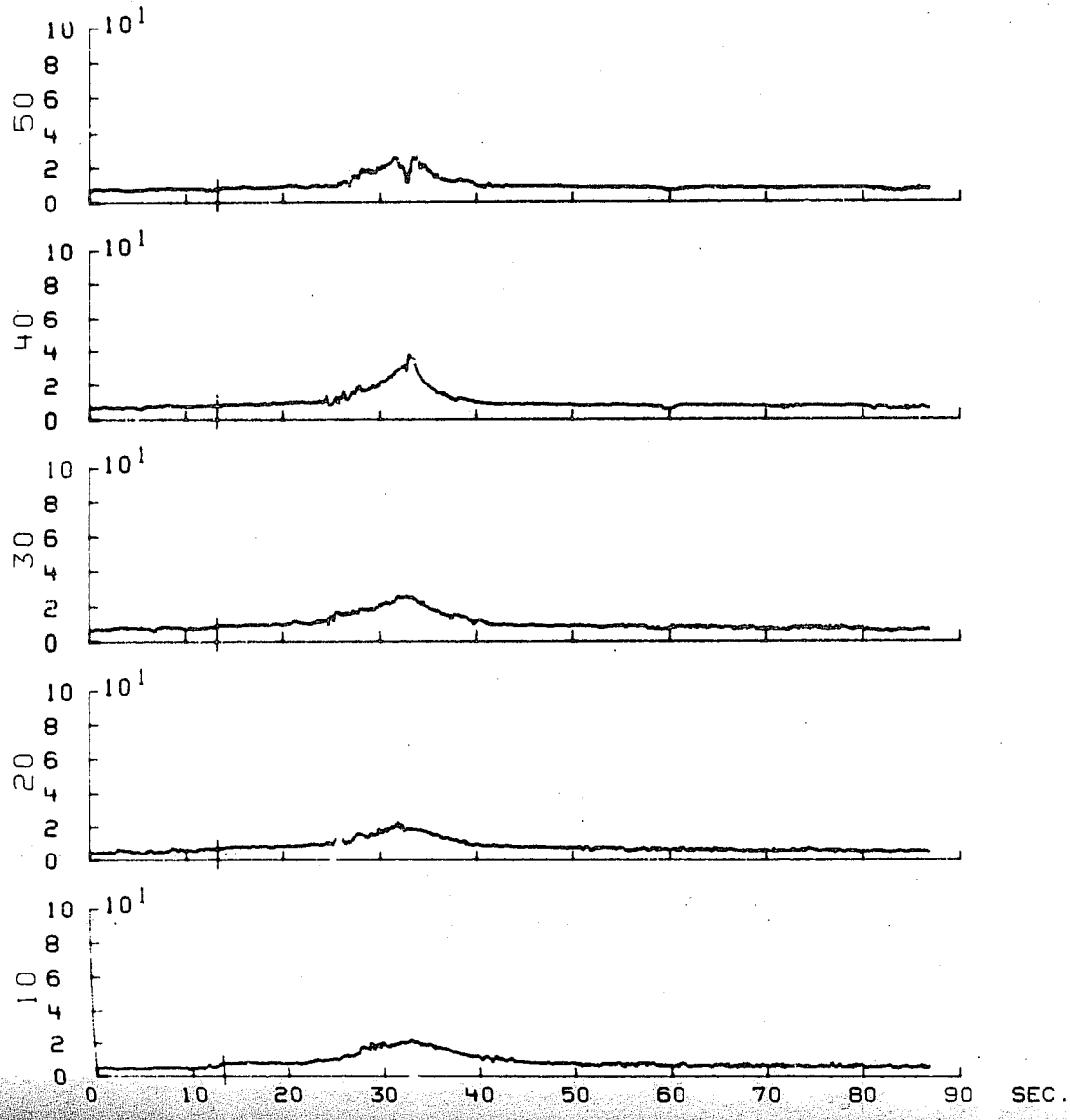

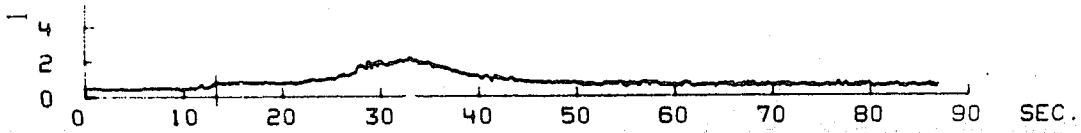

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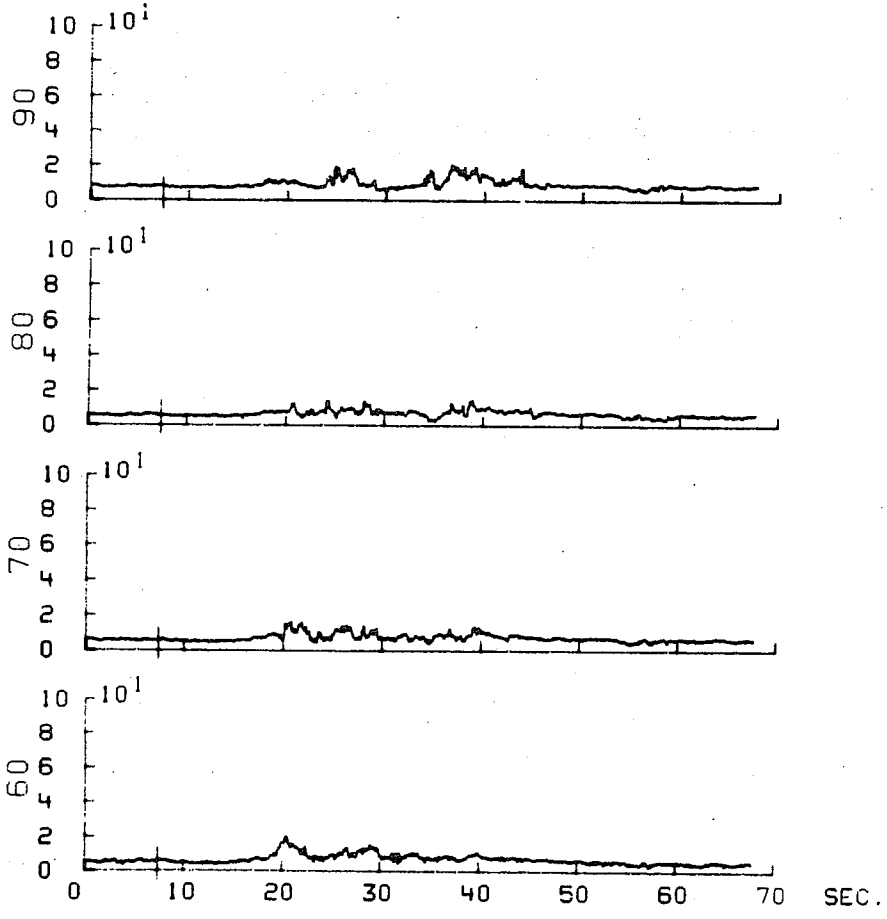

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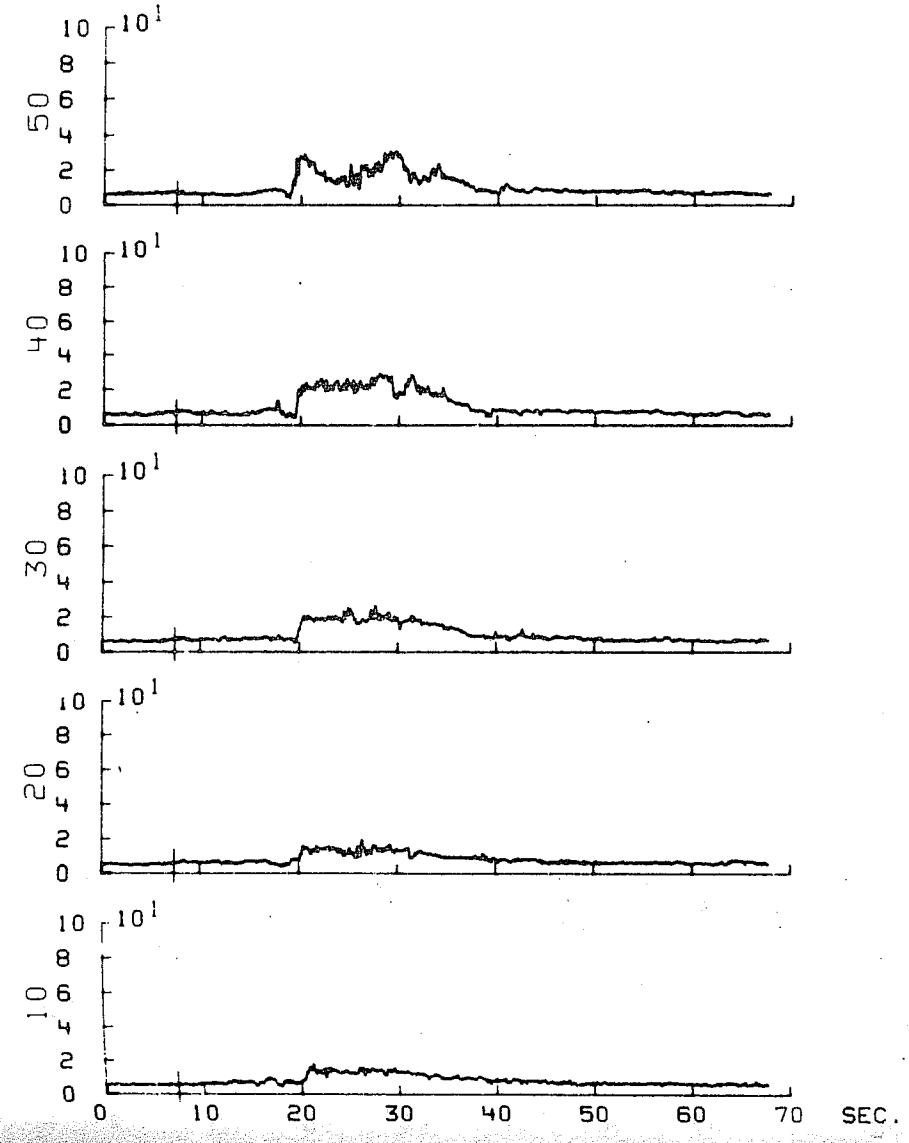
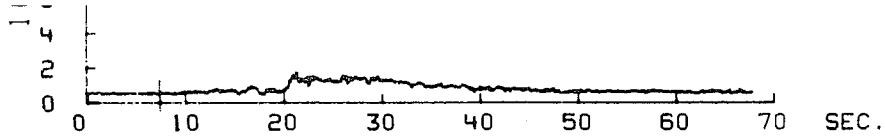
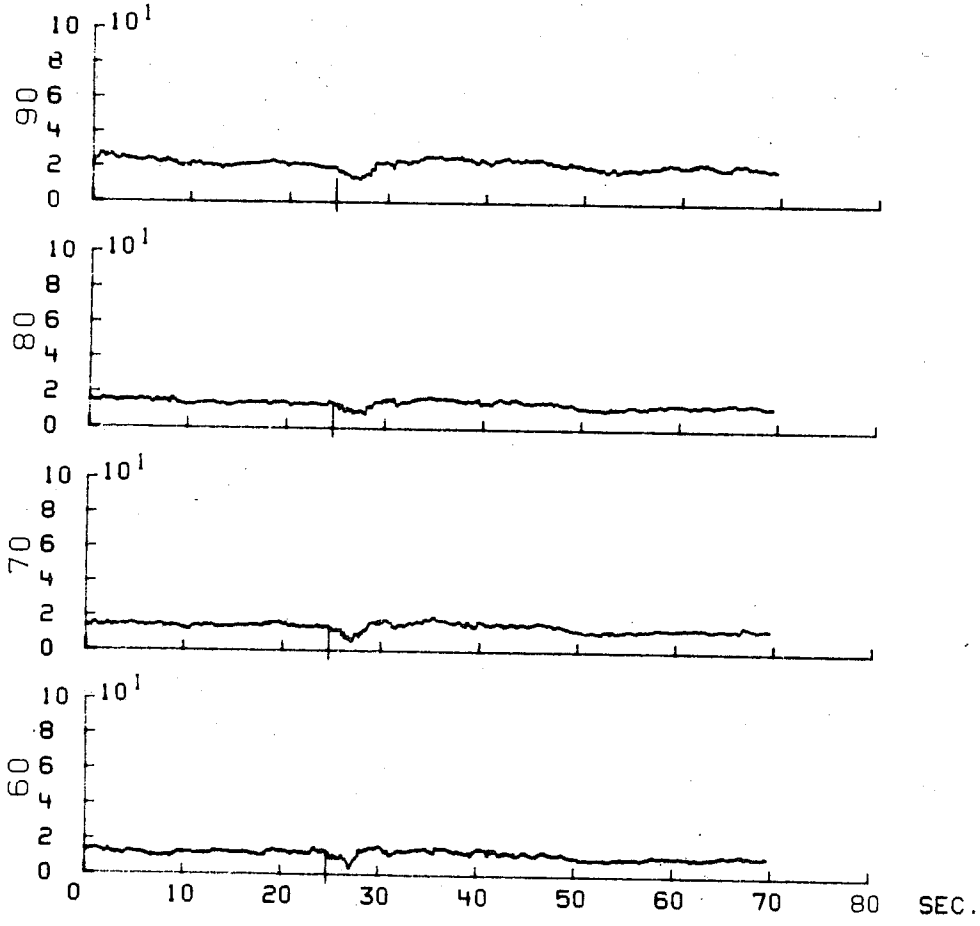




880 PASS 38 06/04/70 1116 22 EDT U=10 FPS



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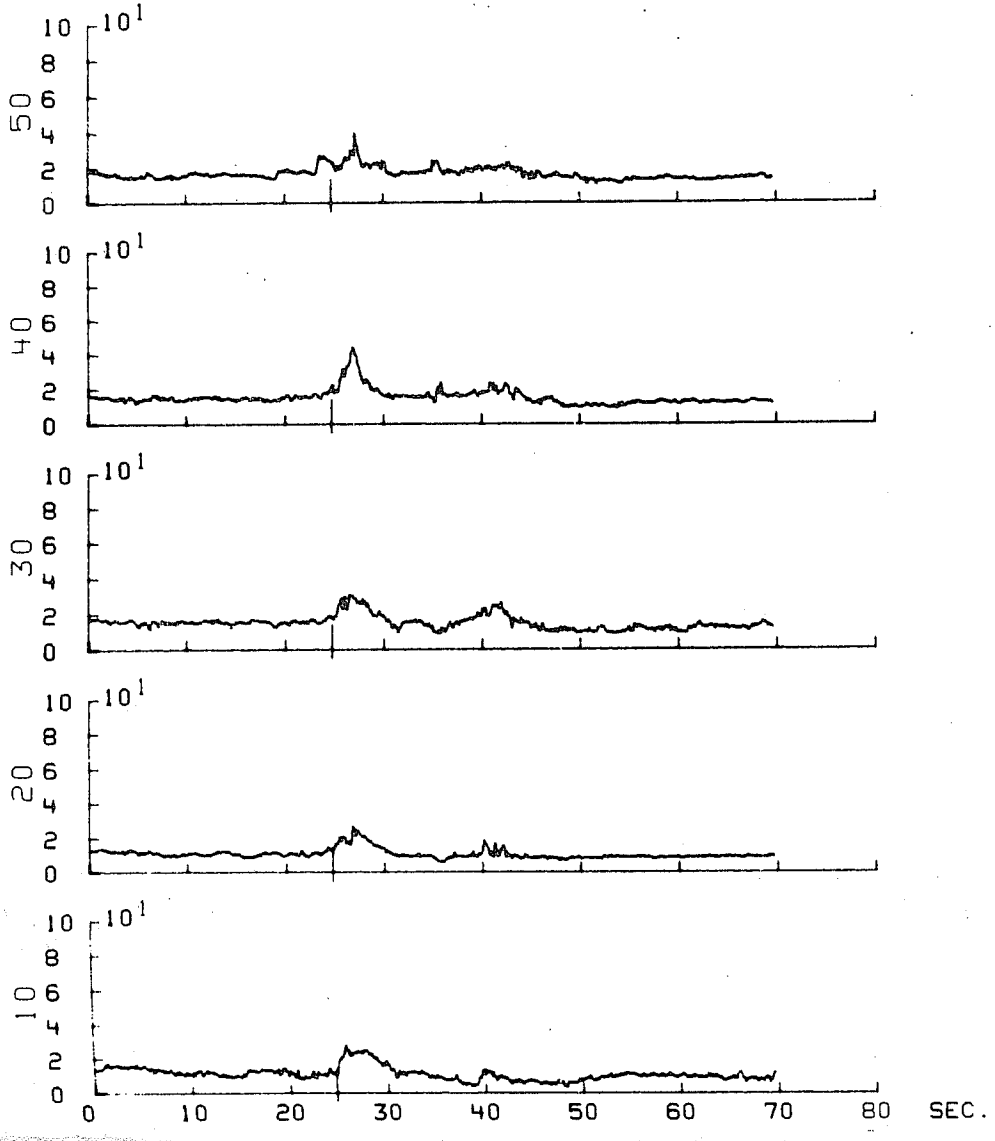
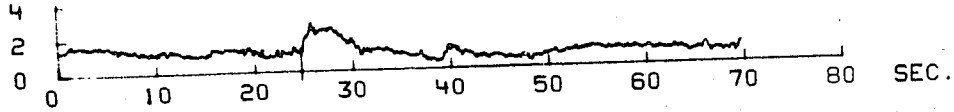
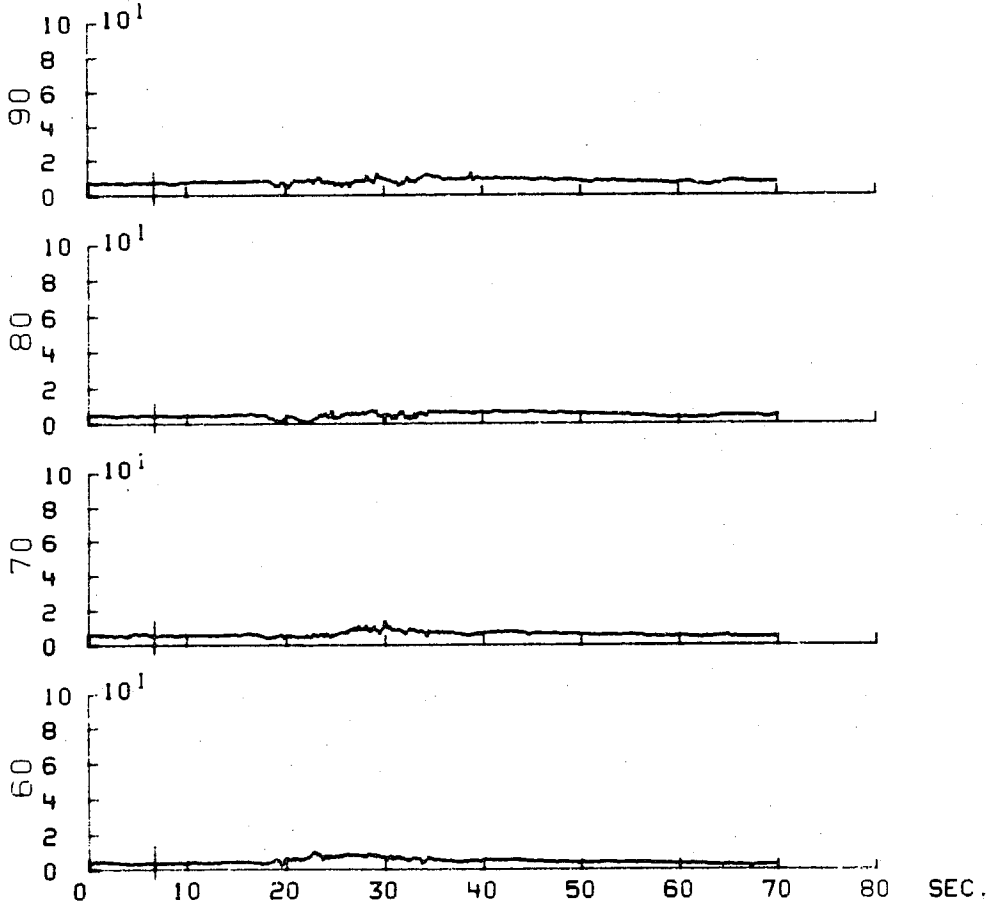
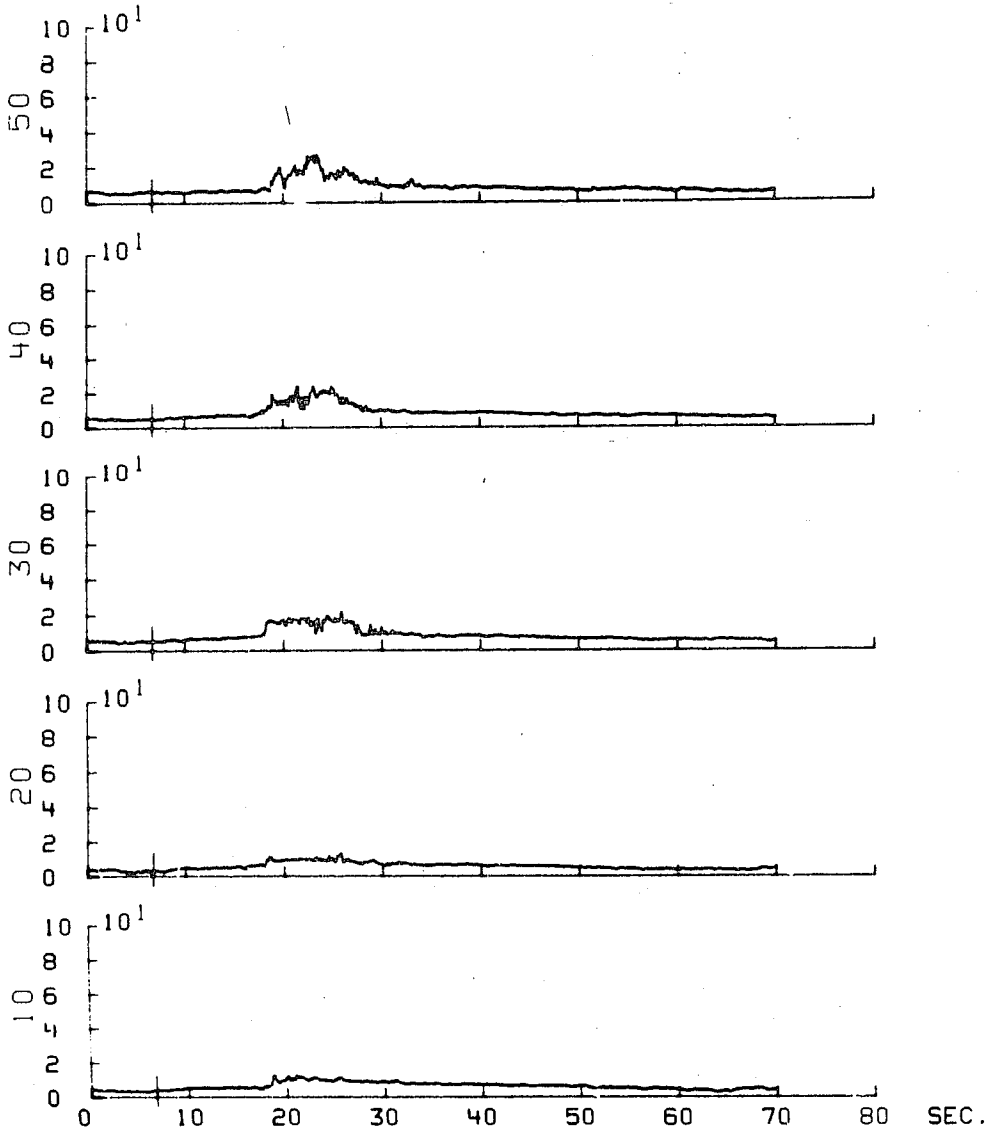




