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TECHNICAL PAPER

ATMOSPHERIC CONSTRAINT STATISTICS FOR THE SPACE SHUTTLE MISSION PLANNING

I. INTRODUCTION

This report describes the procedures that have proven to be effective in addressing specific questions on the frequency of atmospheric conditions of interest for the Space Shuttle mission planning. There are several atmospheric parameters of interest for each of the mission phases. The mission phases considered are (1) pre-launch, (2) launch operations, (3) return to launch site (RTLS), (4) abort once around (AOA), and (5) end of mission landing (EOM). Most standard statistical summaries of atmospheric variables are tabulated for single variables or a combination of a few variables such as cloud ceilings and visibilities. That is, they are parametric statistical summaries. Here, the interest is not only in the probability of each of the several atmospheric variables taken separately, but also in the probability that at least one of several variables will be of concern for a particular mission phase and for the several mission phases. For example, if there is a launch constraint due to several atmospheric parameters of which any one is a No-Go condition, then the probability of interest is the probability that any one of the constraints will occur.

The purpose of the statistical analysis is to address the following questions relative to assigned atmospheric constraints for the Space Shuttle mission phases.

1) What is the probability that the assigned atmospheric constraints will (will not) occur during a particular monthly reference period?

2) What is the probability that the assigned atmospheric constraints will (will not) occur for N consecutive days at a particular time of day during a monthly reference period?

3) Once the assigned atmospheric constraint has occurred (has not occurred) for 1, 2, 3, ... J consecutive days at a particular time of day, what is the probability that the given constraints will continue for N additional days?

Valid answers to these questions have practical applications to the Space Shuttle program in the following interrelated areas:

1) Establishing the natural environment design criteria

2) Mission planning

3) Establishing launch and flight operational rules

4) Shuttle program decisions on cost-trade assessments.

All three questions can be adequately answered for the stated purposes provided that appropriate atmospheric data bases are available. Over the years of assigned roles, this organization has developed sufficiently long periods of atmospheric records to use empirical statistical methods for the Shuttle launch from the Kennedy Space Center (KSC) with the AOA and EOM at Edwards Air Force Base and Northrup Strip or AOA and EOM at KSC.

The first question, "What is the frequency?" is answered by simple empirical probabilities. The second and third questions on the continuation of atmospheric events are answered using empirical probabilities of runs and conditional probabilities.

It soon became apparent after issuing a report [1] that the Shuttle Program Office and the Mission Planning Office at the Johnson Space Center had requirements for answers to many specific questions on the atmospheric conditions. The choice was made to establish computer programs with many options to address these questions. Otherwise a very large volume of statistical tabulations to meet the expanding needs would be required – an impractical approach.

The operations of the Atmospheric Mission Analysis computer programs have been performed to give statistical tabulations for assigned atmospheric constraints routinely on a 24-hr basis. The usage rate has been approximately 30 cases per month over the past year.

Section II gives a brief description of the atmospheric data bases, the atmospheric constraints options by mission phases, and the computer programs. Section III presents illustrative examples to demonstrate a few of the many possible statistical tabulations.

II. COMPUTER SYSTEM DESCRIPTION

A. Atmospheric Data Bases

1. KSC. The surface data used for this site is the WBAN hourly surface observations (Deck 144). The upper altitude wind data used is the two observations per day (Deck 600). The thunderstorm data used is the TD9688 data. The peak surface wind data used is the TD9690 data. All data used covered hours 0 through 23 with the exception of the upper altitude winds which were interpolated from the two observations per day to hourly observations. Period of record is January 1, 1957, through December 31, 1970.

2. Edwards Air Force Base. Data used for this site is the WBAN hourly surface observations (Deck 144). Period of record is January 1, 1957, through December 31, 1970.

3. Northrup Strip. Data used for this site is the WBAN hourly surface observations (Deck 144). Period of record is January 1, 1957, through December 31, 1970.

4. Vandenberg Air Force Base. The surface data used for this site is the WBAN hourly surface observations (Deck 144). The upper altitude wind data used is the two observations per day (Deck 600) which were interpolated to hourly observations. Period of record is January 1, 1965, through December 31, 1973.

B. Atmospheric Constraints by Mission Phases

1. Prelaunch Phase at KSC. There is one constraint for the prelaunch phase. There cannot be any precipitation during the hours of prelaunch activity. The beginning and ending hours for prelaunch activity are variable parameters.

2. Launch Phase at KSC. There are six constraint categories for the launch phase:

1) Thunderstorm – No-GO if a thunderstorm occurs.

2) Precipitation – No-Go if precipitation occurs.

3) Cloud ceiling and/or visibility – No-Go if the cloud ceiling is lower than specified and/or if the visibility is less than specified.

4) Peak surface wind speed – No-Go if the peak surface speed is greater than specified.

5) Upper altitude winds – No-Go if the max Q is greater than the specified U* for the specified altitude region at the specified azimuth.

6) Tower clearance – No-Go if the peak surface wind is greater than specified for the wind direction. Wind from the directions of 150 to 210 degrees has a specified maximum while wind from all other directions may have a different specified maximum.

3. RTLS Phase. There are eight constraint categories for the RTLS phase:

1) Thunderstorm – Same as launch phase.

2) Precipitation – Same as launch phase.

3) Cloud ceiling and/or visibility – Same as launch phase except cloud cover may optionally be used instead of cloud ceiling.

4) Visibility – No-Go if visibility is less than specified.

5) Cloud cover – No-Go if cloud cover is greater than specified.

6) Head/tail wind – No-Go if the head or tail wind is greater than specified.