880 PASS 43 06/05/70 0809 07 EDT U=06 FPS

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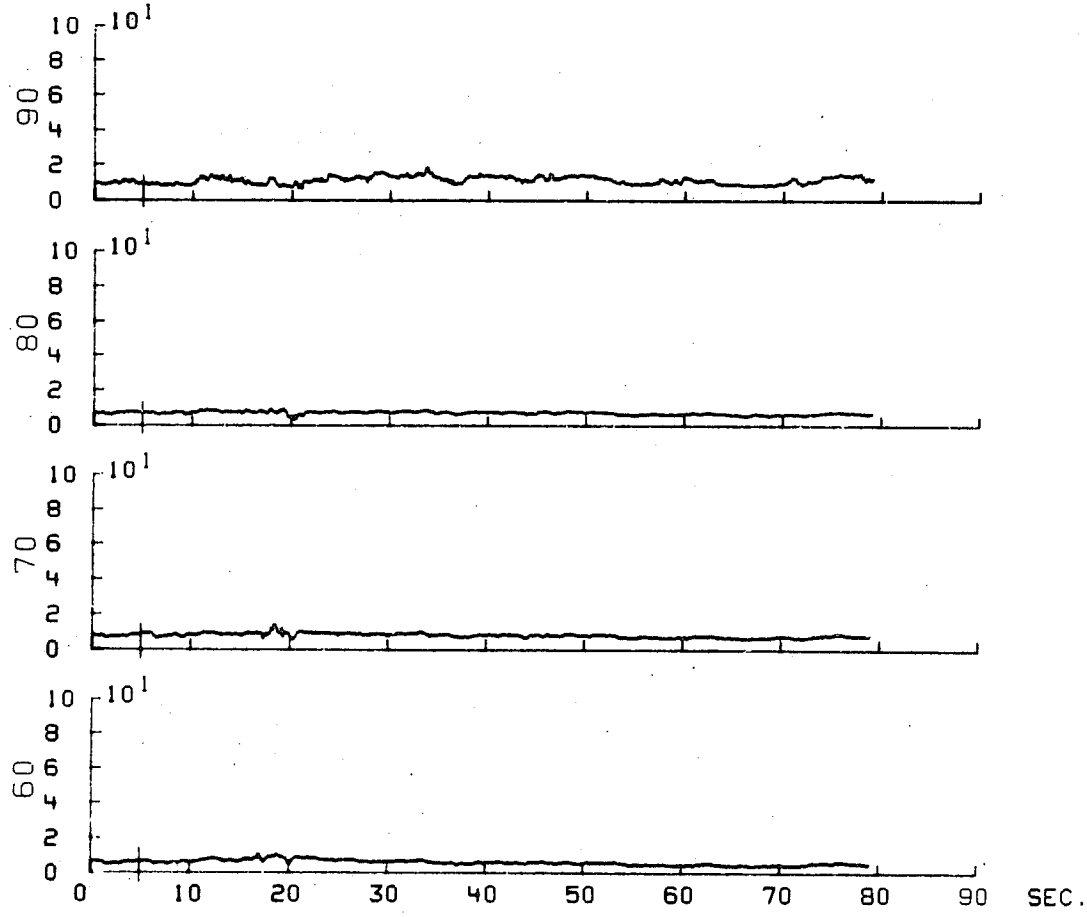
880 PASS 57 06/05/70 1102 35 EDT U=02 FPS



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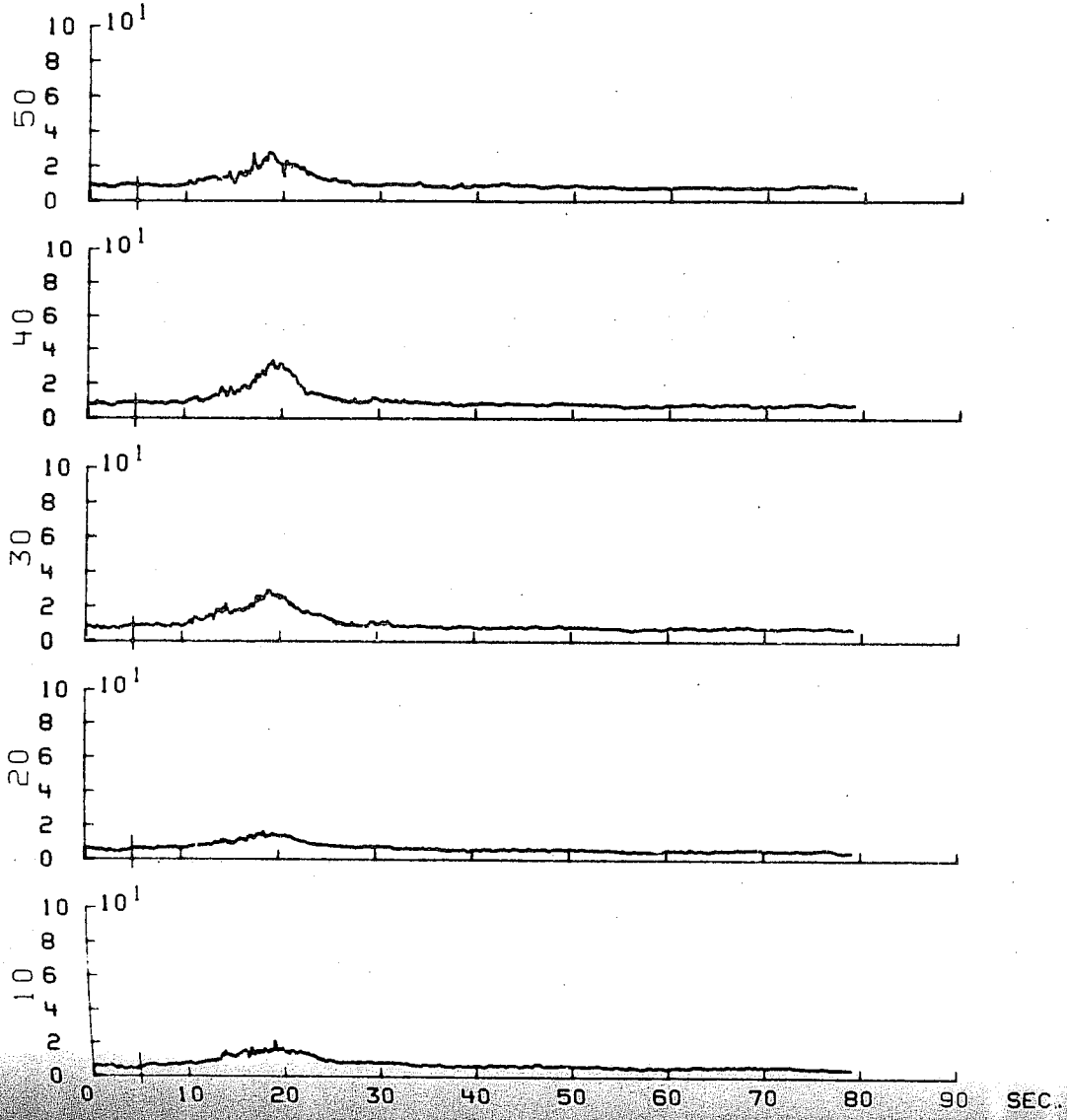
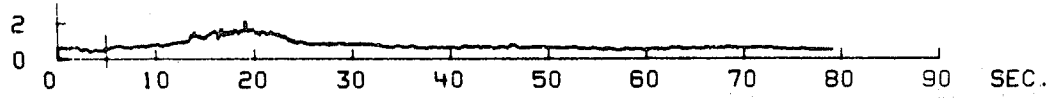
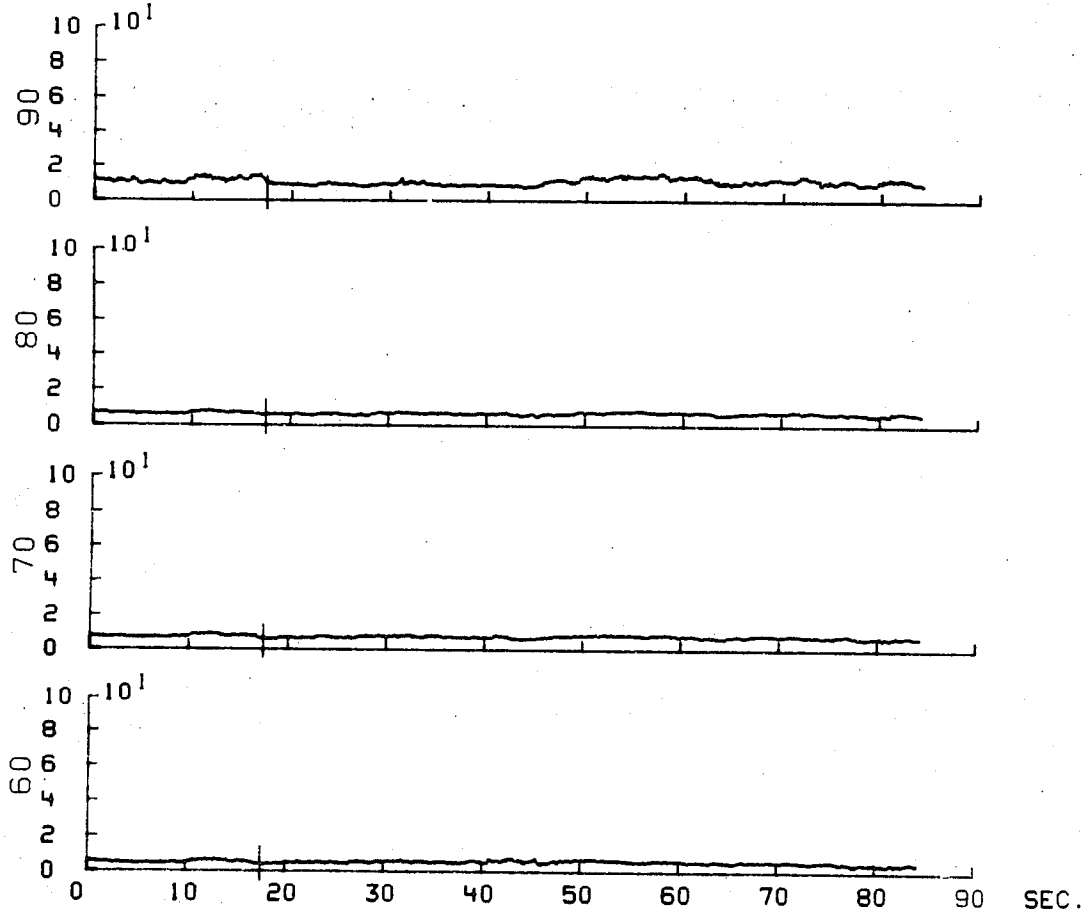




880 PASS 58 06/05/70 1118 18 EDT U=05 FPS



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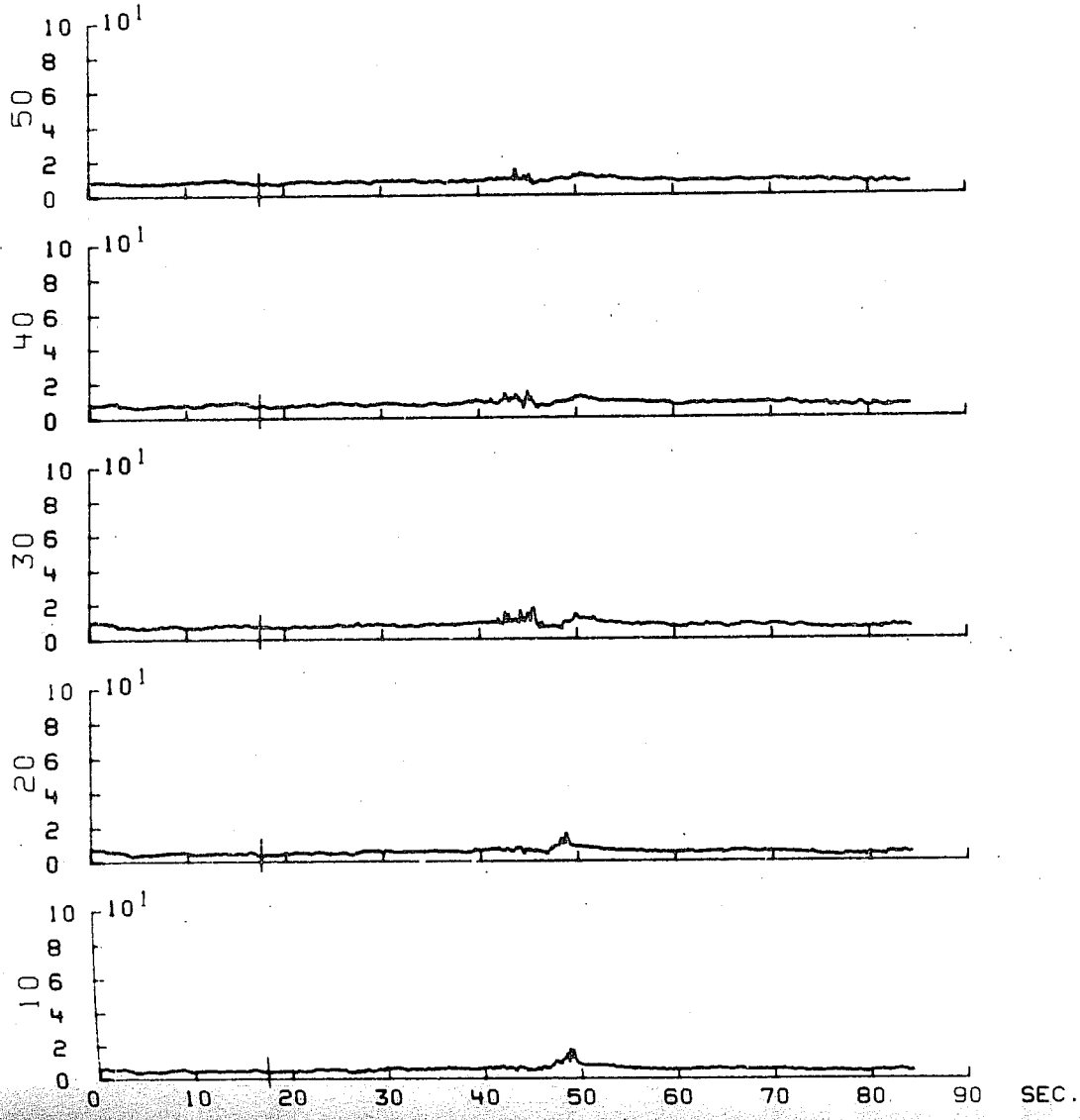

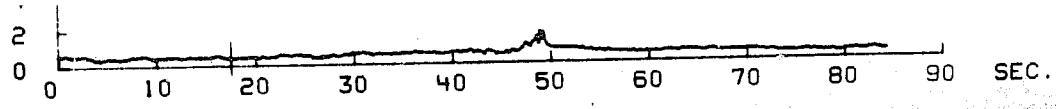

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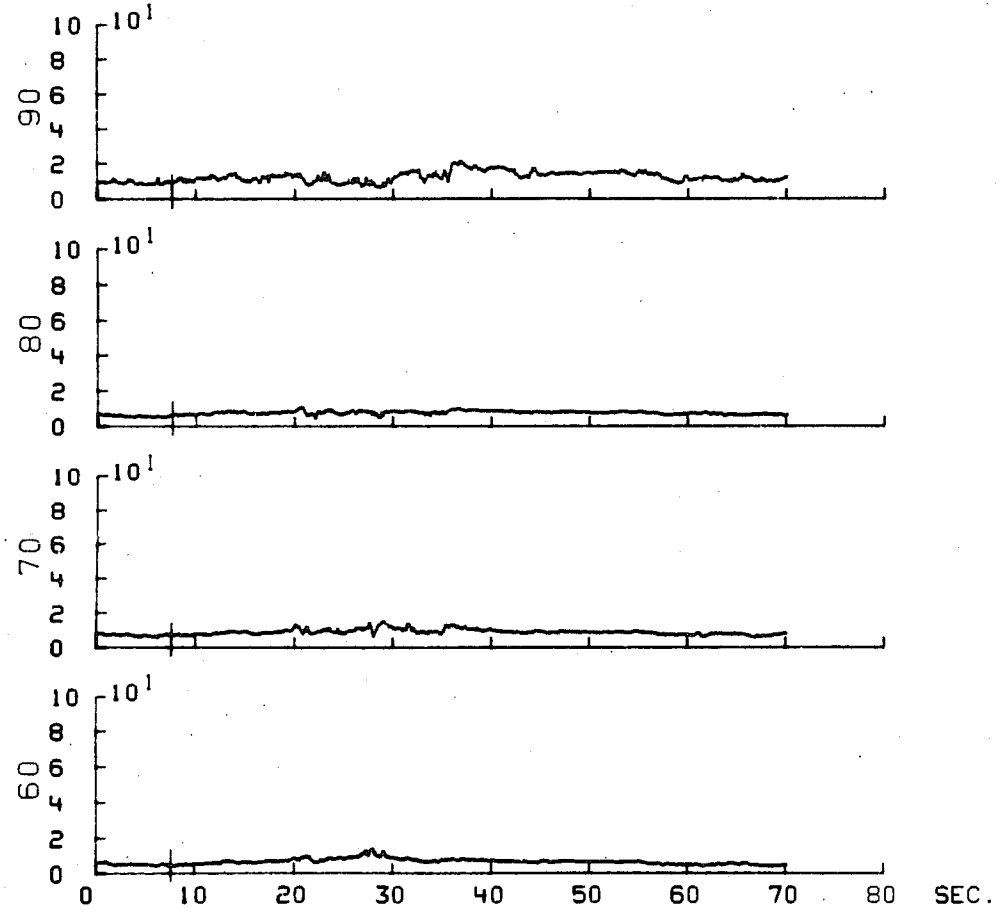

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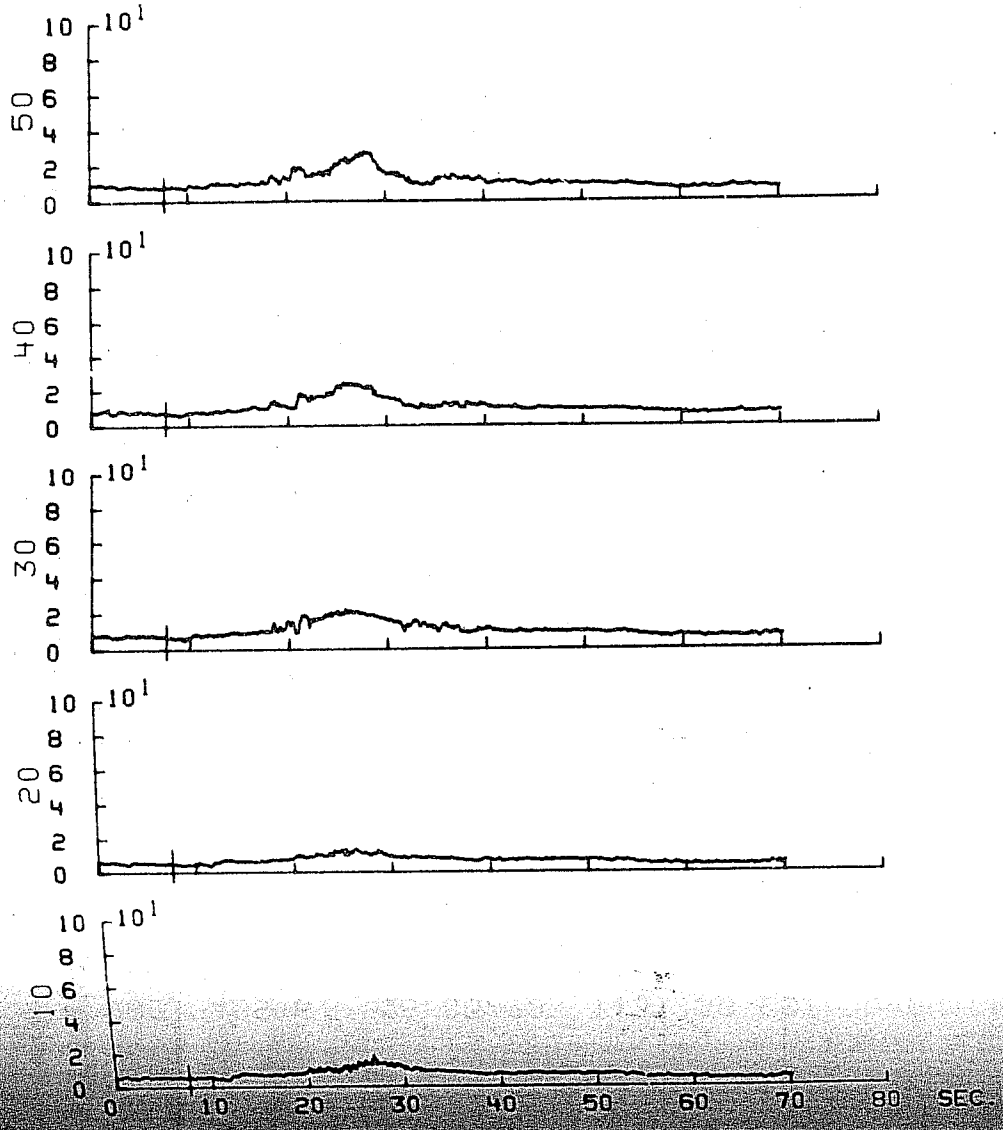

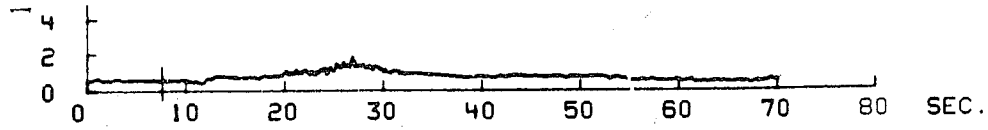

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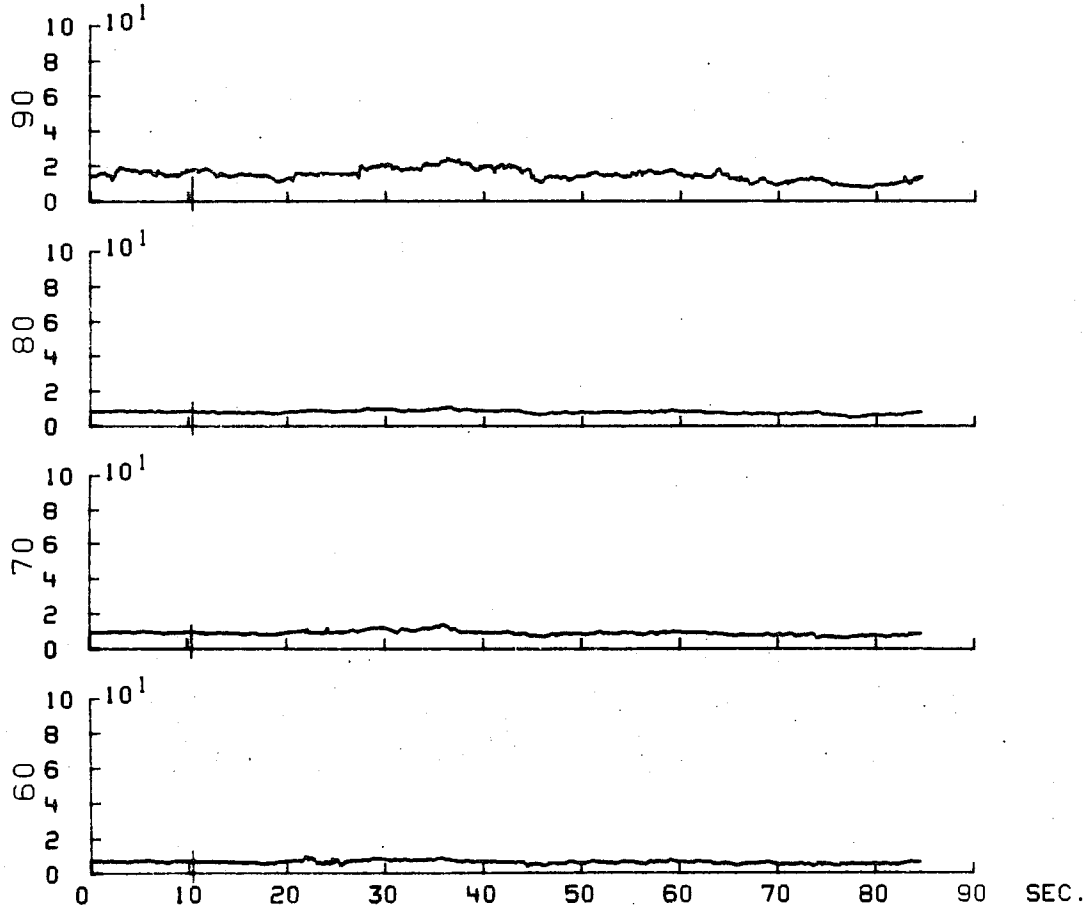

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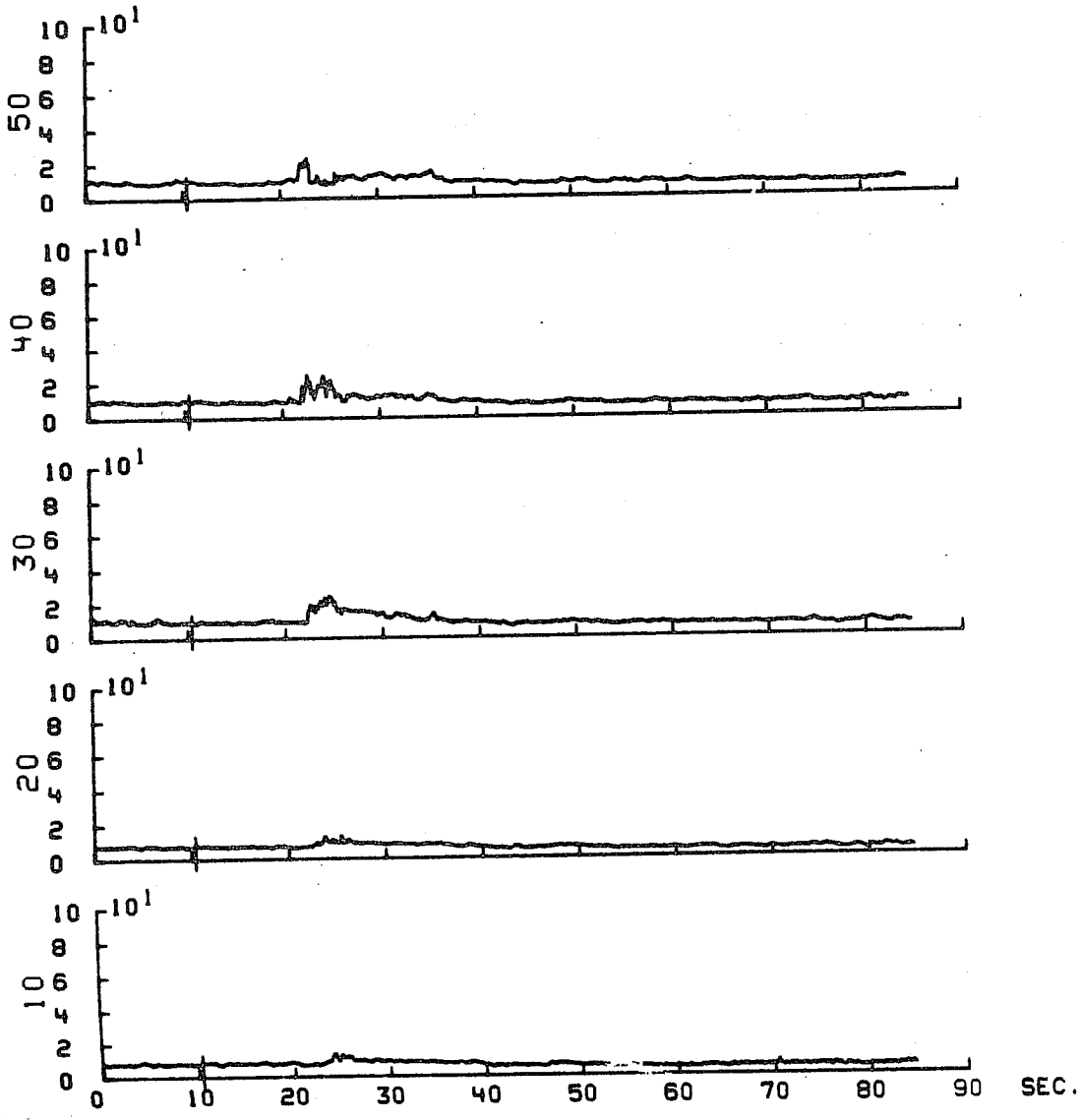

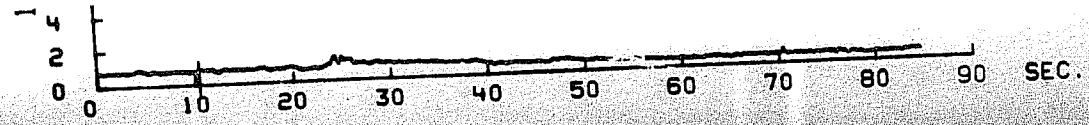

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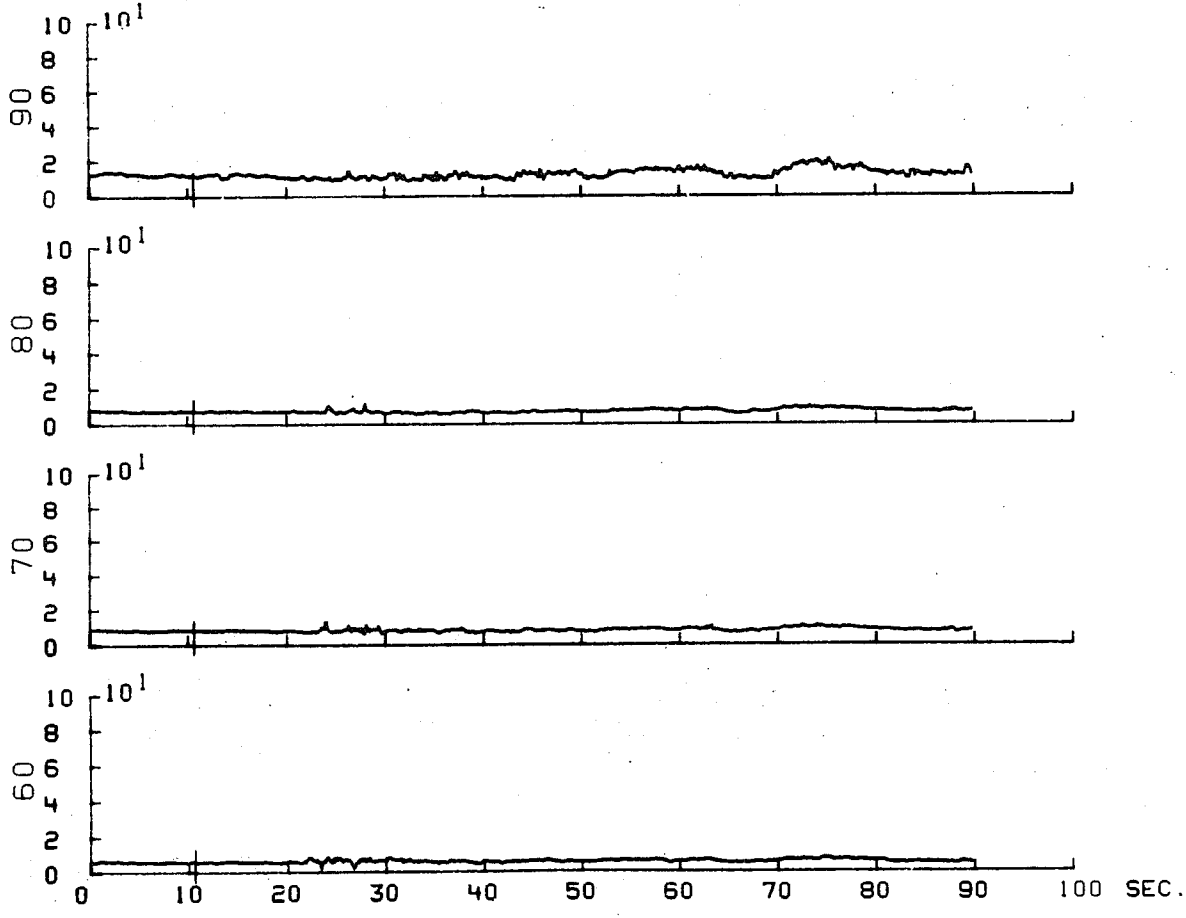

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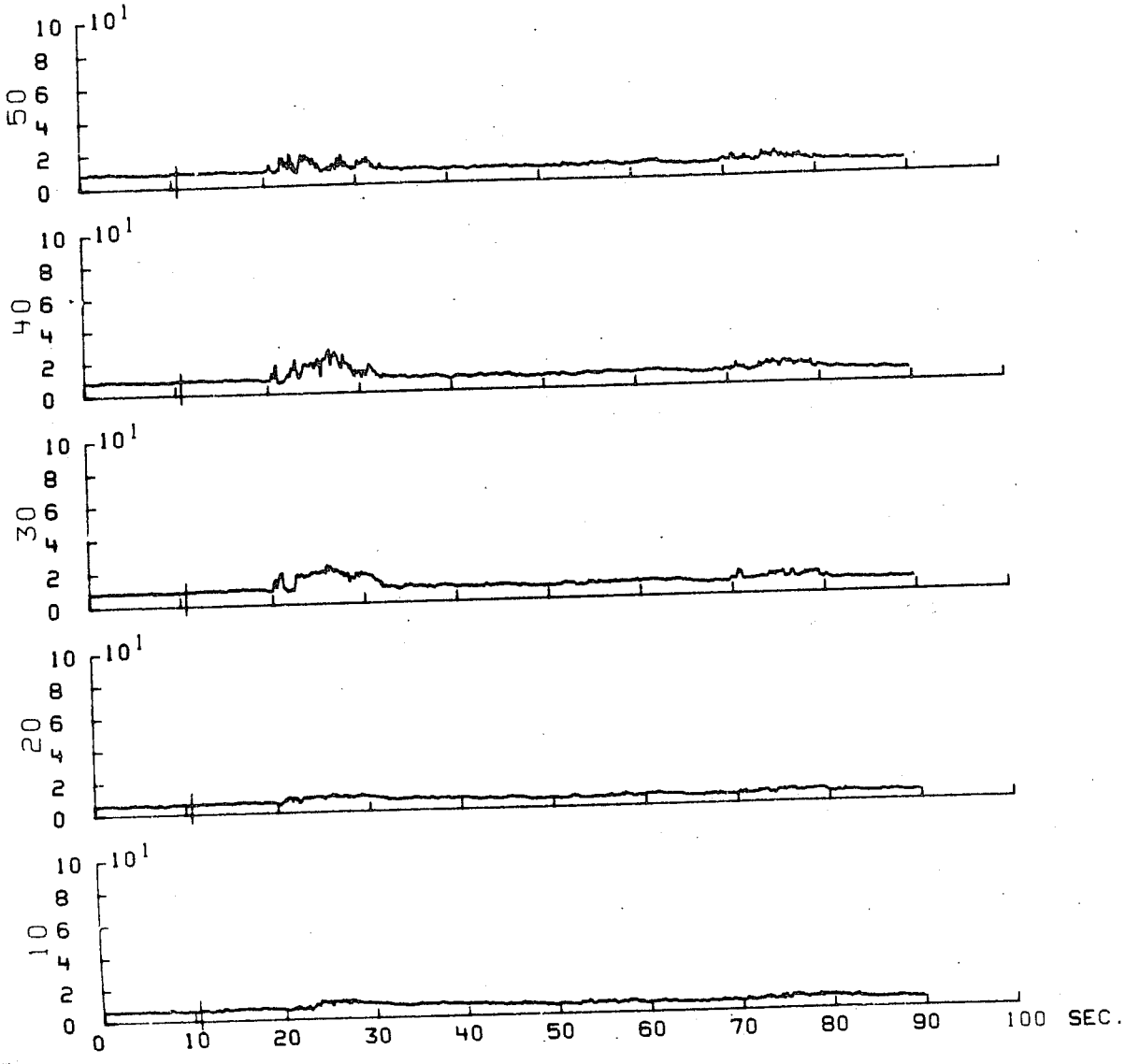
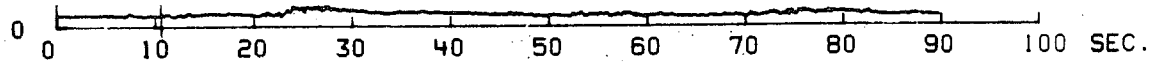
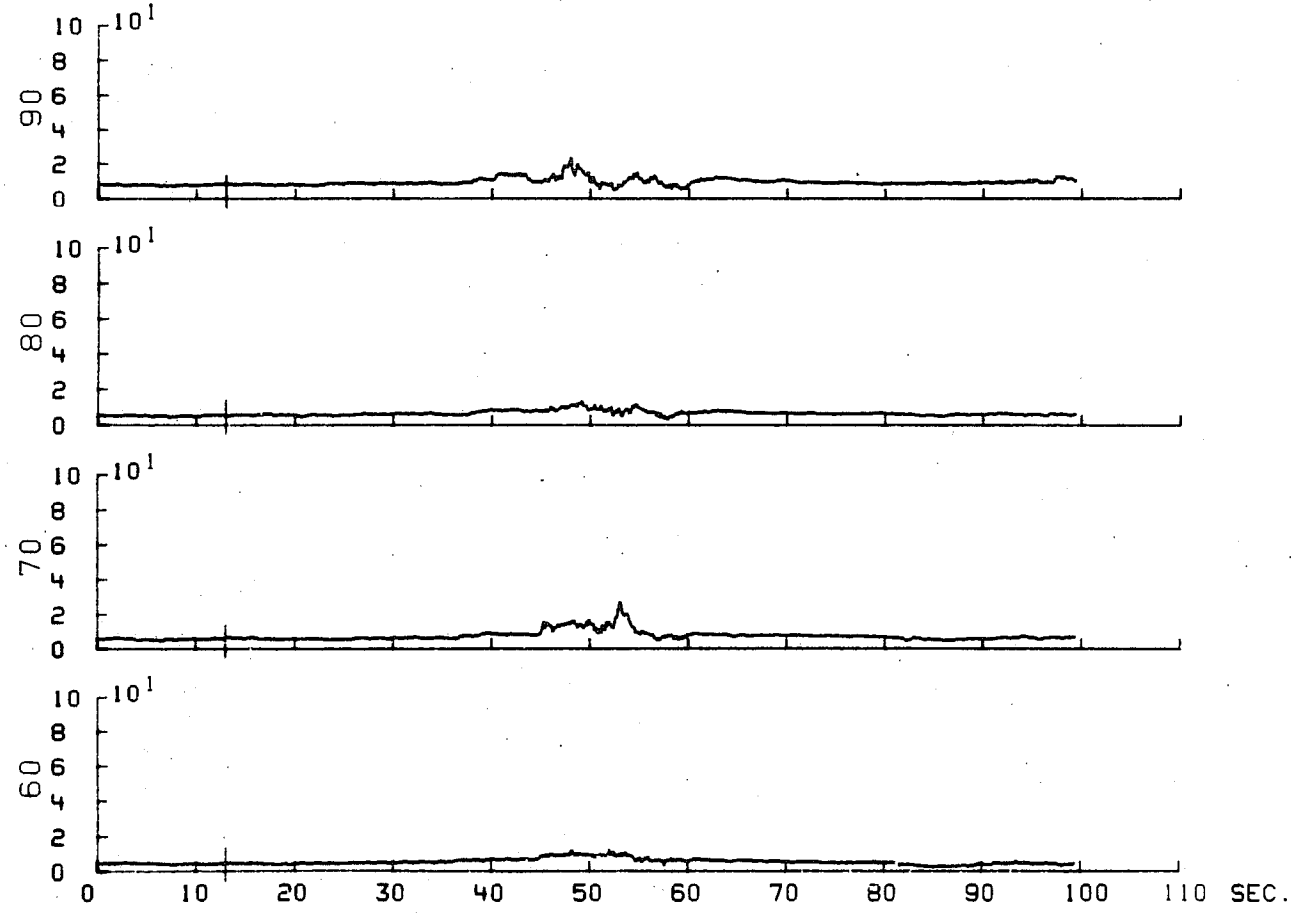
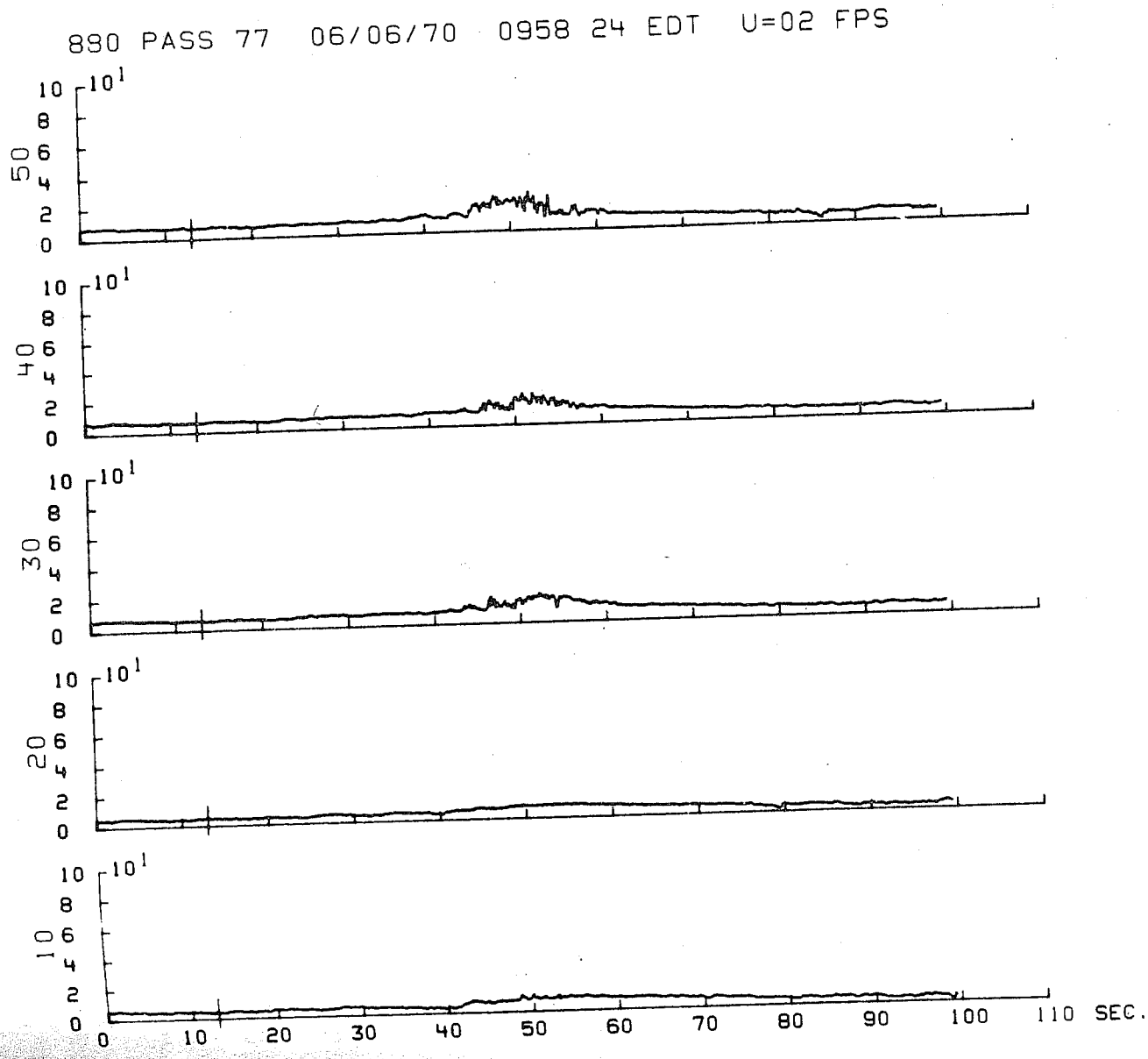