7) Steady state crosswind – No-Go if the steady state crosswind is greater than specified.

8) Peak crosswind – No-Go if the peak crosswind is greater than specified.

4. AOA. Same as for RTLS using the data base for the desired landing site.

5. EOM. Same as for RTLS using the data base for the desired landing site.

C. Techniques

1. Single Site. The desired analysis is performed on one site independently. For a KSC launch, the prelaunch, launch, and RTLS phases are for KSC only. An AOA or EOM phase may be performed on either Edwards Air Force Base, Northrup Strip, or KSC independent of each other.

2. Multiple Sites. The desired analysis is performed using all sites with each phase being dependent upon a Go condition for the previous phase. For example, the launch phase is only analyzed for those cases which are a Go condition from the prelaunch phase. The RTLS phase is only analyzed for those cases which are a Go condition from the launch phase. The AOA phase is only analyzed for those cases which are a Go

condition from the RTLS phase. The AOA phase uses each of the landing sites independently as well as jointly. Also, this technique allows for a launch window rather than a set launch hour.

3. Options. For the single site analysis, there are a total of 28 options which may be exercised at run time. Two of these options are for prelaunch operations, 15 options for the launch operations, and 11 options for the RTLS, AOA, or EOM operations.

1) Prelaunch operation beginning hour.

2) Prelaunch operation ending hour.

3) Launch thunderstorm constraint.

4) Launch precipitation constraint.

5) Launch cloud ceiling constraint.

6) Launch visibility constraint.

7) Launch surface peak wind speed constraint.

8) Launch azimuth for upper winds analysis.

9) Launch upper winds beginning altitude.

10) Launch upper winds ending altitude.

11) Launch U* constraint for upper winds.

12) Launch option to disregard upper winds.

13) Launch tower clearance minimum wind direction.

14) Launch tower clearance maximum wind direction.

15) Launch tower clearance wind speed constraint for the winds occurring between the minimum and maximum wind direction.

16) Launch tower clearance wind speed constraint for the winds occurring at all other wind directions.

17) Launch wind type to be used for head/tail wind constraint (either steady state or peak winds may be used).

18) RTLS, AOA, and EOM runway angles which allow for up to two runways with the option to use any combination of landing directions.

19) RTLS, AOA, and EOM thunderstorm constraint.

20) RTLS, AOA, and EOM precipitation constraint.

21) RTLS, AOA, and EOM option to use either the cloud ceiling or cloud cover constraint.

22) RTLS, AOA, and EOM cloud ceiling constraint.

23) RTLS, AOA, and EOM visibility constraint.

24) RTLS, AOA, and EOM cloud cover constraint.

25) RTLS, AOA, and EOM head wind constraint.

26) RTLS, AOA, and EOM tail wind constraint.

27) RTLS, AOA, and EOM steady state crosswind constraint.

28) RTLS, AOA, and EOM peak crosswind constraint.

For the multiple site analysis, all of the above options apply plus the launch window time and the order of landing sites desired for AOA and EOM.

4. Analysis of Runs and Time Conditional Probabilities. This analysis provides the capability of determining the Go or No-Go status for each day of the month for each year of the data sample. These are then analyzed to give the length of runs for both Go and No-Go, if a given day is No-Go, what is the probability of succeeding days being a Go; or, if a given day is Go, what is the probability of succeeding days being Go or No-Go.

III. ILLUSTRATIVE EXAMPLES

This section presents illustrative examples for the probability of atmospheric constraints for launch, return to launch site, and prelaunch for a March 0800 LST launch from the KSC. Another set of examples is given for the end of mission landing atmospheric constraints to illustrate the frequency of occurrence, runs probabilities, and time conditional probabilities.

A. Example for Launch, RTLS, and Prelaunch

These examples are for illustrative purpose only. They do not necessarily represent the atmospheric constraints for any particular orbiter configuration.

1. Probability of Atmospheric Constraints for KSC Launch Operations for March (Table 1.a). For this example, there are five assigned atmospheric constraints. The body of the table gives the percentage probability for the occurrence for each of the five constraints for each hour of the day versus local standard time. For brevity, this table is also called No-Go probabilities for launch operations. The Go probabilities in percent would be these values subtracted from 100 percent. There must be some rationale in the selection of the atmospheric constraints:

1) The thunderstorm constraint is set by the Space Shuttle program design requirement. The vehicle is not designed to be launched through a thunderstorm.

2) The precipitation constraint is an operational concern for ice/frost accumulation on the ET. There was also an early concern for rain erosion of the tiles during ascent.

3) The cloud ceiling and visibility constraint is an early range safety constraint established to meet the requirement for visual sighting in the first 1600 ft of flight by a camera located 5 miles from the launch complex.

4) The peak wind speed has been eliminated from this example by setting the value above the observed range of this variable; i.e., > 99 knots.

5) The upper winds constraint is an algorithm for the maximum dynamic pressure constraint. In this example, the 25-m/sec wind component in the 10- to 15-km altitude region is a head wind component relative to the monthly mean in-plane wind component for the flight azimuth of 59 degrees.

6) The tower clearance peak surface wind ≥ 20 knots from the south plus and minus 30 degrees and greater than 28.7 knots for all other wind directions has been established as a facilities design limit.

The last line in Table 1.a gives the percentage probability of No-Go for the occurrence of one or more of the above listed constraints. Note that the occurrences of the individual constraints are not mutually exclusively events. The sum of the probability of the individual constraints exceeds, in some cases, the last entry in this table.

2. Probability of Atmospheric Constraints for KSC Return to Launch Site (RTLS) for March (Table 1.b). For this example, the selected atmospheric constraints are:

1) The occurrence of a thunderstorm.