880 PASS 77 06/06/70 0958 24 EDT U=02 FPS




890 PASS 77 06/06/70 0958 24 EDT U=02 FPS
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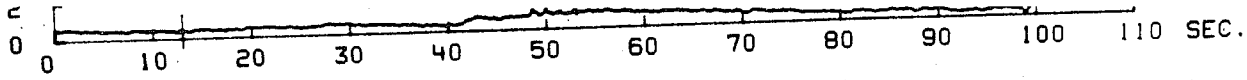

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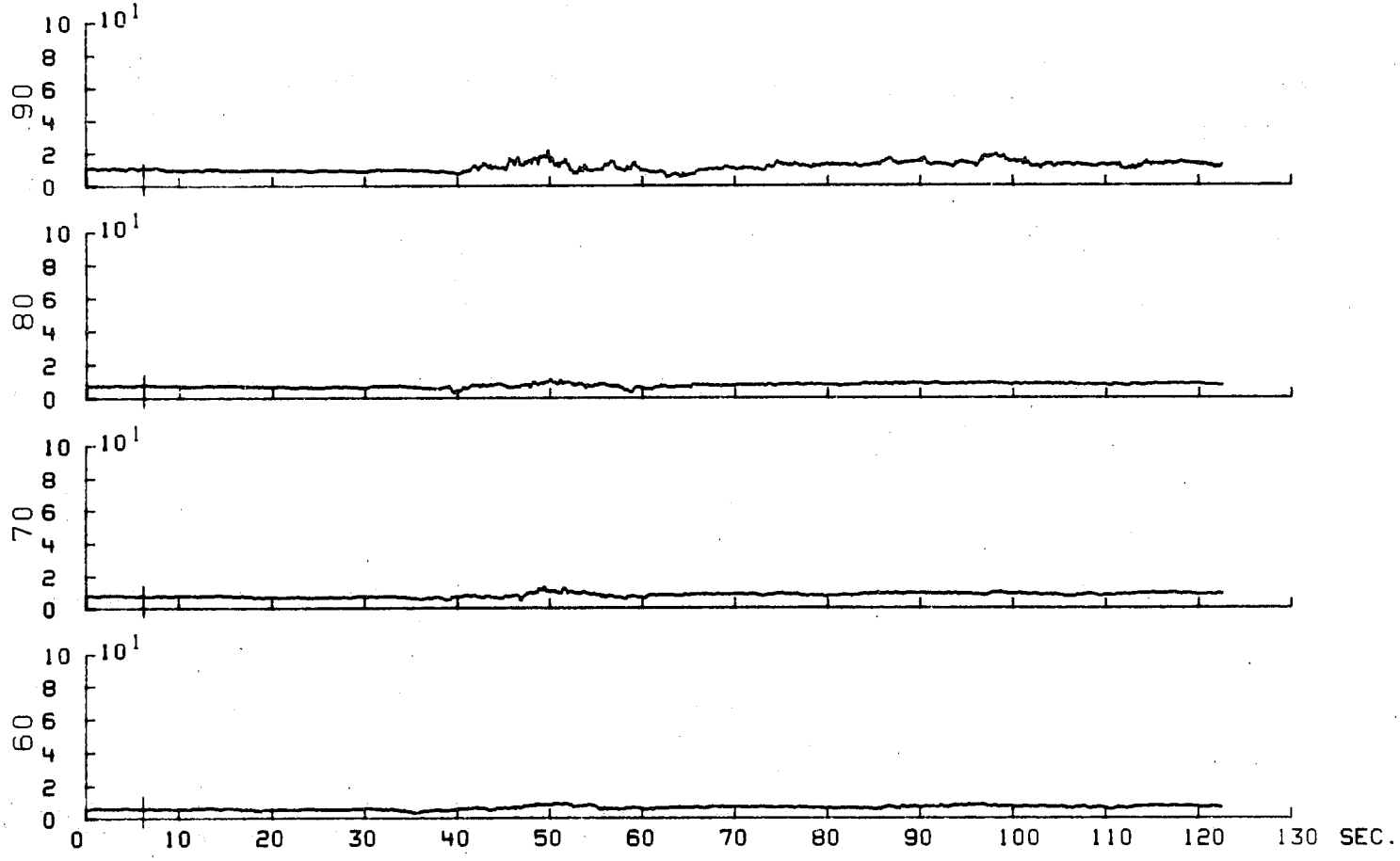

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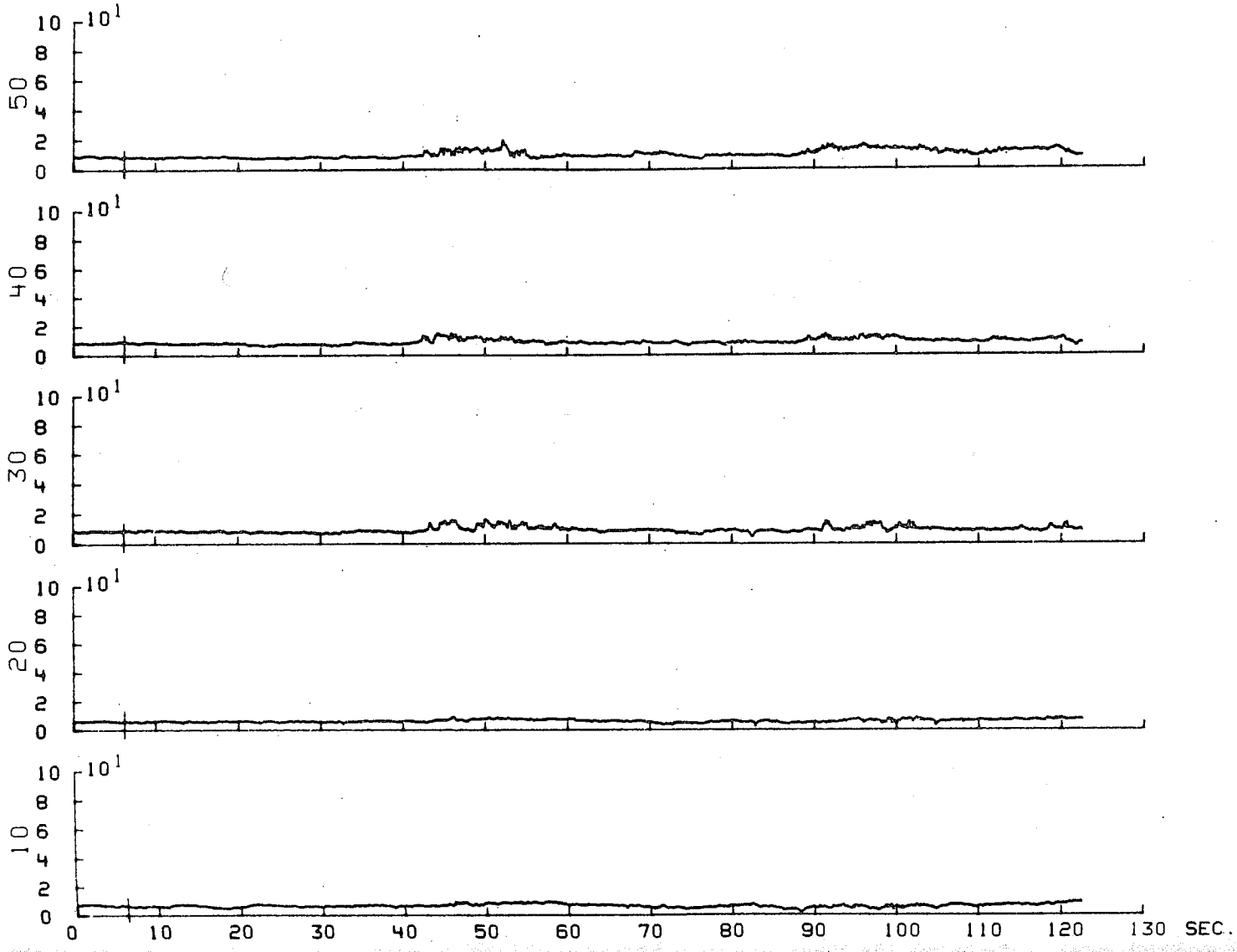

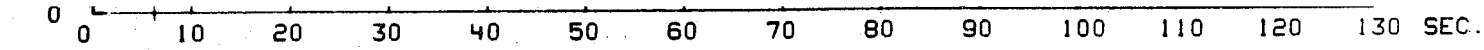

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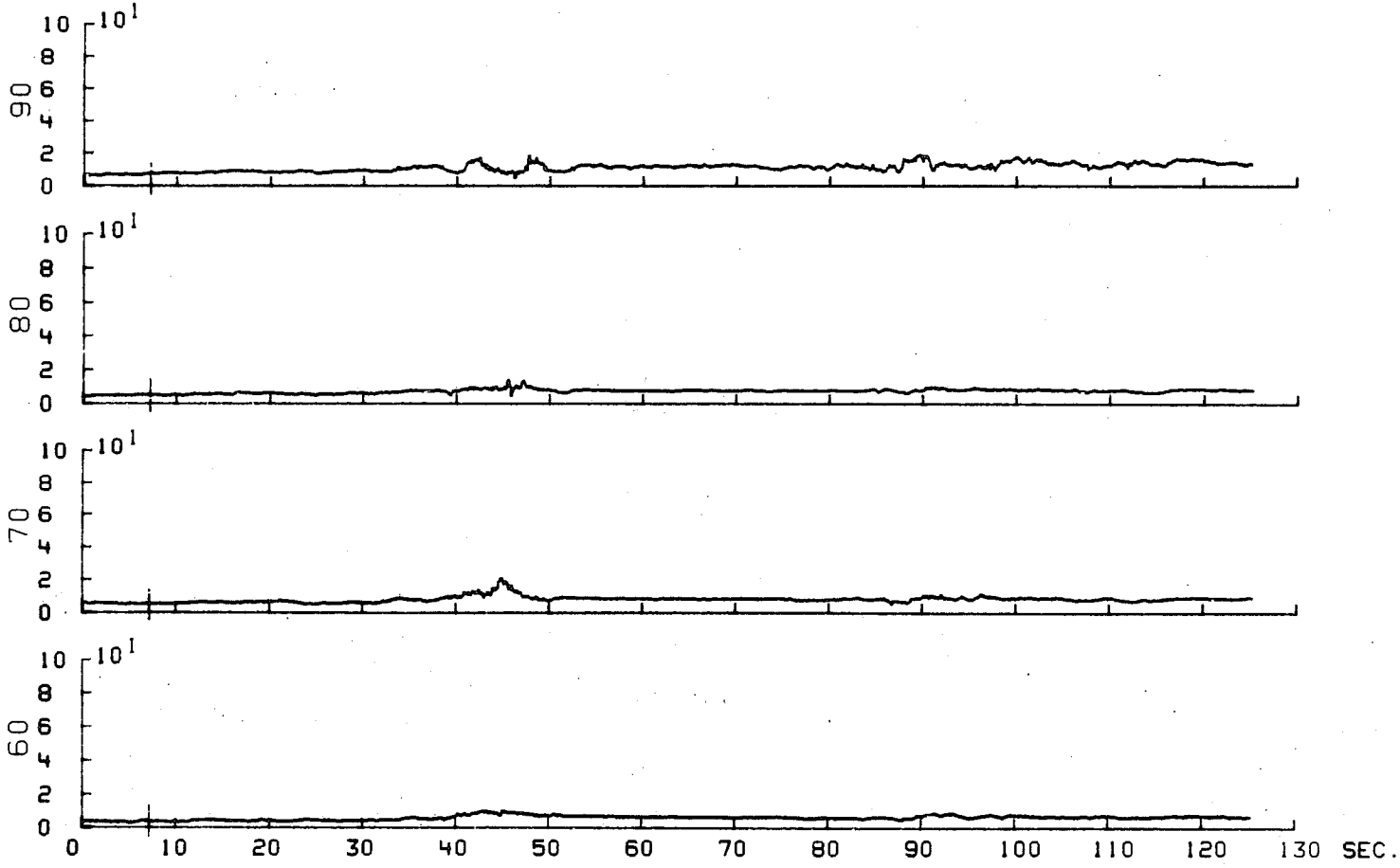

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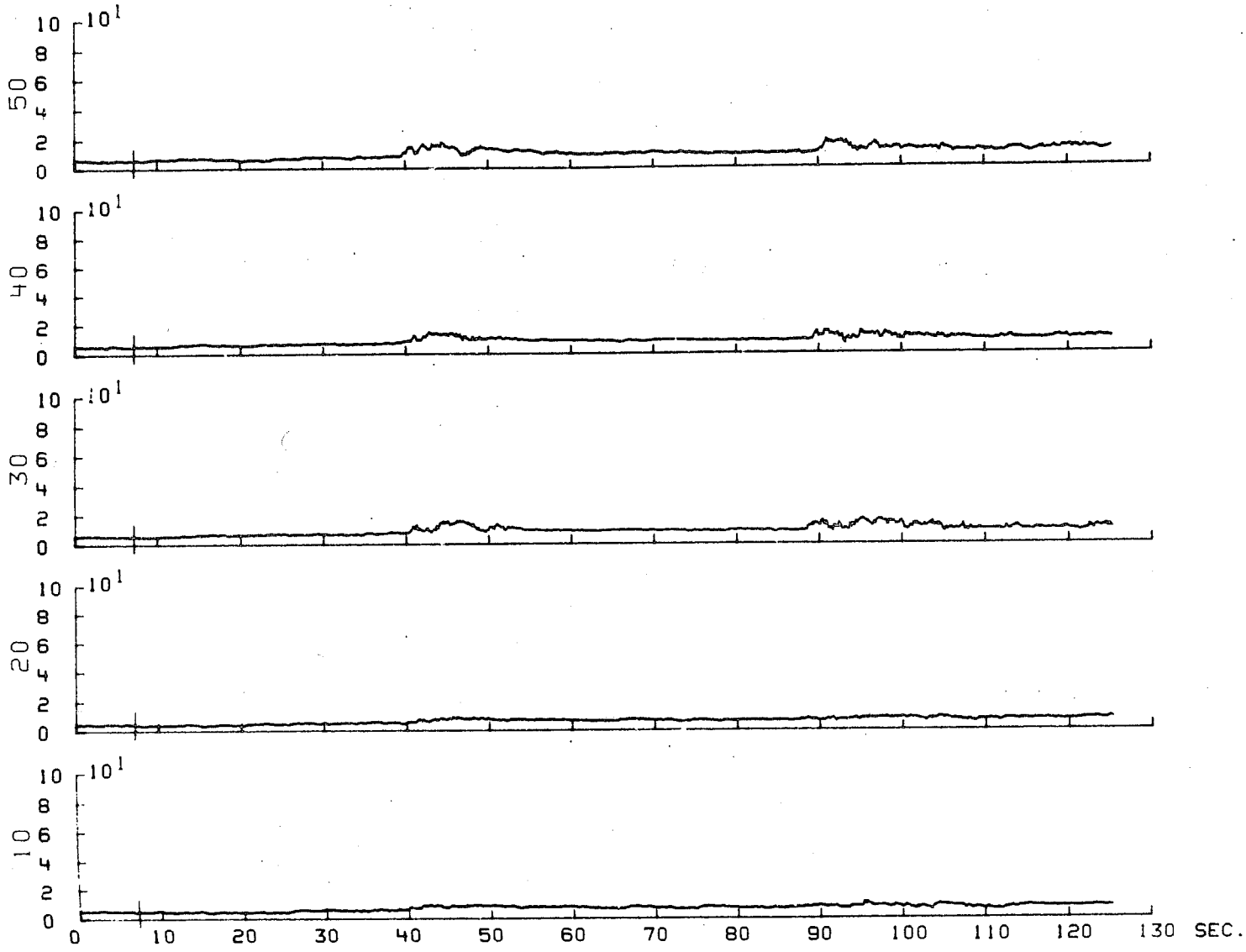