2) The occurrence of precipitation.

3) A cloud ceiling ≤ 5000 ft and/or visibility < 8 n.mi.

4) There is a separate breakout for the visibility < 8 n.mi.

5) Cloud cover > 0.5. A cloud ceiling is defined as the height at which 0.6 or more of the sky is obscured by clouds. The concern for cloud cover and visibility is the desire of the flight crew to be able to see the runway in the event of an RTLS.

6) For peak runway winds, a head wind > 20 knots and/or a tail wind > 20 knots is selected for an orbiter flight test. Note, from the heading of this table, both ends of the runway are used in this example; therefore, there is no tail wind occurrence.

7) The surface steady state crosswind has been eliminated from this example by setting the value > 99 knots.

8) The peak crosswind to the runway > 10 knots in this example was selected for an orbiter flight test.

The entry entitled "Any of the Above" is the probability of occurrence of one or more of the above constraints for the RTLS.

The last entry in Table 1.b, entitled "Any of the Above for Launch and RTLS," is the probability for No-Go if any one of the above listed constraints for launch and RTLS is considered as a No-Go condition.

Here it is noted, again, that these constraints are not mutually exclusive events.

3. Probability of Atmospheric Constraints for Prelaunch Operations for KSC for March (Table 1.c). The only prelaunch constraint considered is the occurrence of precipitation at any time after the external tank (ET) loading until launch time. This is because there is concern that ice will form on the ET if precipitation occurs. The concern is that the ice will fall off during ascent and damage the orbiter tiles. In this example, there is a 15 percent chance that precipitation will occur at least one time between the hours of 0200 and 0800 LST. This gives an overall No-Go probability of 73 percent for an 0800 LST March launch for the stated atmospheric constraints for prelaunch, launch, and RTLS

For the future prelaunch statistical analysis for Vandenberg Air Force Base, a different approach will be used for the ET ice constraint. A thermal transfer simulation has been made using the atmospheric variables for Vandenberg Air Force Base to determine the amount of ice accumulated for each hour of the day for various exposure periods. The prelaunch constraint for the ET ice will be made in terms of an ice thickness constraint. The assigned ice thickness will be treated in a statistical manner as any other atmospheric variable.

The examples given for No-Go probabilities in Tables 1.a through 1.c are intended for instructive purposes only. The assigned atmospheric constraints and their values are not to be construed as mission rules. The resulting probabilities are more accurately interpreted as the chances there will be concern for the operating restriction. For example, the launch mission rule may read no launch through a thunderstorm. The meteorological data base gives only the occurrence of thunderstorms and a thunderstorm is reported only when thunder is heard. Thunder is heard over a radius of approximately 10 miles. During operations, there is certainly a reason to be concerned when a thunderstorm is reported. Additional information is required, e.g., where is the thunderstorm in relation to the vehicle flight path, the time of the report, and expected thunderstorm movement.

The range safety requirement rule is for visual sighting of the flight in the first 1600 ft from a position 5 miles from the launch complex. A translation of this rule is made in terms of a cloud ceiling and visibility. The rationale for other atmospheric constraints is similarly interpretations of operating restrictions. Certainly, the statistics given in the mission analysis programs are the chance there will be concerns for the Shuttle operating restrictions as related to atmospheric conditions. Any number of atmospheric constraint limits and options to the computer programs can be exercised to make relative comparisons of various translations of operating restrictions in terms of the available atmospheric data bases.

B. KSC EOM Trade Study Examples

Two sets of atmospheric constraints for EOM landing at KSC are presented to illustrate a trade study analysis for mission planning. These two sets of atmospheric constraints are designated as Case I and Case II throughout the following discussion.

The Case I atmospheric constraints are:

1) Thunderstorm occurrence.

2) Precipitation occurrence.

3) Cloud ceiling ≤ 20,000 ft and/or visibility less than 8 n.mi.

4) Runway winds: peak head wind > 25 knots. (Since both ends of the runway are used, there is no tail wind constraint.)

5) Peak cross runway wind > 10 knots.

The Case II atmospheric constraints are the same as Case I except steady state runway winds are used.

The Shuttle mission planning questions addressed are:

1) For two sets of atmospheric constraints for landing at KSC at the EOM, what is the probability each of the constraints occurring and for any one of the constraints occurring?

2) For the sets of constrictions, what is the probability of EOM landing delays for N consecutive days at a specified time of day?

3) For the sets of constraints, what is the probability of N consecutive additional delay days, given that the EOM landing is delayed for J consecutive days?

Answers to these three questions are illustrated.

1. Probability of Atmospheric Constraints for EOM Landing at KSC, January and July. The percentage probability for No-Go for each of the Case I atmospheric constraints for EOM landing at KSC for each hour local standard time for January and July is presented in Tables 2 and 3. The ceiling and visibility constraint is the most frequent cause for No-Go for landing in January followed by the peak crosswind constraint. Whereas in July, the peak crosswind is the most frequent cause for No-Go for landing. Also, note the high frequency of thunderstorms in the afternoon hours in July. The last line in Tables 2 and 3 gives the probability of No-Go for landing caused by any one of the above listed constraints. A summary chart (Table 4) gives the probability for any one of the Case I atmospheric constraints for all months versus all hours. Here it is seen that the "best" landing times are early morning hours during the summer months and the "worst" times are near noon to midafternoon with 60 percent chance for No-Go for landing in all months except November and December.

To contrast the No-Go probability for the Case I atmospheric constraints presented in Tables 2, 3, and 4, similar tables for the Case II atmospheric constraints are presented as Tables 5, 6, and 7. Here, the contribution to the No-Go probabilities caused by the peak runway wind constraint is noted. All other constraints are the same. From Table 7 there is a 20 to 55 percent chance for No-Go for landing due to one or more of the stated atmospheric constraints.

2. Runs and Time Conditional Probabilities. Tables 8, 9, and 10 are presented to illustrate the techniques for the analysis of runs and conditional probabilities for the Case I atmospheric constraints for the EOM landing at KSC at 0900 hr LST in January.

In Table 8, the entries are consecutive listings of codes "0" for Go and "1" for No-Go for each January day for the 14 years of records. This table gives the No-Go days and Go days for landing for the Case I atmospheric constraints at 0900 hr LST at KSC when any one of the five constraints occurred or did not occur for the 434 days. It is from a listing of Go and No-Go days (Table 8) that Tables 9 and 10 are derived.

A run is a succession of like events or things. An explanation of the computational procedures used to derive Tables 9 and 10 from Table 8 is in order because of the unusual techniques used to count runs and overlapping runs. To illustrate, let there be a sequence, as:

aaa, bb, aaaa, b, aaaaaa, bbbb

There are four runs of a's and three runs of b's. There is one run of a's of length 1, no runs of a's of length 2, two runs of a's of length 3, and one run of a's of length 5. There are three runs of a's of length 3 or more, one run of length 4 or more, and one run of length 5. There are, by counting all possible overlapping lengths of runs, twelve runs of a's of length 1 (i.e., there are twelve a's in the sequence), there are eight runs of length 2, five runs of length 3, two runs of length 4, and one run of length 5.

The computational format for the above counting of runs can be conveniently arranged as in the following:

Illustration for Counting Runs

(1) Length of Run, N_i	(2) Number of Runs of a's of Length N_i	(3) First Sum	(4) Second Sum	(5) Prob. of a Run of a of Length N_i	(6) Number of Runs of b's of Length N_i	(7) First Sum	(8) Second Sum	(9) Prob. of a Run of b of Length N_i
1	1	4	12	0.63	1	3	7	0.36
2	0	3	8	0.42	1	2	4	0.21
3	2	3	5	0.26	0	1	2	0.11
4	0	1	2	0.11	1	1	1	0.05
5	1	1	1	0.05	–			

12 + 7 = 19 = N_T, the number of observations in the sequence.

Now, turning to Table 9, the first column gives the length of run for No-Go for the stated atmospheric constraints. The second column gives the observed number (frequency) of runs of length N, the first column. For example, there was one run of length 13 and there were no runs of length 12. These frequencies are obtained by counting the lengths of runs of 1's in Table 8. In Table 8, there are 14 sequences of length 31. A fun is not continued from one January year to another. The fifth column, heading Probability Percent of No-Go Days, gives the probability there will be No-Go conditions for N consecutive days for the Case I atmospheric constraints for the EOM landing at 0900 LST. For example, there is a 58 percent chance of No-Go for landing at 0900 LST at KSC in January. This is the same probability obtained from the previous computer program for Table 2. There is a 38 percent chance for No-Go landing on two consecutive days at 0900 LST and there is a 13 percent chance for No-Go landing for five consecutive days.

The array of probabilities (Table 9) under the headings J=1, J=2, etc., are the time conditional probabilities. These probabilities are obtained by dividing the N_{i+j} values by N_j in column 4, the second sum column, e.g., For J=1, (163/253) 100 = 64 percent , (112/253) 100 = 47 percent , etc.

and for

J=2, (112/163) 100 = 69 percent , (76/163) 100 = 47 percent , etc.

The application of these conditional probabilities is illustrated. Suppose the Shuttle Orbiter is in orbit in January and scheduled to land at KSC at 0900 LST and the Case I atmospheric constraints exist. Now it is a certainty, a probability of 100 percent, there is no landing today; then there is a 64 percent chance (read under the J=1 column) that there will be no landing tomorrow at 0900 LST; and a 44 percent chance for no landing for the day after tomorrow at 0900 LST. Now let it be given that there was no landing yesterday and no landing today due to the Case I atmospheric constraints; then there is a 69 percent chance (read under column J=2) there will be no landing tomorrow at 0900 LST.

Table 10 gives the runs and conditional probabilities for favorable conditions for the KSC EOM landing at 0900 LST for the Class I atmospheric constraints. For example, reading from the fifth column in Table 10, there is a 42 percent chance for landing at 0900 LST in January; there is a 21 percent chance for landing at 0900 LST on two consecutive days, etc. Given that it is favorable for landing today, then there is a 50 percent chance (read under J=1) that the Case I atmospheric constraints will be favorable for landing tomorrow, etc.

The runs and conditional probabilities contained in Tables 1 and 2 are illustrated in Figures 1 and 2. Further, for the Case I, atmospheric constraints for the EOM landing at KSC at 0900 LST for July are shown in Figures 3 and 4. The straight line labeled P(N) in the figures give the probability for the length of runs for independent events. If the observed probabilities for run lengths were independent from day to day, then there would be close agreement between the observed runs probabilities (labeled with triangles) and the P(N) curve. Further, the observed conditional probabilities would be coincident to the P(N) curve shifted by each unit for J=1, J=2, etc. There is definitely persistence in the Case I atmospheric constraints because there are observed longer runs that would be the case for independent events.

Figures 5, 6, 7, and 8 are the illustrations for the runs and conditional probabilities for the Case II atmospheric constraints for the No-Go and Go statistics for a KSC EOM landing at 0900 LST. In these examples, the observed probability for the run length appears sufficiently close to the P(N) curve to be considered as independent events. However, the rule for independent event does not appear in agreement for the conditional probabilities. Three simple theoretical structures may be considered; viz.