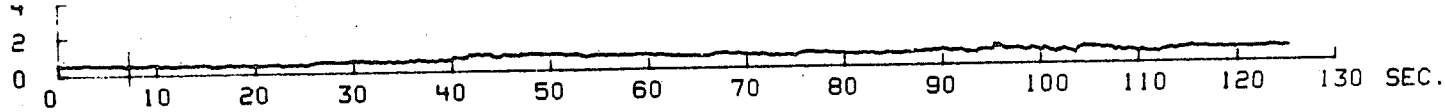

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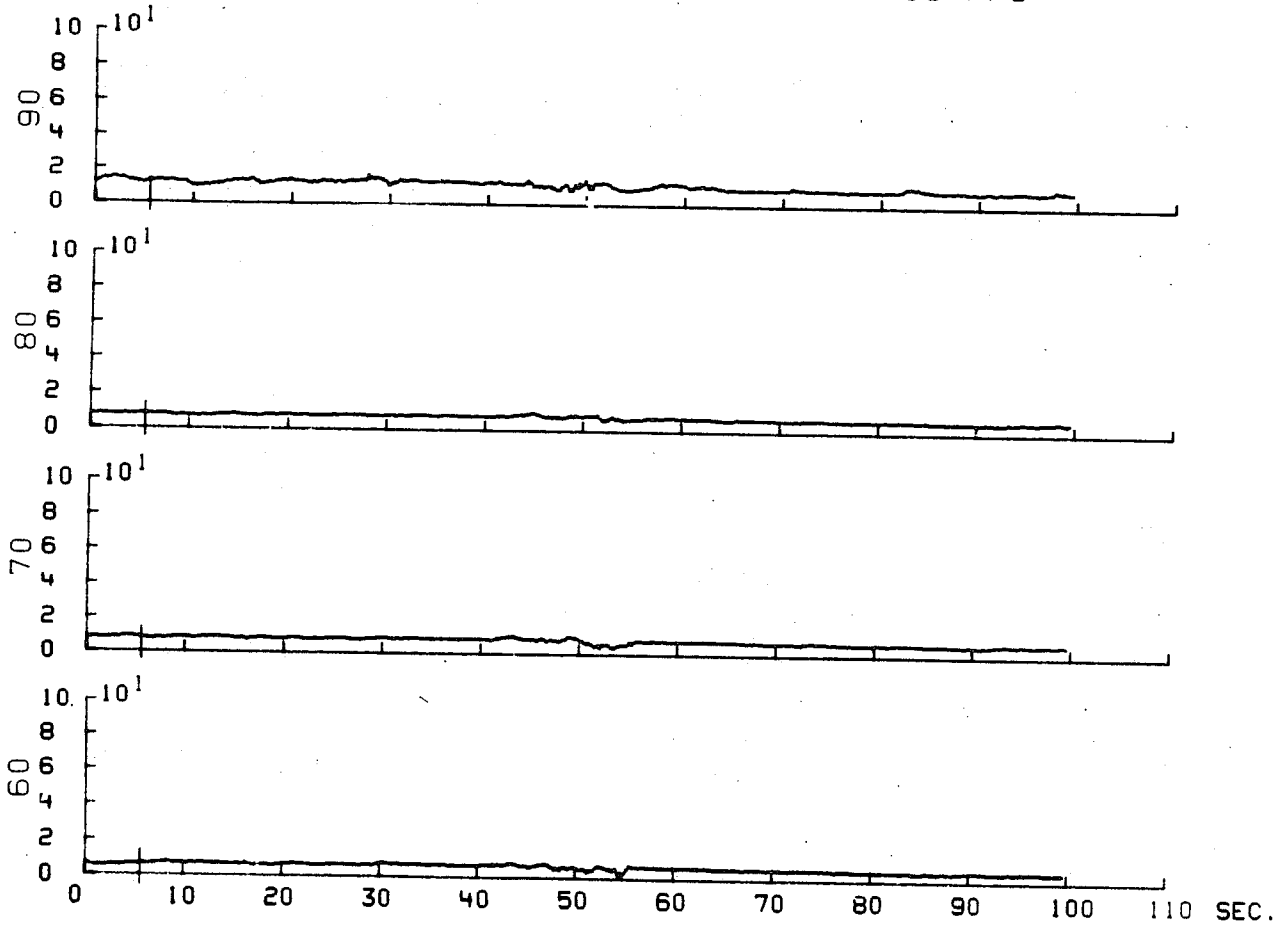

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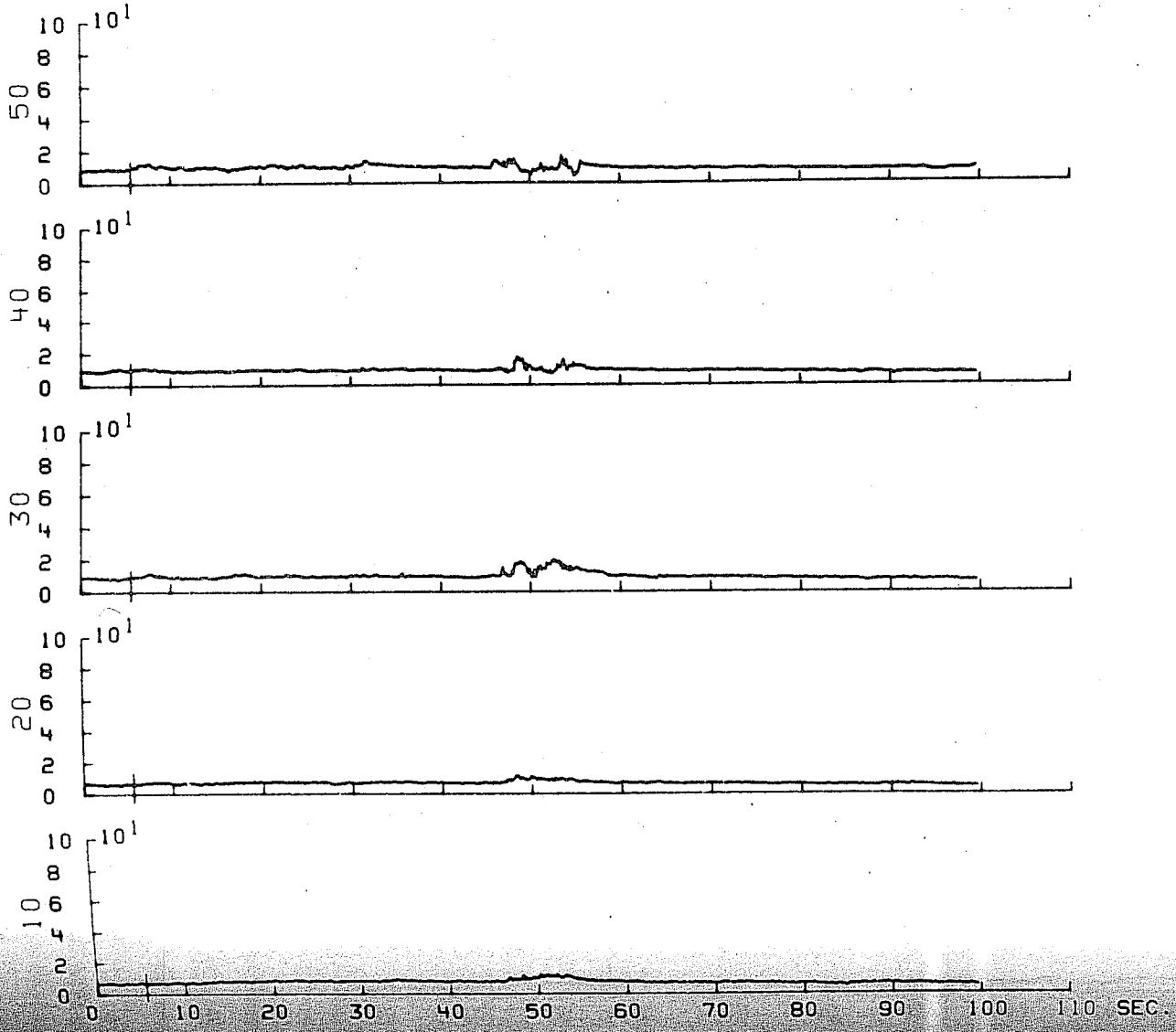

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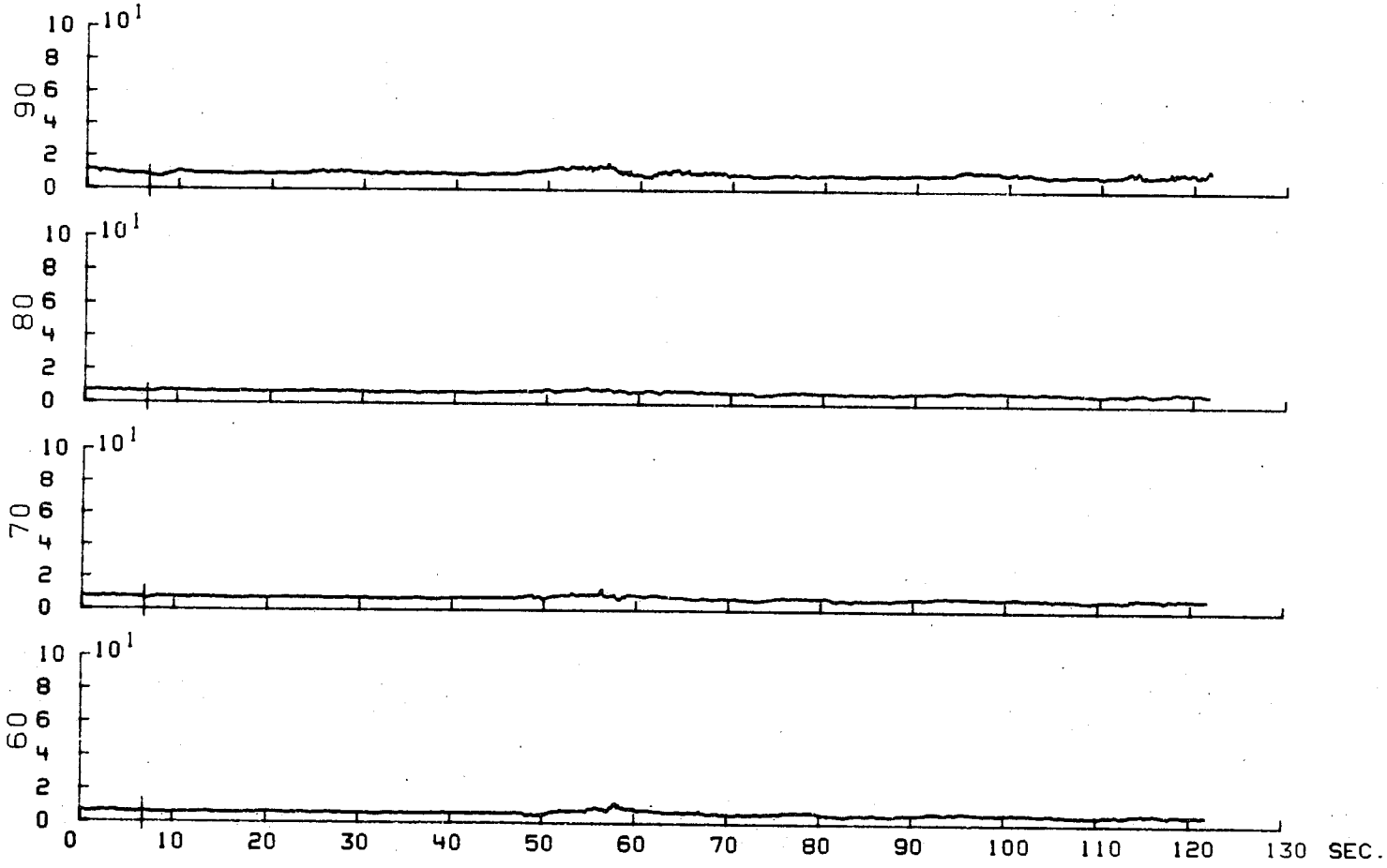

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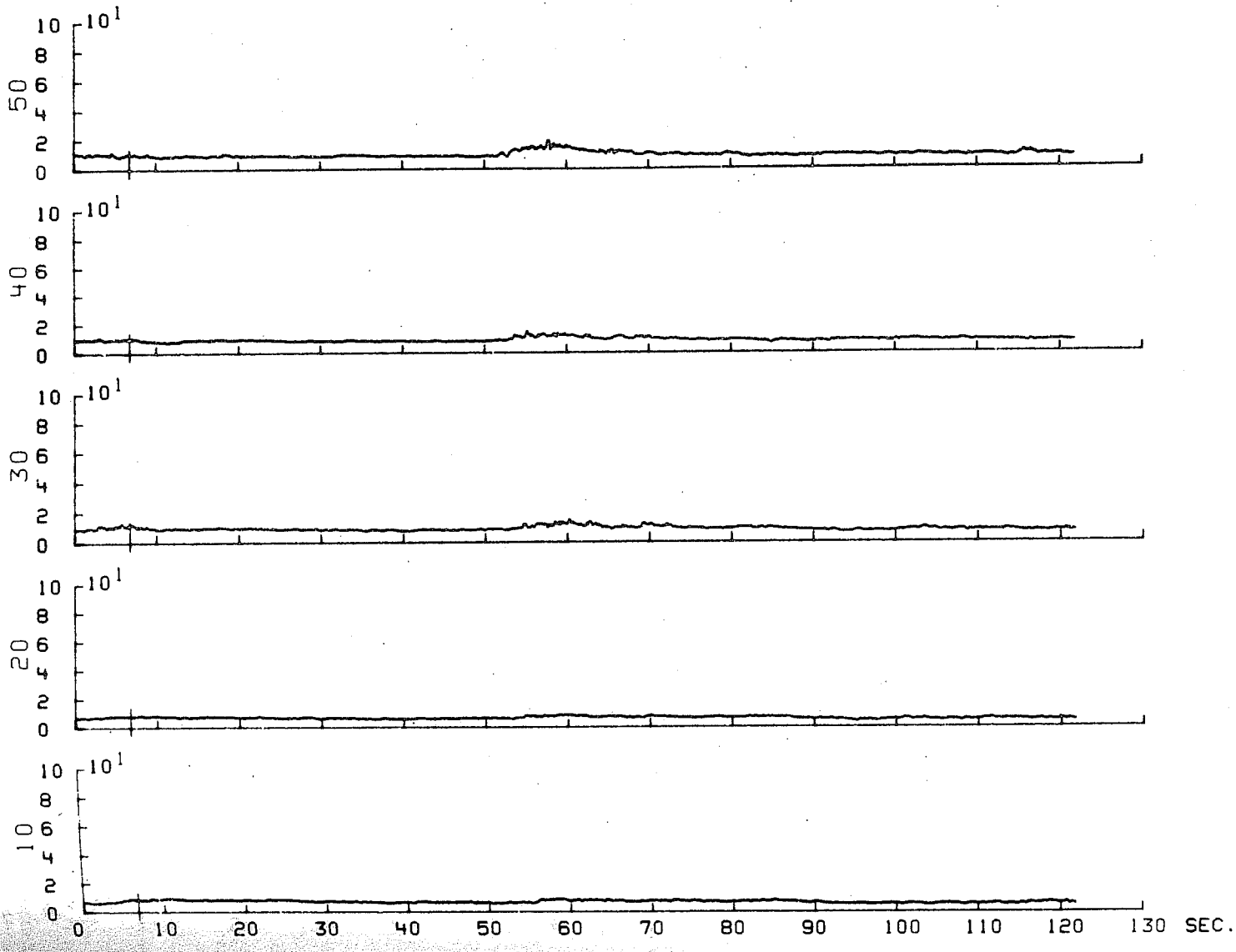
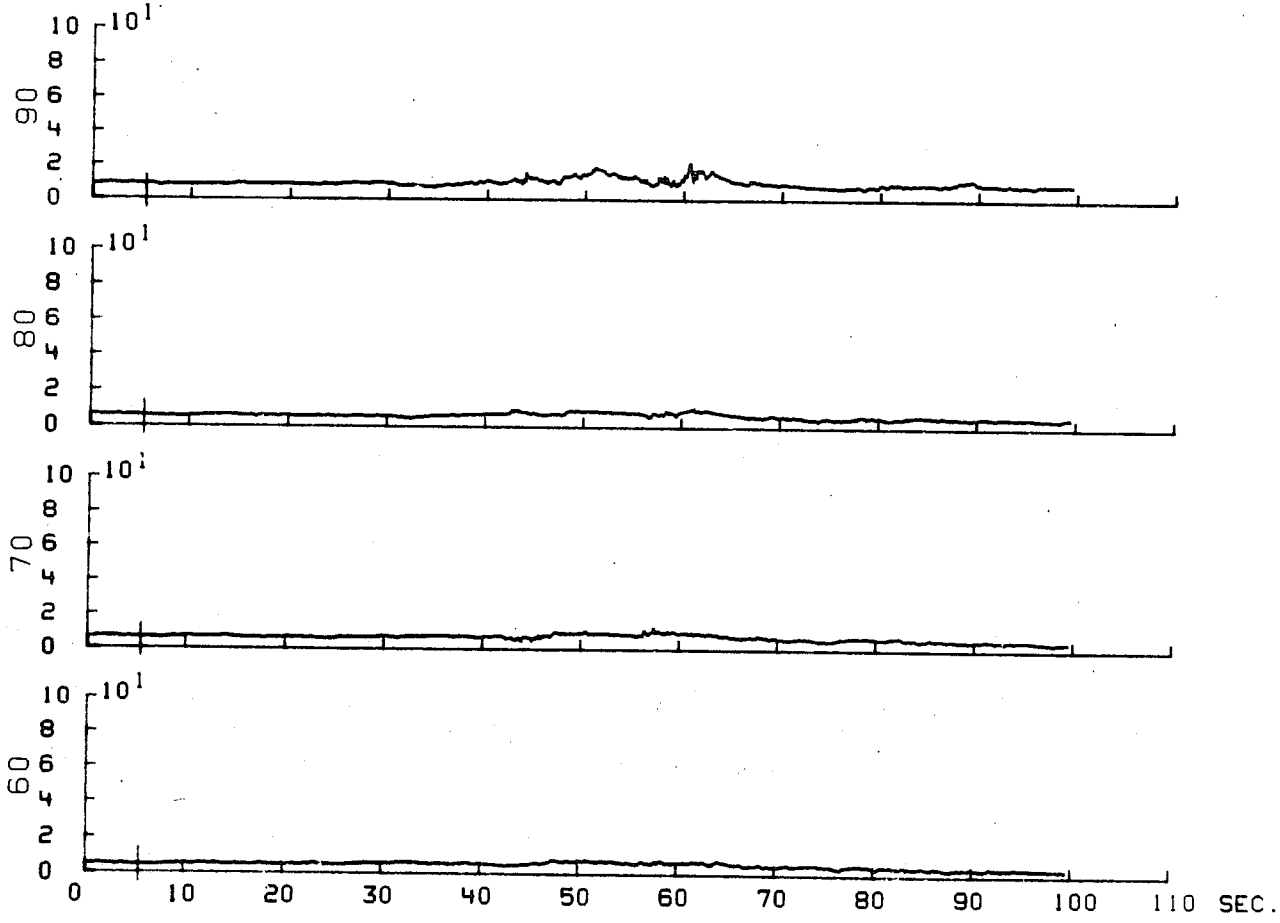