1) The probability of the events is constant from day to day.

2) The probability of the events is constant after 1 or 2 days.

3) The probability of the events is continually increasing from day to day.

Because the run probabilities are so highly dependent on the assigned atmospheric constraints, season, and time of day, there is little hope that a general probability law could apply. Hence, the recommended approach is to use the observed (empirical) probabilities for runs and conditional probabilities.

The application of these statistics to the Space Shuttle operations lies in developing planning strategies. For example, the decision strategy for the EOM landing for the assigned atmospheric constraints would be to prepare for continuation in orbit for several days if unfavorable landing conditions exist. If favorable landing conditions exist at the EOM, proceed to land at the earliest opportunity. Another strategy is to prepare for an alternative landing site to decrease the risk of landing under unfavorable atmospheric conditions. It is in this planning of operating strategies that there is value in the statistical analysis of runs and conditional probabilities.

The techniques used to count runs and the computation of conditional probabilities were first introduced for space vehicle applications by O. E. Smith in 1961 and used subsequently by other investigators [2,3] in the analysis of atmospheric data. The technique has proven useful and valid for related applications.

IV. CONCLUSIONS/RECOMMENDATIONS

A capability to furnish in a timely manner specific atmospheric constraint statistics for the Space Shuttle mission phases for management decisions in mission planning and trade studies has been demonstrated. A few examples of the many options for the computer programs have been presented to illustrate the statistical methods. The locations covered by the present capability are for the KSC launch site and for the Edwards Air Force Base and Northrup Strip landing sites. Work is in progress to include the Vandenberg Air Force Base launch site in the mission analysis programs. Additional landing sites, for example AOA sites for Vandenberg Air Force Base launches, and down range abort and landing sites for which there are standard atmospheric data available could be included in the mission analysis programs if the demand develops for these extensions. Further, if the demand develops for more efficient decision aids, then formal decision strategy computer programs could be developed.

A distinction is made between the Space Shuttle operating rules as related to meteorological variables and atmospheric constraints. The atmospheric constraints are translations or interpretations of the Shuttle operating rules so that the probability of occurrence and nonoccurrence of these atmospheric constraints can be obtained from standard historical meteorological data as is available from the national weather services.

It is recommended that the Space Shuttle launch and flight operational rules for atmospheric restrictions be continually reviewed for rule changes. As these rule changes develop, they can be translated into atmospheric constraints and updates for the mission analysis statistics can be performed.

TABLE 1.a. PROBABILITY OF ATMOSPHERIC CONSTRAINTS FOR KSC LAUNCH OPERATIONS FOR MARCH

KSC LAUNCH OPERATIONS FOR THE MONTH OF MAR 1

RUNDATE 3-16-82 TIME 2[illegible]:[illegible]5:21

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
DECK 14
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	1	1	1	1	0	1	1	1	0	1	1	1	2	2	2	2	2	2	2	3	2	2	3	1
PRECIPITATION	7	9	7	7	6	6	6	4	6	5	6	6	5	6	6	6	6	6	7	9	10	8	7	6
CLOUD CEILING < OR = 1600 FT AND OR VISIBILITY < 5. N. MILES	5	5	6	6	7	8	10	13	11	9	8	5	4	4	4	5	4	5	4	4	3	4	4	4
PEAK SURFACE WS > 99 KNOTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPPER WINDS AT MAX 0 10-15 KM AZIMUTH = 59.0 U* > 25.0 M/S	3	3	3	2	2	2	2	3	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3
TOWER CLEARANCE PEAK SURFACE WS > 20.0 KNOTS AT 150.0-210.0 DEG. WD > 23.7 KNOTS AT ALL OTHER WD	3	3	3	3	3	3	3	4	4	6	6	9	9	8	10	9	10	6	4	4	3	3	2	3
ANY OF THE ABOVE	14	16	17	15	15	17	19	20	19	21	20	21	20	18	20	19	21	17	16	18	17	14	13	14

TABLE 1.b. PROBABILITY OF ATMOSPHERIC CONSTRAINTS FOR KSC RETURN TO LAUNCH SITE FOR MARCH

KSC RETURN TO LAUNCH SITE FOR THE MONTH OF MAR

RUNDATE 3-16-82 TIME 20:16:21

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
DECK 144
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

RUNWAY ANGLE 155.0 AND 335.0 DEGREES

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	1	1	1	1	0	1	1	1	0	1	1	1	2	2	2	2	2	2	2	3	2	2	3	1
PRECIPITATION	7	9	7	7	6	6	6	4	6	5	6	6	5	6	6	6	6	6	7	9	10	8	7	6
CLOUD CEILING < OR = 5000 FT AND OR VISIBILITY < 5. N. MILES	18	21	24	24	27	26	28	27	24	22	20	20	20	22	20	19	17	17	18	17	18	18	18	18
VISIBILITY < 5. N. MILES	9	12	12	13	16	15	16	18	12	10	8	7	7	8	7	6	6	7	9	8	8	7	7	7
CLOUD COVER > .5	45	47	47	48	48	44	52	56	57	58	56	54	55	58	58	56	56	58	59	53	47	47	47	44
PEAK WINDS HEAD WIND > 20 KNOTS TAIL WIND > 20 KNOTS	3	3	5	6	5	4	3	5	7	10	10	12	15	13	13	15	13	10	6	4	5	5	3	3
SURFACE CROSSWIND > 99 KNOTS-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PEAK CROSSWIND > 10 KNOTS-	23	19	16	16	17	16	16	15	25	29	33	33	39	43	47	45	44	35	27	21	22	22	23	22
ANY OF THE ABOVE	60	59	58	60	61	59	65	69	72	74	76	74	77	81	84	82	81	78	73	64	59	60	61	59
ANY OF THE ABOVE FOR LAUNCH AND RTLS	61	60	59	61	61	60	66	70	72	75	76	75	78	81	85	82	81	78	73	64	60	61	61	59

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TABLE 1.c. PROBABILITY OF ATMOSPHERIC CONSTRAINTS FOR PRELAUNCH OPERATIONS FOR KSC FOR MARCH

KSC PRELAUNCH OPERATION FOR MONTH OF MAR

PERIOD OF RECORD 1957-1979

CONSTRAINT/REQUIREMENT	PROBABILITIES IN PERCENT							
	HR 2	HR 3	HR 4	HR 5	HR 6	HR 7	HR 8	COMBINED HRS 2 - 8
PRECIPITATION	7	7	6	6	6	4	6	15

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08
ANY OF THE ABOVE FOR LAUNCH, RTLS, AND PRELAUNCH	61	60	59	61	61	60	66	70	73

TABLE 2. PROBABILITY OF CASE I ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC, JANUARY

KSC RETURN TO LAUNCH SITE FOR THE MONTH OF JAN PAGE 1

RUNDATE 4-13-82 TIME 21:16: 8

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
DECK 144
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

RUNWAY ANGLE 155.0 AND 335.0 DEGREES

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRECIPITATION	6	4	7	6	7	9	7	8	7	9	7	7	7	7	6	4	6	5	6	6	7	6	7	6
CLOUD CEILING < OR = 20000 FT AND OR VISIBILITY < B. N. MILES	40	45	42	45	48	50	49	54	52	45	45	41	38	36	37	36	34	35	35	33	36	35	37	36
VISIBILITY < D. N. MILES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLOUD COVER > 9.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PEAK WINDS HEAD WIND > 25 KNOTS TAIL WIND > 10 KNOTS	1	1	1	1	1	1	2	1	1	2	3	2	3	3	3	2	4	2	1	1	1	1	0	0
SURFACE CROSSWIND > 99 KNOTS-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PEAK CROSSWIND > 10 KNOTS-	17	16	17	15	15	16	15	16	16	23	29	32	32	35	33	30	30	22	17	15	16	19	19	18
ANY OF THE ABOVE	47	53	50	51	54	57	56	62	59	59	61	62	58	59	57	54	55	48	44	41	45	44	46	45
ANY OF THE ABOVE FOR LAUNCH AND RTLS	47	53	50	51	54	57	56	62	59	59	61	62	58	59	57	54	55	48	44	41	45	44	46	45

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
ANY OF THE ABOVE FOR LAUNCH, RTLS, AND PRELAUNCH	47	53	50	51	54	57	56	62	59	59	61	62	58	59	57	54	55	48	44	41	45	44	46	45

TABLE 3. PROBABILITY OF CASE I ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC, JULY

KSC RETURN TO LAUNCH SITE FOR THE MONTH OF JUL

RUNDATE 4-13-82 TIME 21:20:10

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
DECK 144
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

RUNWAY ANGLE 155.0 AND 335.0 DEGREES

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	3	3	3	2	3	3	3	3	3	2	3	5	9	15	19	24	27	24	21	14	9	8	6	5
PRECIPITATION	3	1	1	1	1	2	2	2	1	1	2	3	4	6	8	8	11	12	14	10	8	6	3	3
CLOUD CEILING < OR = 2000 FT AND OR VISIBILITY < 6. N. MILES	15	18	16	17	15	18	21	21	20	18	20	19	21	19	24	25	27	31	33	32	29	22	18	17
VISIBILITY < 0. N. MILES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLOUD COVER > 9.9	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PEAK WINDS HEAD WIND > 25 KNOTS TAIL WIND > 10 KNOTS	0	0	0	0	0	0	0	0	0	0	0.	0	0	0	0	1	0	1	1	0	C	0	0	0
SURFACE CROSSWIND > 99 KNOTS-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PEAK CROSSWIND > 10 KNOTS-	5	4	4	5	4	3	3	11	17	22	27	25	32	37	41	38	35	28	21	9	6	6	4	4
ANY OF THE ABOVE	21	23	21	23	19	21	24	30	34	38	38	40	47	52	61	63	63	57	53	41	35	27	24	23
ANY OF THE ABOVE FOR LAUNCH AND RTLS	21	23	21	23	19	21	24	30	34	38	38	40	47	52	61	63	63	57	53	41	35	27	24	23

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
ANY OF THE ABOVE FOR LAUNCH, RTLS, AND PRELAUNCH	21	23	21	23	19	21	24	30	34	38	38	40	47	52	61	63	63	57	53	41	35	27	24	23

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TABLE 4. PROBABILITY OF NO-GO FOR ANY ONE OF CASE I ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC FOR ALL MONTHS