880 PASS 82 06/06/70 1025 47 EDT U=02 FPS



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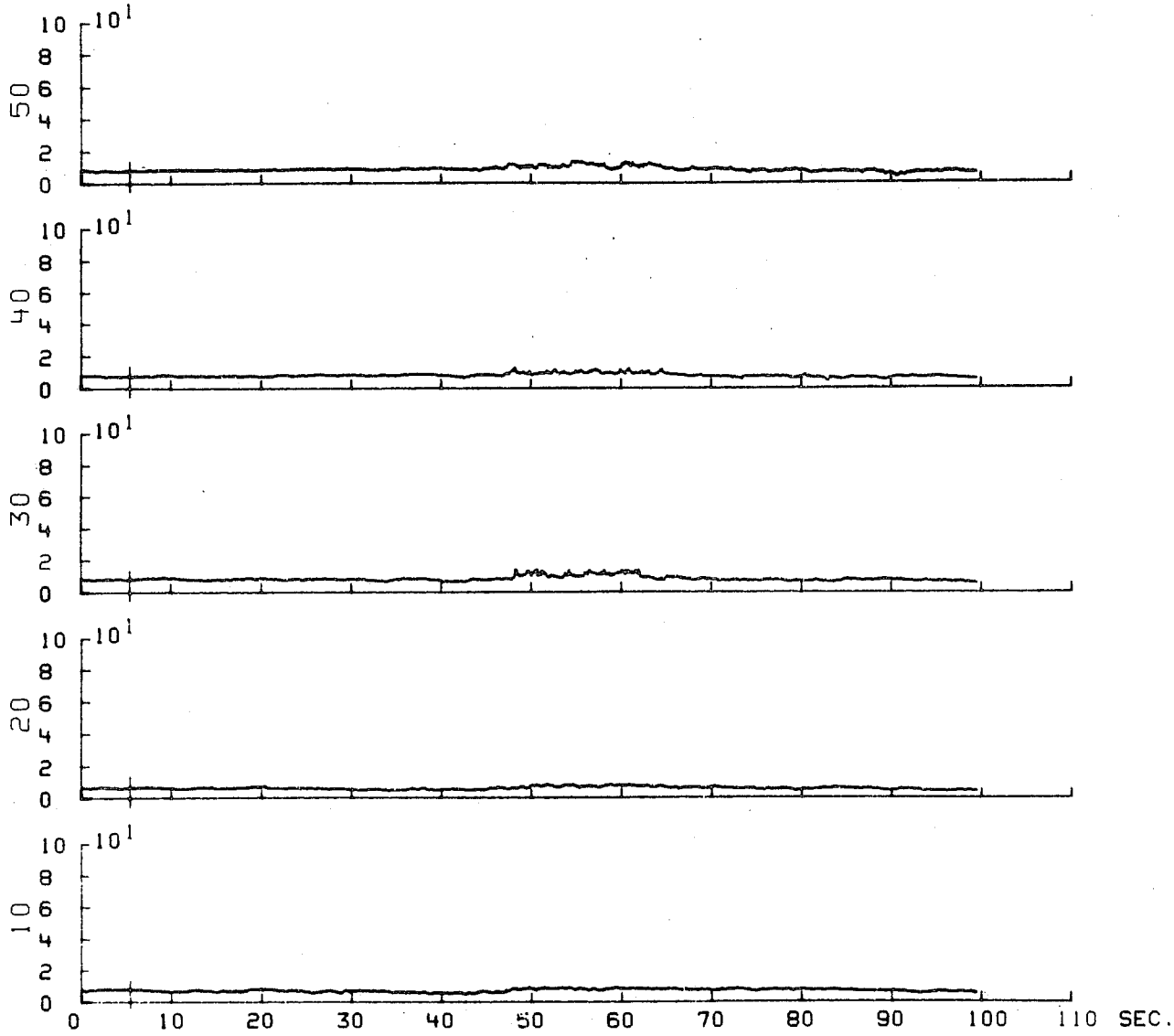
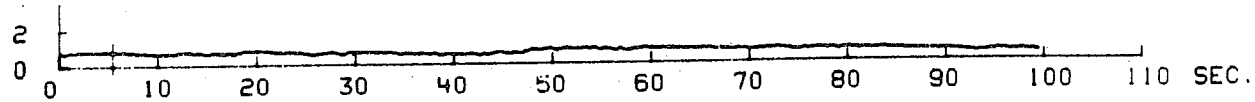
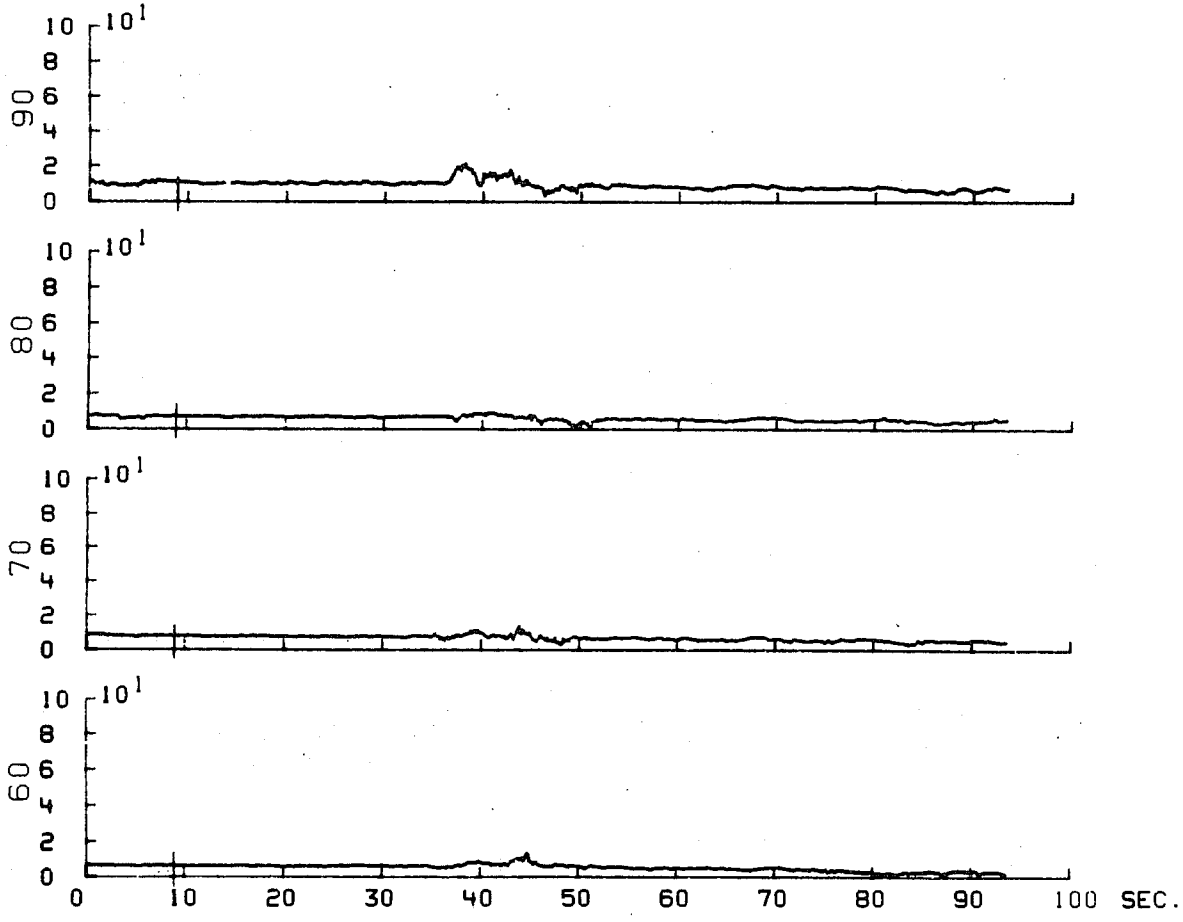




880 PASS 83 06/06/70 1031 59 EDT U=05 FPS



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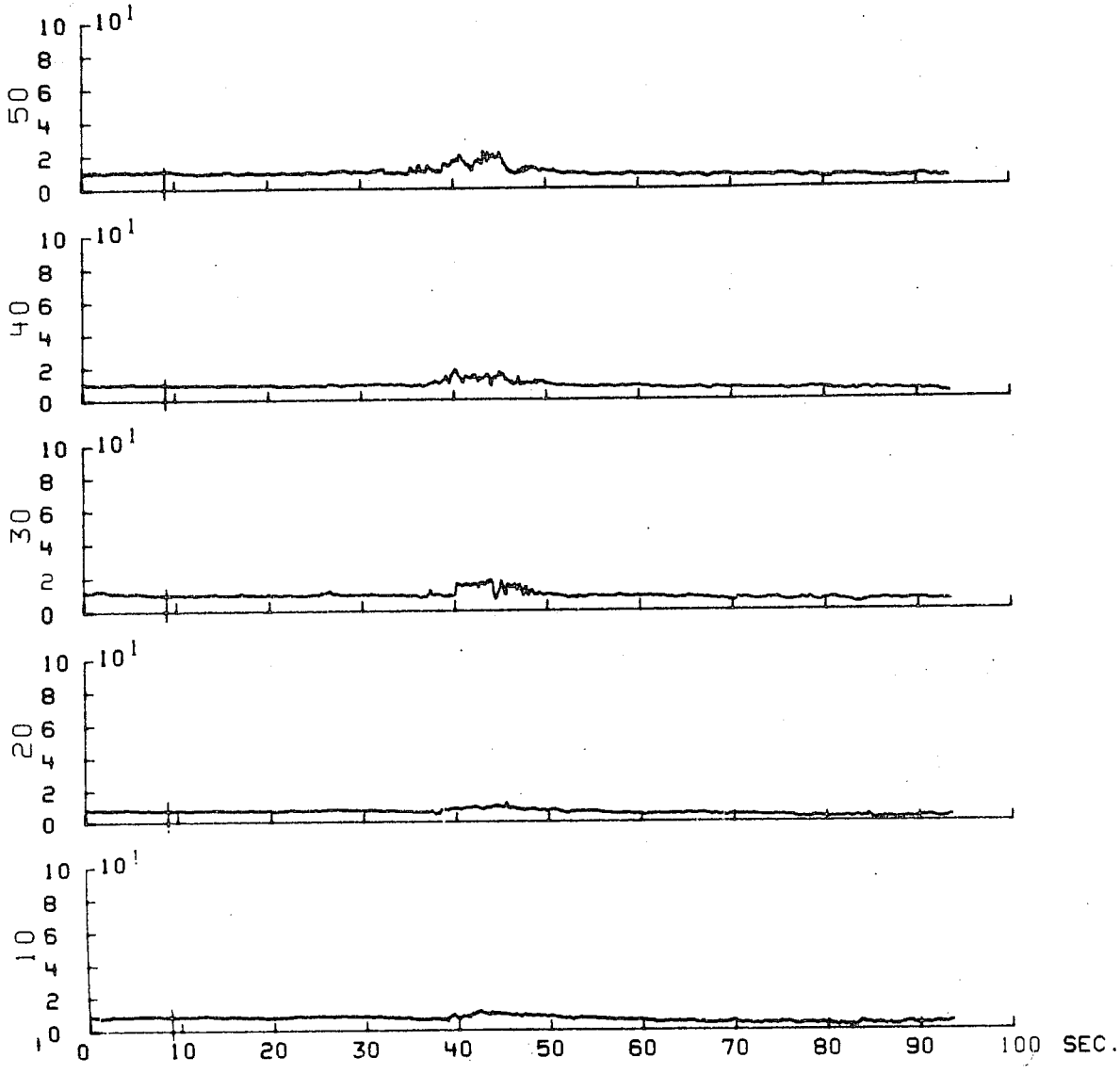

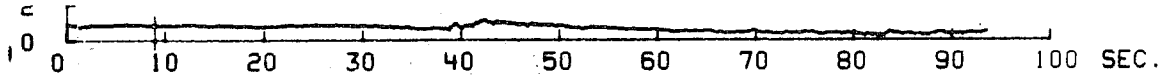

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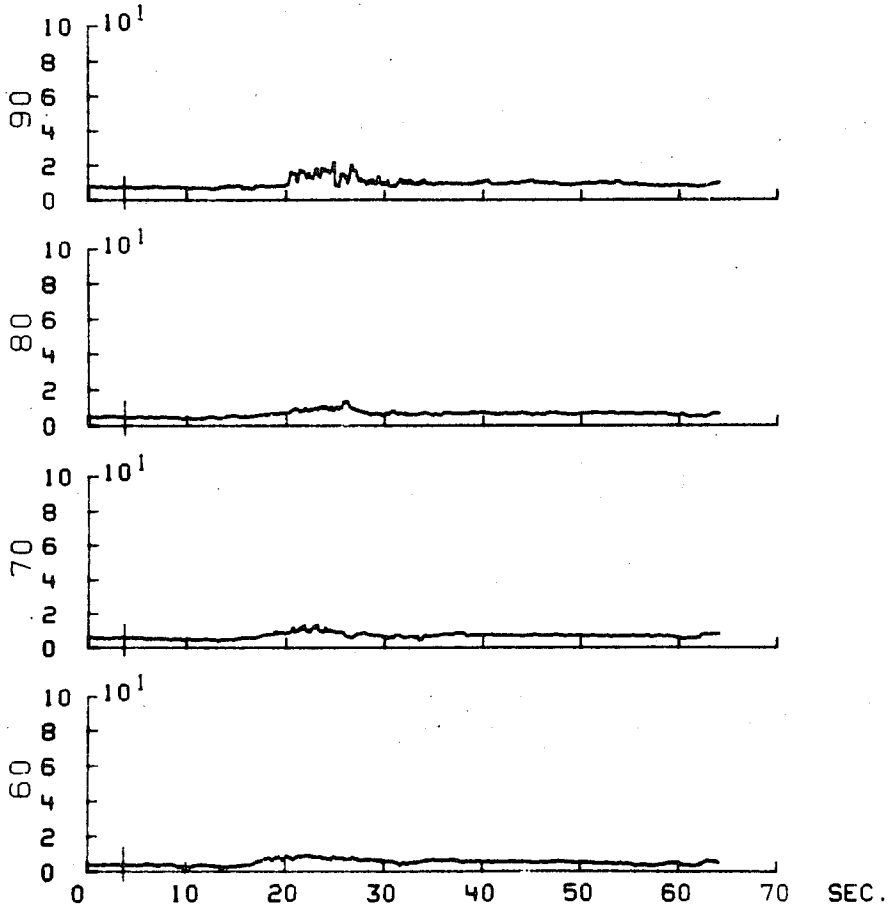
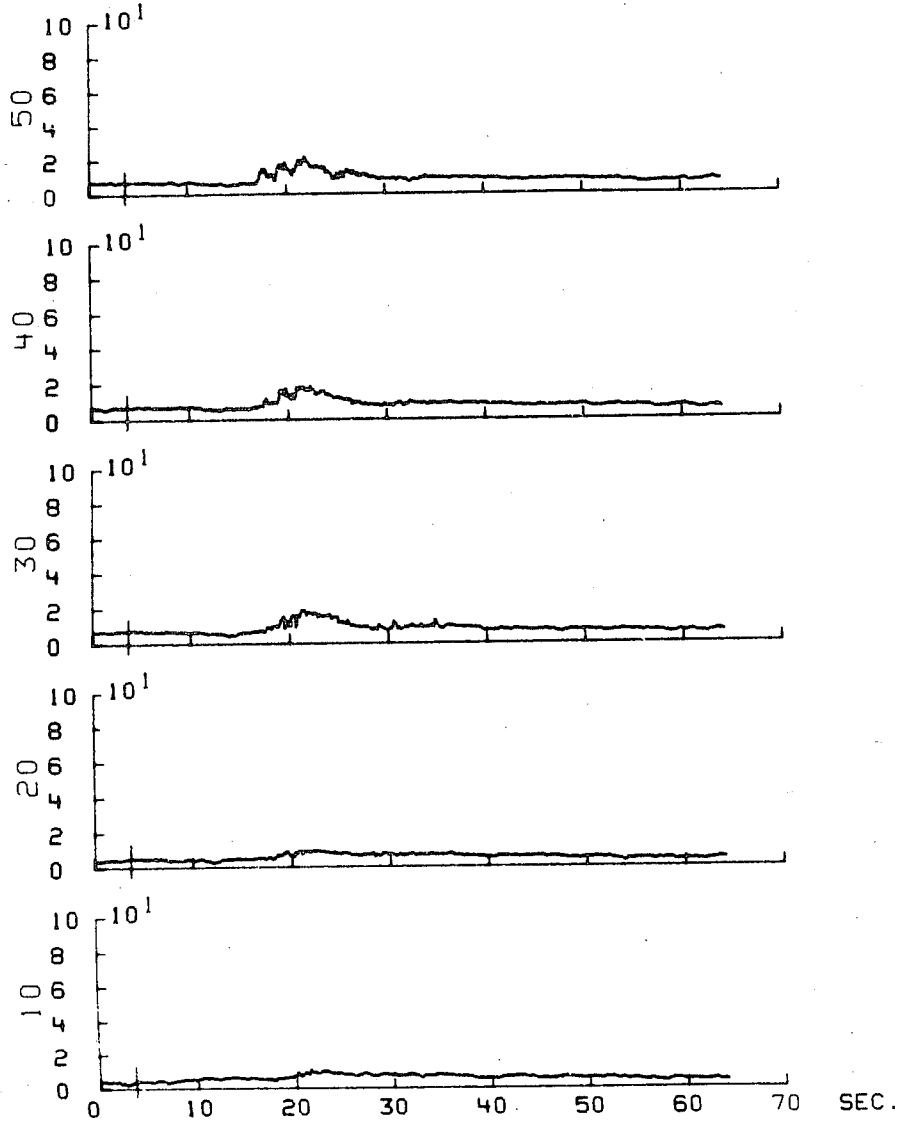
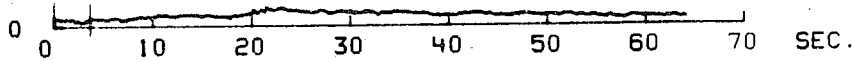
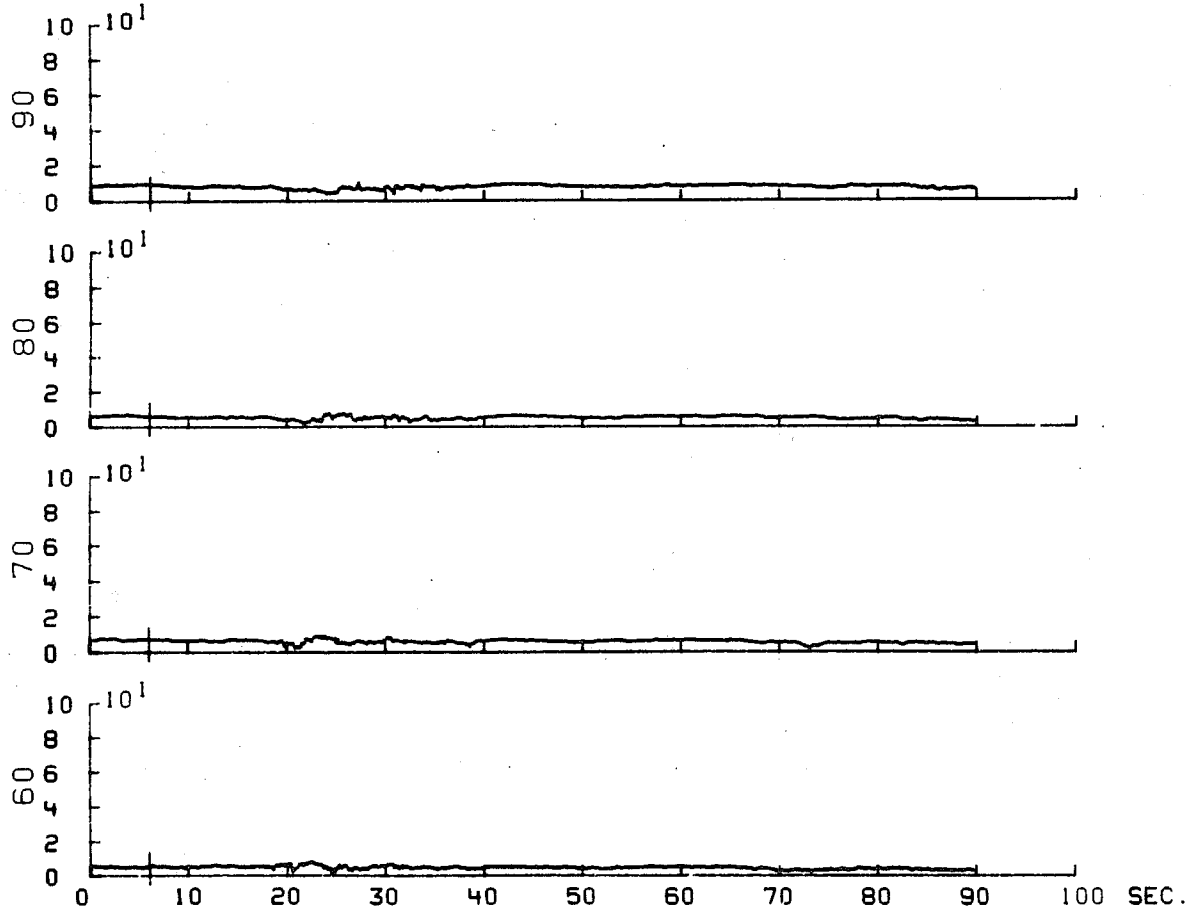