RUNDATE 4-13-82 TIME 21:24:11 Case I

KSC ANY OF THE ABOVE FOR EOM Hour LST

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
JAN	47	53	50	51	54	57	56	62	59	59	61	62	58	59	57	54	55	48	44	41	45	44	46	45
FEB	46	46	50	51	54	56	55	62	60	58	61	61	63	63	64	62	58	52	46	46	48	47	48	48
MAR	47	45	45	46	49	50	54	53	56	57	61	55	59	65	67	65	63	59	52	47	46	47	47	47
APR	42	43	42	41	41	40	45	47	52	54	53	58	64	63	65	66	63	55	46	40	36	38	39	39
MAY	34	32	33	32	31	36	38	43	47	50	56	58	64	69	70	72	70	63	52	42	36	36	37	35
JUN	28	27	31	30	29	31	37	40	45	47	51	59	67	78	75	75	73	65	57	50	44	39	32	28
JUL	21	23	21	23	19	21	24	30	34	38	38	40	47	52	61	63	63	57	53	41	35	27	24	23
AUG	21	20	21	19	20	21	26	26	29	32	36	40	46	52	59	64	63	56	46	36	29	29	23	23
SEP	42	40	36	37	37	35	41	44	45	51	57	61	67	69	71	75	70	65	53	51	50	47	44	40
OCT	47	48	50	49	48	48	56	53	52	55	58	60	62	66	66	63	60	57	51	53	50	48	49	47
NOV	42	42	43	42	46	46	45	52	51	53	53	54	55	54	55	53	48	42	41	40	40	41	41	40
DEC	4	[illegible]	45	45	44	43	49	52	52	49	51	52	54	55	51	49	46	40	36	37	35	40	41	40

Constraints:

1. Thunderstorms
2. Precipitation
3. Ceiling ≤ 20,000 feet or visibility < 8 nautical miles – a major factor winter AM
4. Peak head wind > 25 knots; peak tail wind no factor because both ends of runway are used.
5. Peak crosswind > 10 knots – a major factor in PM

TABLE 5. PROBABILITY OF CASE II ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC, JANUARY

KSC RETURN TO LAUNCH SITE FOR THE MONTH OF JAN

RUNDATE 4-24-82 TIME 19:14:56

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
TECH 186
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

RUNWAY ANGLE 155.0 AND 335.0 DEGREES

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRECIPITATION	6	4	7	6	7	9	7	8	7	9	7	7	7	7	6	4	6	5	6	6	7	6	7	6
CLOUD CEILING < OR = 2000 FT AND OR VISIBILITY < 8. N. MILES	40	45	42	45	48	50	49	54	52	45	45	41	38	36	37	36	34	35	35	33	36	35	37	36
VISIBILITY < 3. N. MILES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLOUD COVER > 9.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEADY WINDS HEAD WIND > 25 KNOTS TAIL WIND > 10 KNOTS	0	0	0	0	0	0	0	0	0	0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0
SURFACE CROSSWIND > 10 KNOTS-	5	4	4	5	3	4	4	3	3	4	8	10	11	12	12	11	10	7	4	5	4	4	6	5
PEAK CROSSWIND > 99 KNOTS-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANY OF THE ABOVE	41	46	43	46	48	51	50	55	53	48	49	47	45	44	44	42	40	39	38	35	38	36	39	38

****

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
ANY OF THE ABOVE FOR LAUNCH AND RTLS	41	46	43	46	48	51	50	55	53	48	49	47	45	44	44	42	40	39	38	35	38	36	39	38
ANY OF THE ABOVE FOR LAUNCH, RTLS, AND PRELAUNCH	41	46	43	46	48	51	50	55	53	48	49	47	45	44	44	42	40	39	38	35	38	36	39	38

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TABLE 6. PROBABILITY OF CASE II ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC, JULY

KSC RETURN TO LAUNCH SITE FOR THE MONTH OF JUL PAGE 1

RUNDATE 4-14-82 TIME 19:17:32

PERIOD OF RECORD 1957 - 1970
DATA SOURCES :
DECK 144
SERIALLY COMPLETE
THUNDERSTORM
PEAK WINDS

RUNWAY ANGLE 155.0 AND 335.0 DEGREES

PROBABILITIES IN PERCENT

CONSTRAINT/REQUIREMENT	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
THUNDERSTORM	3	3	3	2	3	3	3	3	3	2	3	5	9	15	19	24	27	24	21	14	9	8	6	5
PRECIPITATION	3	1	1	1	1	2	2	2	1	1	2	3	4	6	8	8	11	12	14	10	8	6	3	3
CLOUD CEILING < OR = 20000 FT AND VISIBILITY < 5.0 MILES	15	18	16	17	15	18	21	21	20	18	20	19	21	19	24	25	27	31	33	32	29	22	18	17
VISIBILITY < [illegible] MILES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLOUD COVER > 0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEADY WINDS HEAD WIND > 25 KNOTS TAIL WIND > 10 KNOTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SURFACE CROSSWIND > 10 KNOTS-	0	0	0	0	0	0	0	1	3	4	4	4	4	5	6	6	5	3	2	1	1	0	0	0
PEAK CROSSWIND > 99 KNOTS-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANY OF THE ABOVE	17	20	18	20	17	20	23	24	24	23	24	24	27	30	37	41	43	42	41	38	32	25	21	20
ANY OF THE ABOVE FOR LAUNCH AND RTLS	17	20	18	20	17	20	23	24	24	23	24	24	27	30	37	41	43	42	41	38	32	25	21	20

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
ANY OF THE ABOVE FOR LAUNCH, RTLS, AND PRELAUNCH	17	20	18	20	17	20	23	24	24	23	24	24	27	30	37	41	43	42	41	38	32	25	21	20