880 PASS 86 06/06/70 1053 57 EDT U=0.5 FPS





880 PASS 87 06/06/70 1059 21 EDT U=02 FPS



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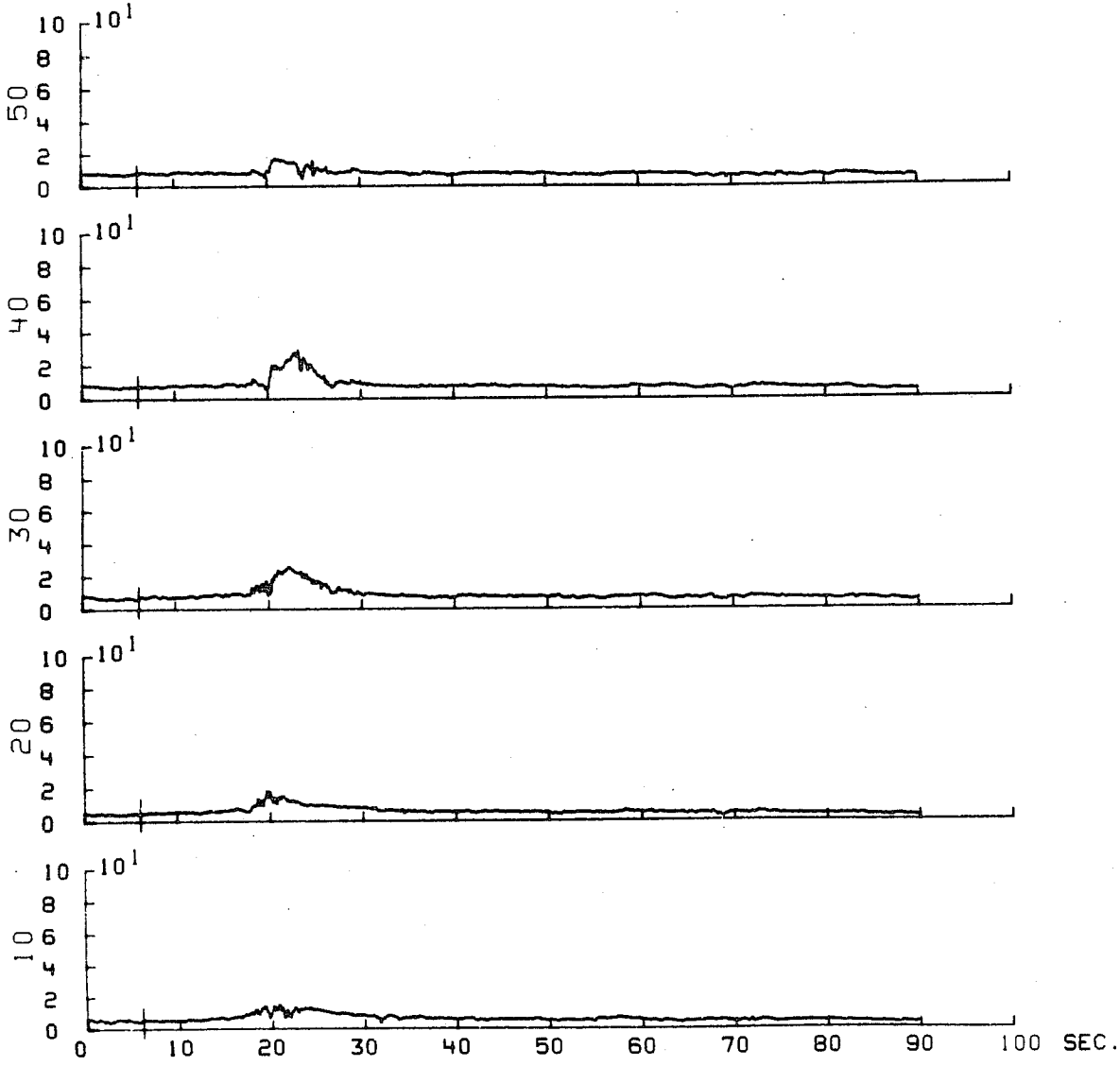
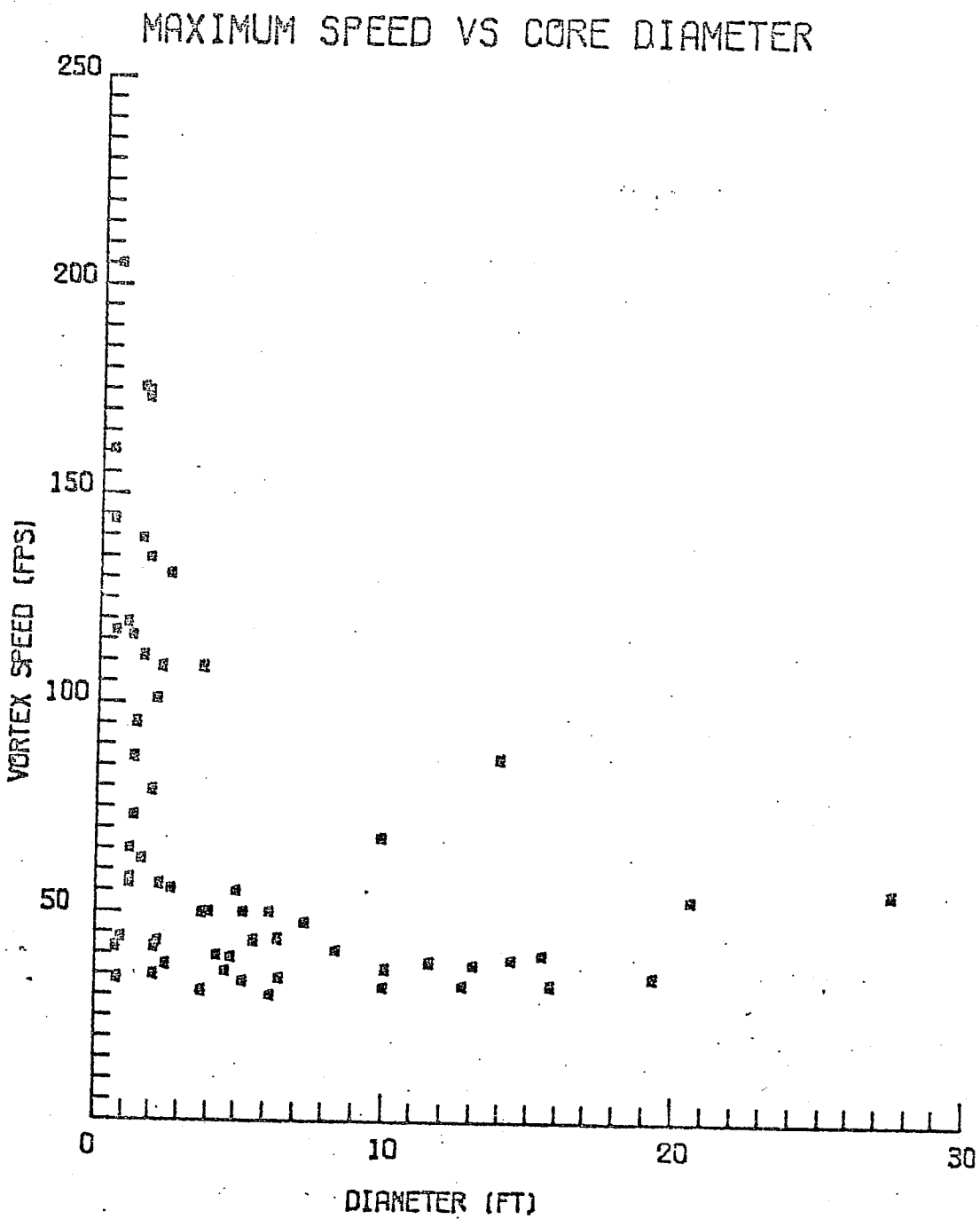
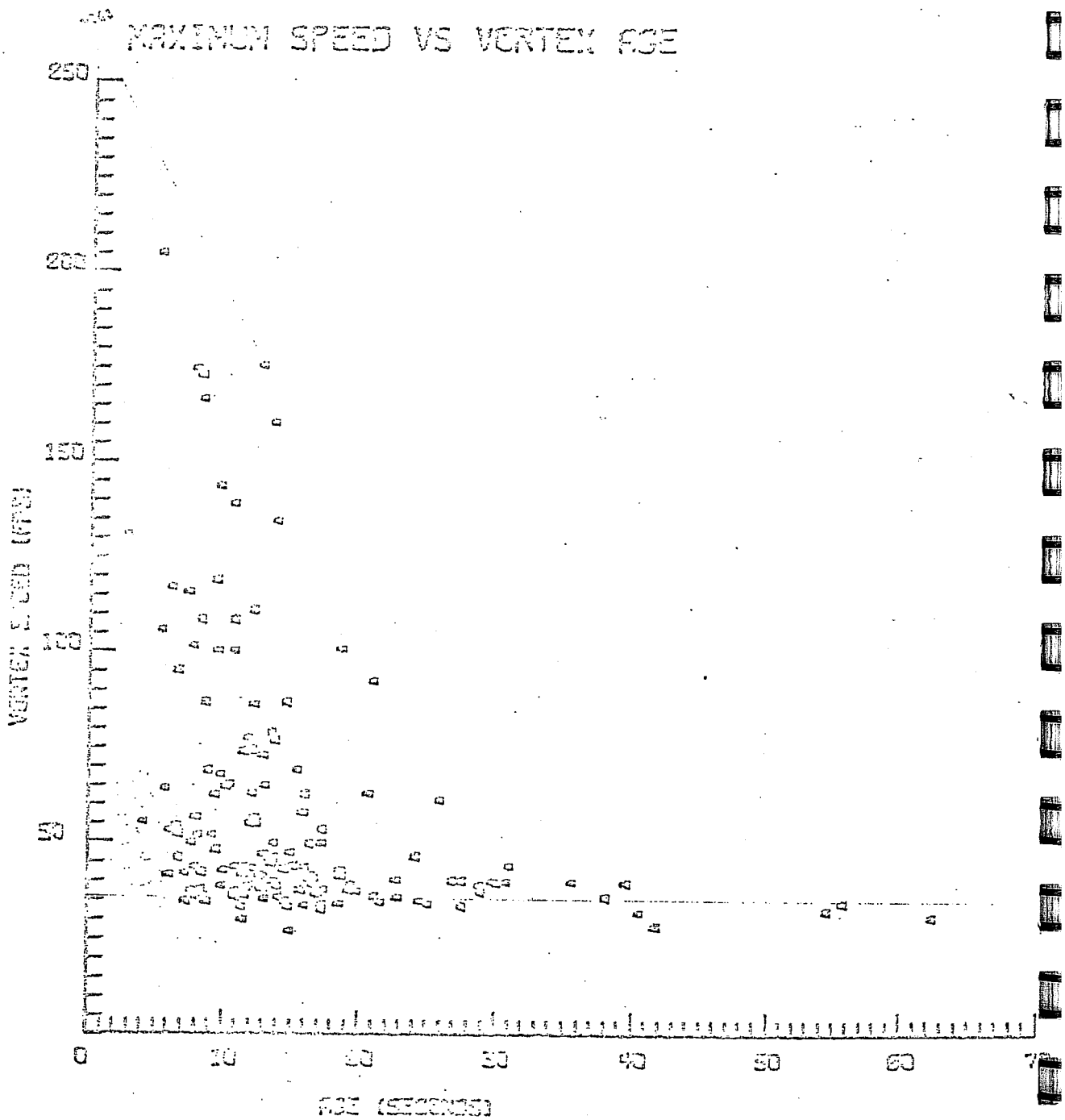
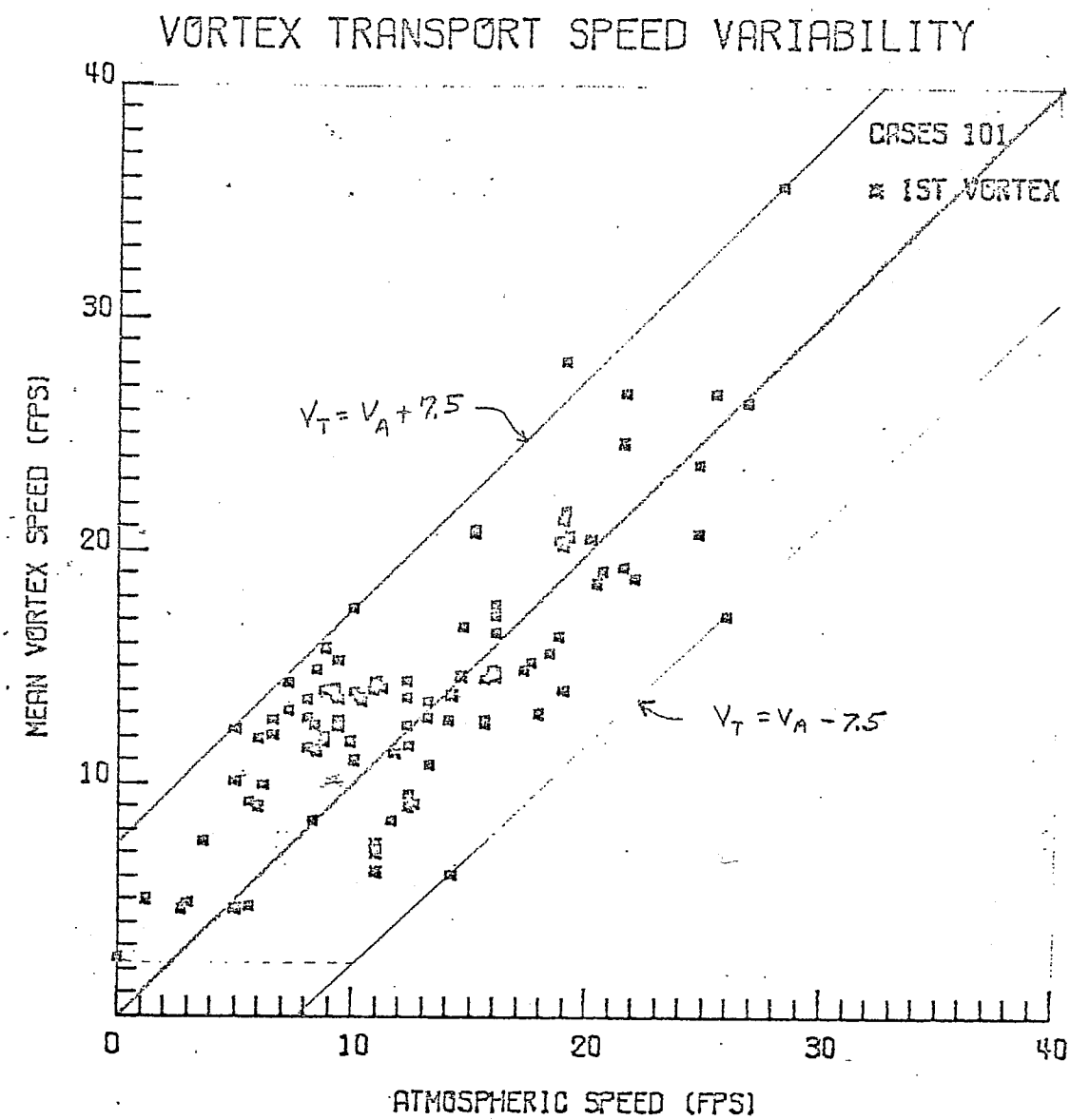
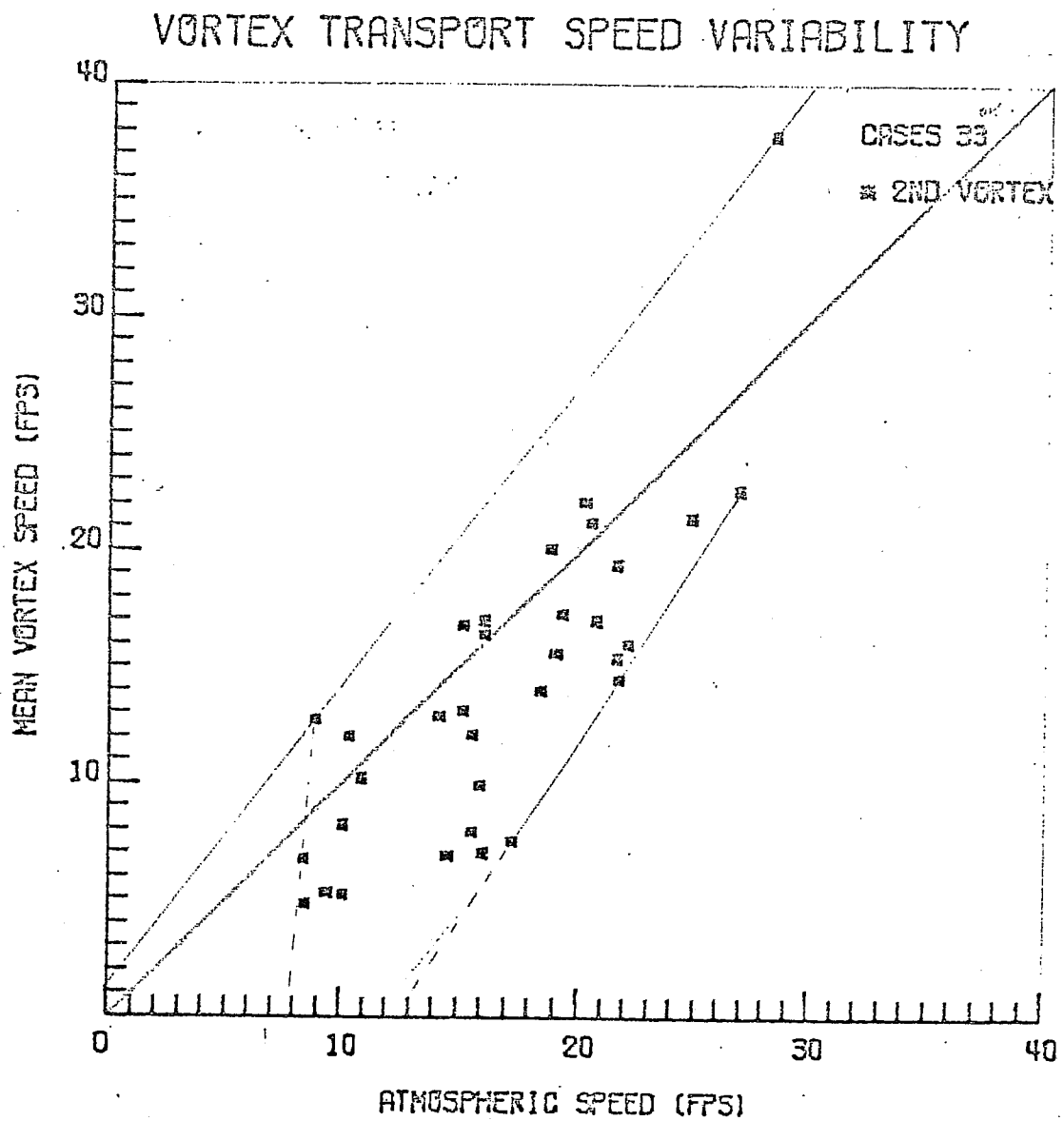


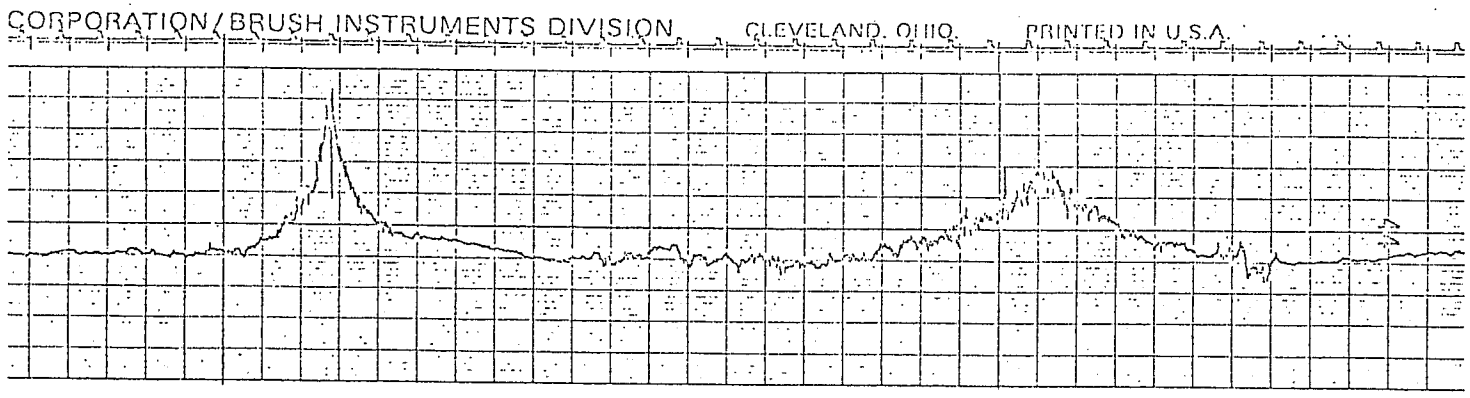
VORTEX SPEED (FPS)


MAXIMUM SPEED VS CORE DIAMETER
250
200
150
100
50
0
10
20
30
VORTEX SPEED (FPS)
DIAMETER (FT)

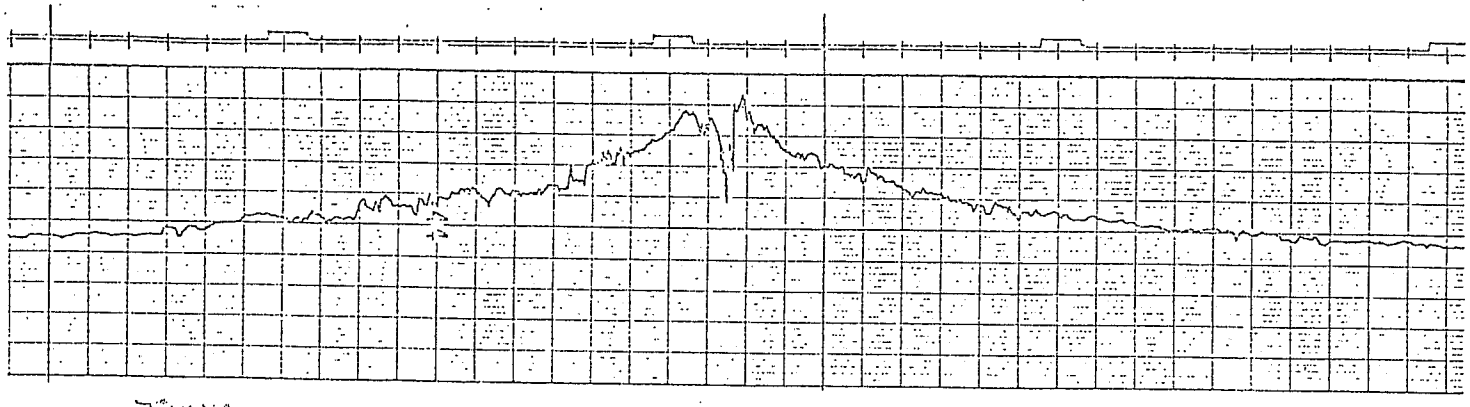

MAXIMUM SPEED VS VORTEX AGE
VORTEX SPEED (KTS)
250
200
150
100
50
0
10
20
30
40
50
60
70
AGE (SECONDS)


VORTEX TRANSPORT SPEED VARIABILITY
CASES 101
IST VORTEX
$V_T = V_A + 7.5$
$V_T = V_A - 7.5$
MEAN VORTEX SPEED (FPS)
ATMOSPHERIC SPEED (FPS)
0
10
20
30
40

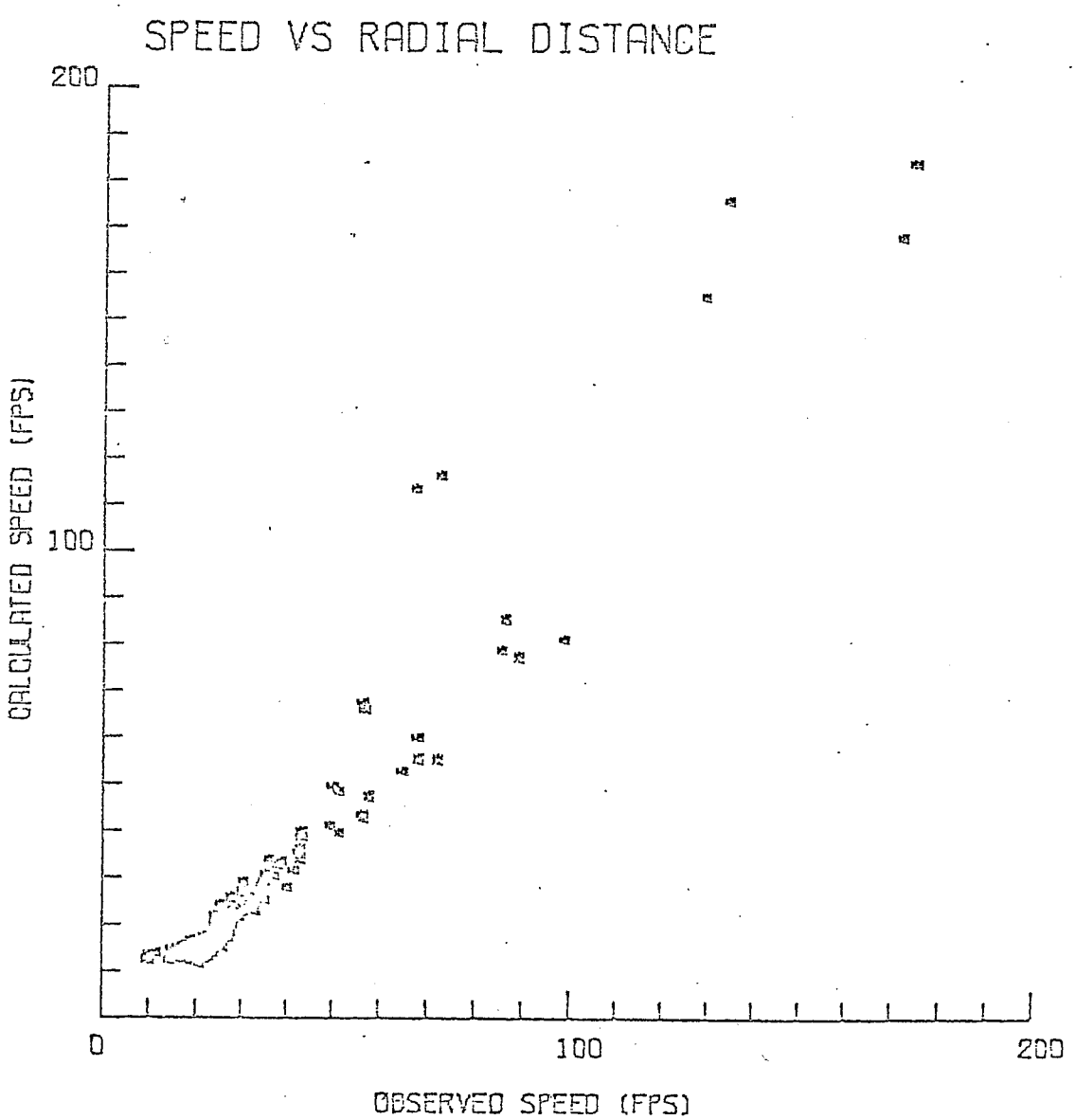

VORTEX TRANSPORT SPEED VARIABILITY
CASES 33
2ND VORTEX
MEAN VORTEX SPEED (FPS)
ATMOSPHERIC SPEED (FPS)
0
10
20
30
40

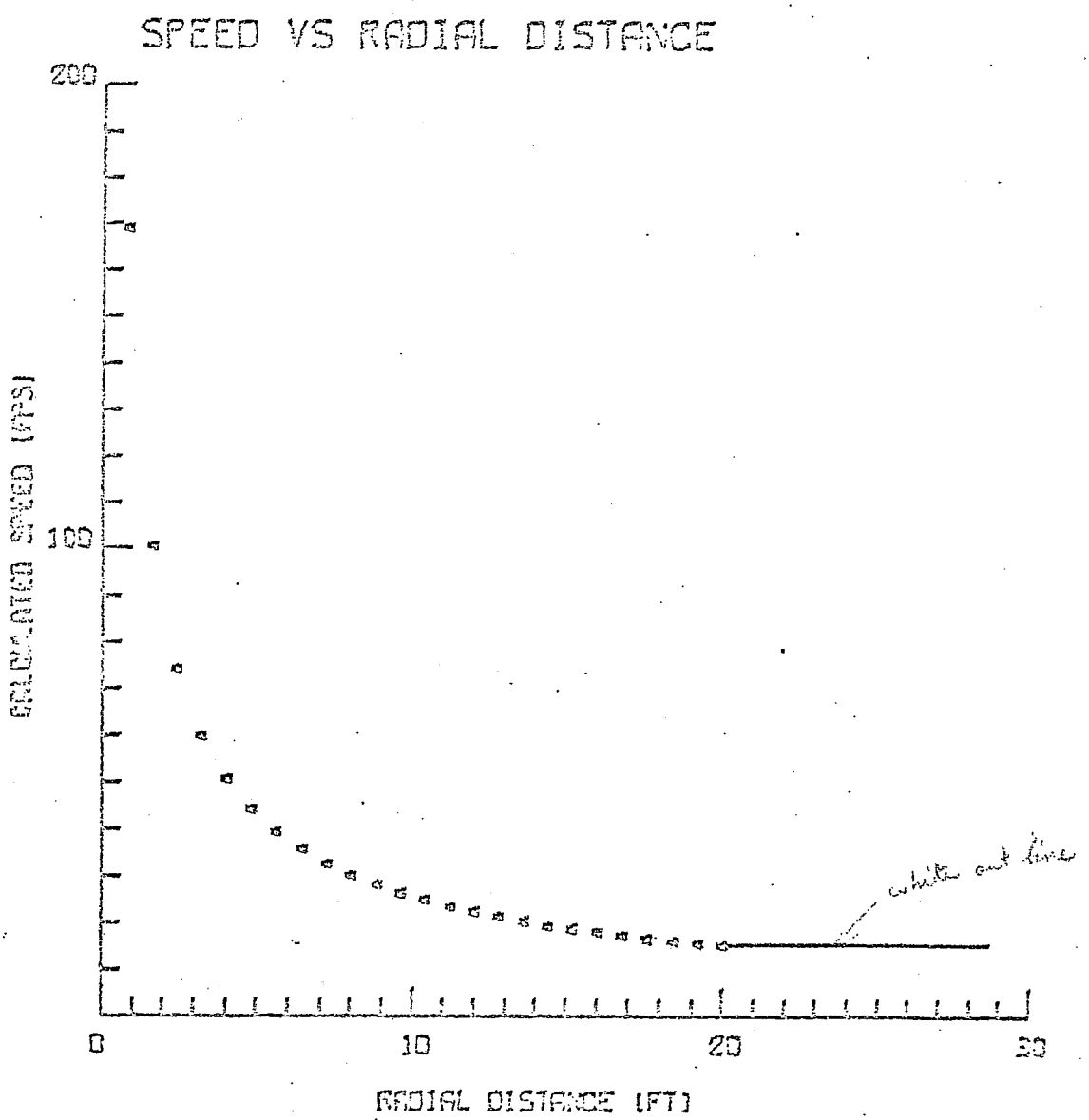


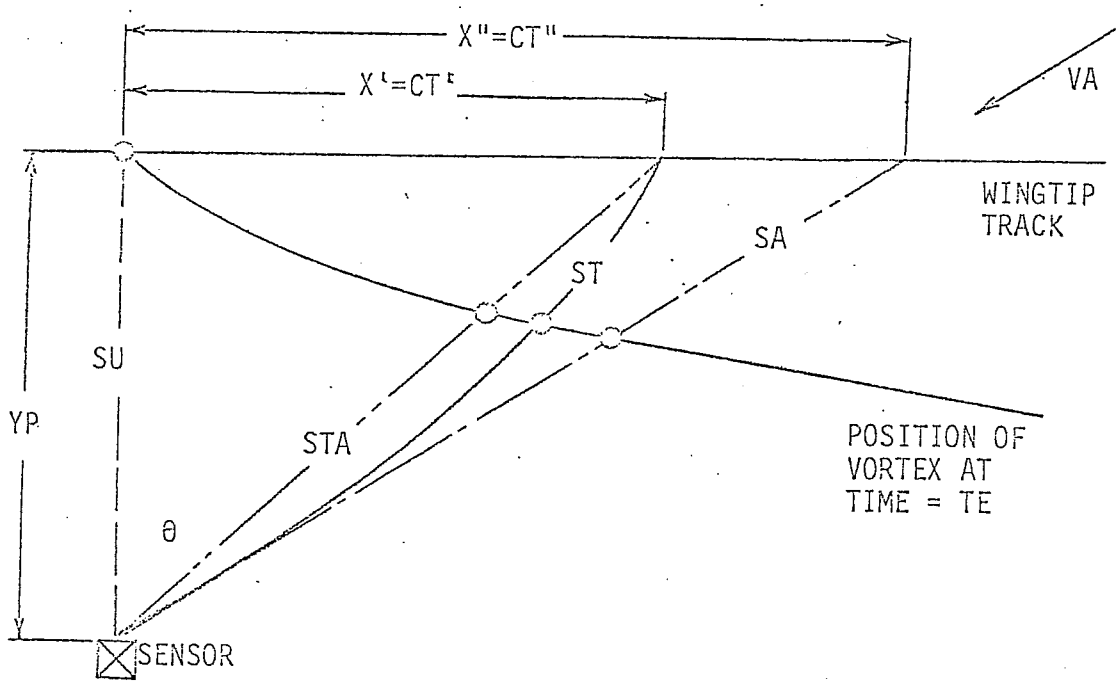
ANALOG VOLTAGE TRACES FOR 727, run #3, AT the 40 FOOT HEIGHT.



TIME EXPANDED VOLTAGE TRACE FOR THE FIRST VORTEX, 727 run #3.


SPEED VS RADIAL DISTANCE
200
100
0
100
200
CALCULATED SPEED (FPS)
OBSERVED SPEED (FPS)


SPEED VS RADIAL DISTANCE
200
100
0
10
20
30
CALCULATED SPEED (MPS)
RADIAL DISTANCE (FT)
white out line



SA, TRAJECTORY ALONG WIND VECTOR VA

STA, STRAIGHT LINE APPROX. OF ACTUAL TRAJECTORY

SU, MINIMUM LENGTH TRAJECTORY, LATERALLY

ST, ACTUAL TRAJECTORY

○ VORTEX ELEMENT POSITION AT TIME TE

YP = DISTANCE OF AIRCRAFT WINGTIP FROM SENSOR ALONG THE PERPENDICULAR FROM THE AIRCRAFT TRACK.

C = SPEED OF THE AIRCRAFT.

VA = ATMOSPHERIC WIND FECTOR.

T"(T') = TIME REQUIRED FOR AIRCRAFT TO FLY FROM POINT OF VORTEX GENERATION TO POINT ABEAM OF THE TOWER SENSORS.

TE = TIME AT WHICH THE AIRCRAFT WINGTIP WAS ABEAM OF TOWER SENSORS.

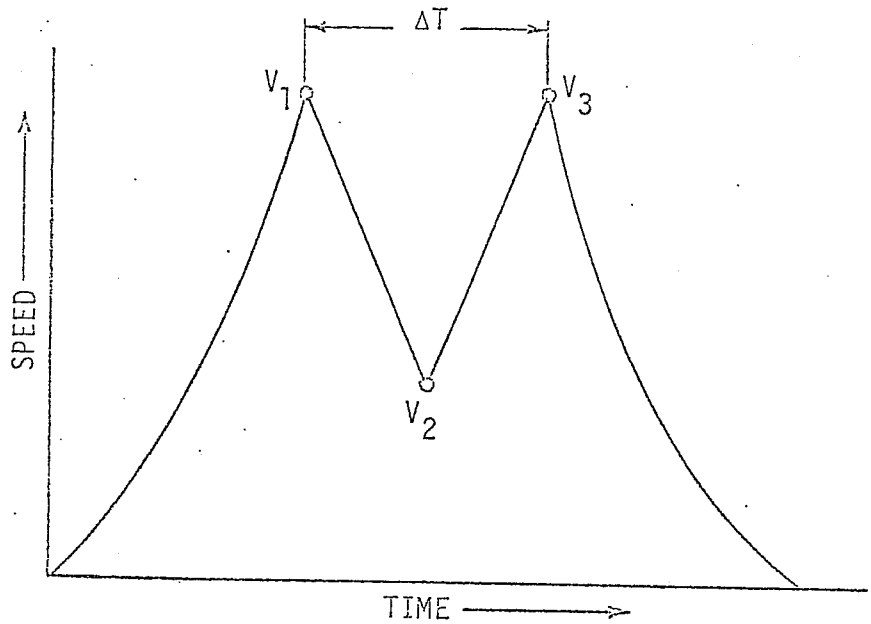


Figure A

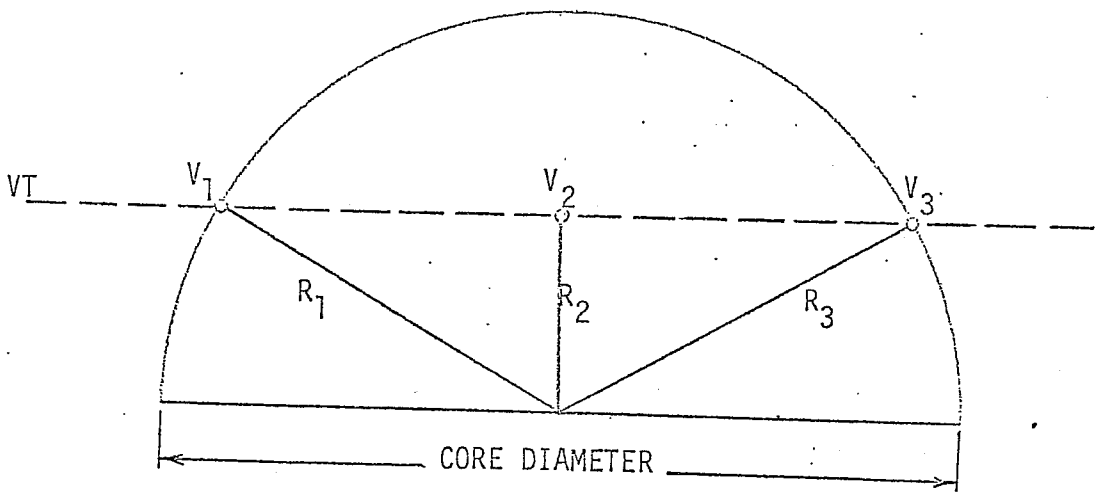


Figure B

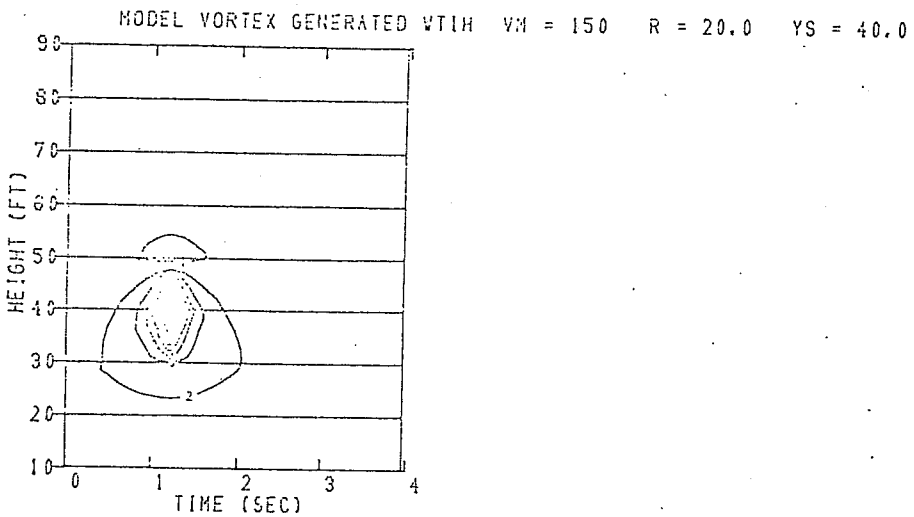


Figure A

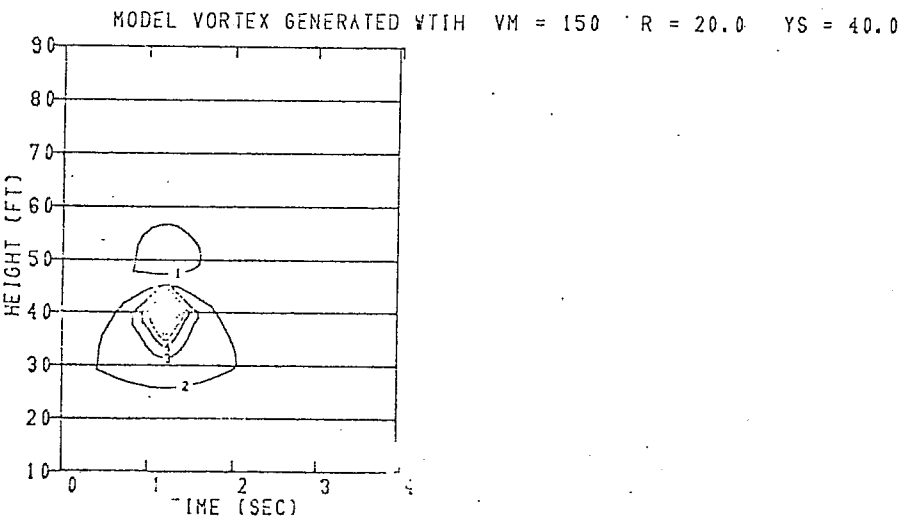


Figure B

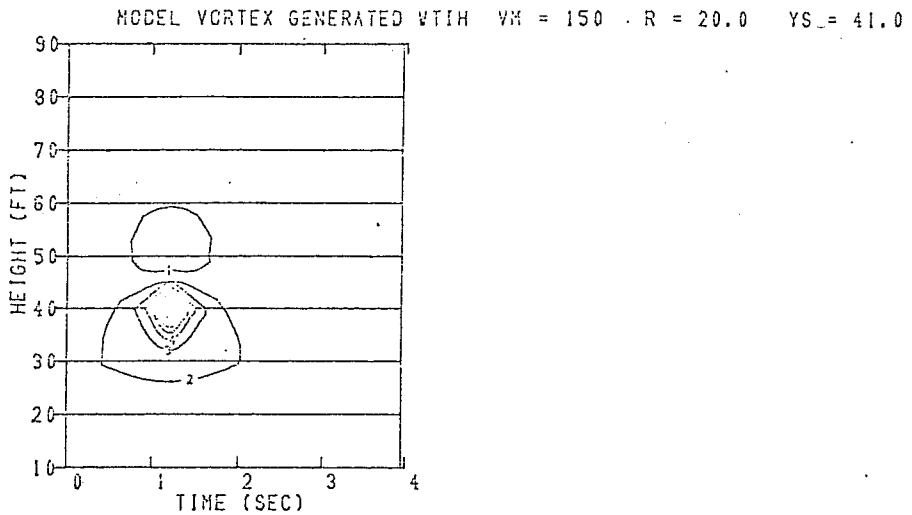


Figure A

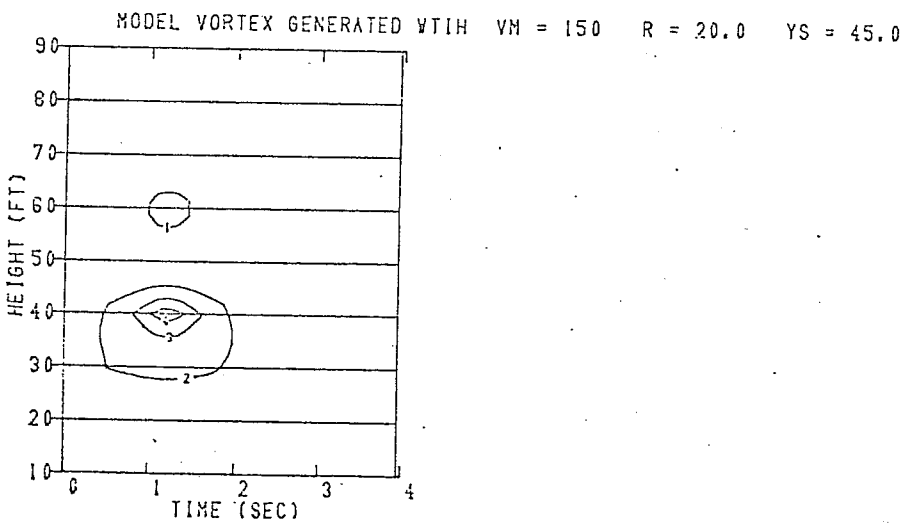


Figure B