TABLE 7. PROBABILITY OF CASE II, ANY ONE OF ATMOSPHERIC CONSTRAINTS FOR EOM LANDING AT KSC FOR ALL MONTHS

RUNDATE 4-14-82 TIME 19:20: 7 Case II

KSC ANY OF THE ABOVE FOR EOM — Hour LST

	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
JAN	41	46	43	46	48	51	50	55	53	48	49	47	45	44	44	42	40	39	38	35	38	36	39	38
FEB	37	41	43	45	47	49	53	56	53	50	49	47	47	45	44	45	45	42	41	39	39	39	41	38
MAR	36	37	40	40	42	42	47	47	44	44	45	41	42	44	43	44	43	45	41	40	38	38	38	35
APR	28	28	29	31	31	32	37	37	34	35	32	35	35	36	34	34	32	30	27	25	23	24	22	23
MAY	22	22	23	24	23	28	32	30	29	30	33	32	32	35	35	38	40	36	33	28	27	26	24	23
JUN	22	23	26	26	25	28	30	31	33	31	34	36	37	43	46	50	48	44	41	39	35	33	26	23
JUL	17	20	18	20	17	20	23	24	24	23	24	24	27	30	37	41	43	42	41	38	32	25	21	20
AUG	18	18	19	16	18	19	24	20	21	20	25	26	28	29	34	39	41	38	35	30	25	25	19	20
SEP	30	30	30	29	30	27	34	33	36	36	37	40	40	40	42	42	43	40	39	39	38	35	31	30
OCT	34	36	36	39	38	38	40	42	41	42	44	44	45	47	45	43	41	41	40	39	38	36	35	35
NOV	33	36	36	35	40	40	39	46	45	42	42	42	41	40	36	36	35	34	35	32	32	34	31	31
DEC	36	37	39	39	38	39	44	47	45	41	39	37	38	40	38	36	34	33	31	32	30	33	33	33

Constraints:

1. Thunderstorms
2. Precipitation
3. Ceiling ≤ 20,000 feet and/or visibility < 8 nautical miles
4. Steady state head wind > 25 knots; both ends of runway used, no tail wind constraint.
5. Steady state crosswind > 10 knots

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TABLE 8. NO-GO AND GO FOR CASE I ATMOSPHERIC CONSTRAINTS FOR KSC EOM LANDING AT 0900 LST, JANUARY

KSC LST, PRELAUNCH, LAUNCH, AND RTLS

1 = NO/GO DATE OF RUN 9-15-82 TIME 19:10:59
0 = GO
* = MISSING MONTH = 1, HOUR = 9

	DAY																													
YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1957	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	1	0	0
1958	0	1	1	1	1	1	1	1	0	0	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1
1959	1	1	1	1	0	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	0
1960	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1
1961	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	0	1	0	0	1	1	1	1	1
1962	1	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	0	1	0	1	0	1	1	0	0	1
1963	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	0	1	1	0
1964	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1	1
1965	1	0	1	1	1	0	0	1	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0
1966	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0
1967	0	1	0	1	0	0	1	1	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1	0	1	1	0	1	0	0
1968	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	1	1	1	0	1	1	0	1	1
1969	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	0	1	0	1	0	1	0	0
1970	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	0	1	0

TABLE 9. PROBABILITY OF NO-GO RUNS AND CONDITIONAL PROBABILITIES FOR ANY ONE OF CASE I ATMOSPHERIC CONSTRAINTS FOR KSC EOM LANDING AT 0900 LST, JANUARY

KSC LST, PRELAUNCH, LAUNCH, AND RTLS

DATE OF RUN 4-15-92 TIME 19:10:59 MONTH = 1 HOUR = 9

LENGTH OF RUN	FREQ. OF RUN LENGTHS	SUM 1	SUM 2	PROB. % OF NO/GO DAYS	J-1	J-2	J-3	J-4	J-5	J-6	J-7	J-8	J-9	J-10
1	39	90	253	58	100	0	0	0	0	0	0	0	0	0
2	15	51	163	38	64	100	0	0	0	0	0	0	0	0
3	16	36	112	26	44	69	100	0	0	0	0	0	0	0
4	3	20	76	18	30	47	68	100	0	0	0	0	0	0
5	7	17	56	13	22	34	50	74	100	0	0	0	0	0
6	0	10	39	9	15	24	35	51	70	100	0	0	0	0
7	2	10	29	7	11	18	26	38	52	74	100	0	0	0
8	4	8	19	4	8	13	17	25	34	49	66	100	0	0
9	1	4	11	3	4	7	10	14	20	28	38	58	100	0
10	1	3	7	2	3	4	6	9	13	18	24	37	64	100
11	1	2	4	1	2	2	4	5	7	10	14	21	36	57
12	0	1	2	0	1	1	2	3	4	5	7	11	15	29
13	1	1	1	0	0	1	1	1	2	3	3	5	9	14

TABLE 10. PROBABILITY OF GO RUNS AND CONDITIONAL PROBABILITIES FOR ANY ONE OF CASE I ATMOSPHERIC CONSTRAINTS FOR KSC EOM LANDING AT 0900 LST, JANUARY

KSC LST, PRELAUNCH, LAUNCH, AND RTLS

DATE OF RUN 4-15-92 TIME 19:10:59 MONTH = 1 HOUR = 9

LENGTH OF RUN	FREQ. OF RUN LENGTHS	SUM 1	SUM 2	PROB. % OF GO DAYS	J-1	J-2	J-3	J-4	J-5	J-6	J-7	J-8	J-9	J-10
1	45	90	191	42	100	0	0	0	0	0	0	0	0	0
2	20	45	91	21	50	100	0	0	0	0	0	0	0	0
3	15	25	46	11	25	51	100	0	0	0	0	0	0	0
4	2	10	21	5	12	27	46	100	0	0	0	0	0	0
5	5	5	11	3	6	12	24	52	100	0	0	0	0	0
6	1	2	3	1	2	3	7	14	27	100	0	0	0	0
7	1	1	1	0	1	1	2	5	9	33	100	0	0	0

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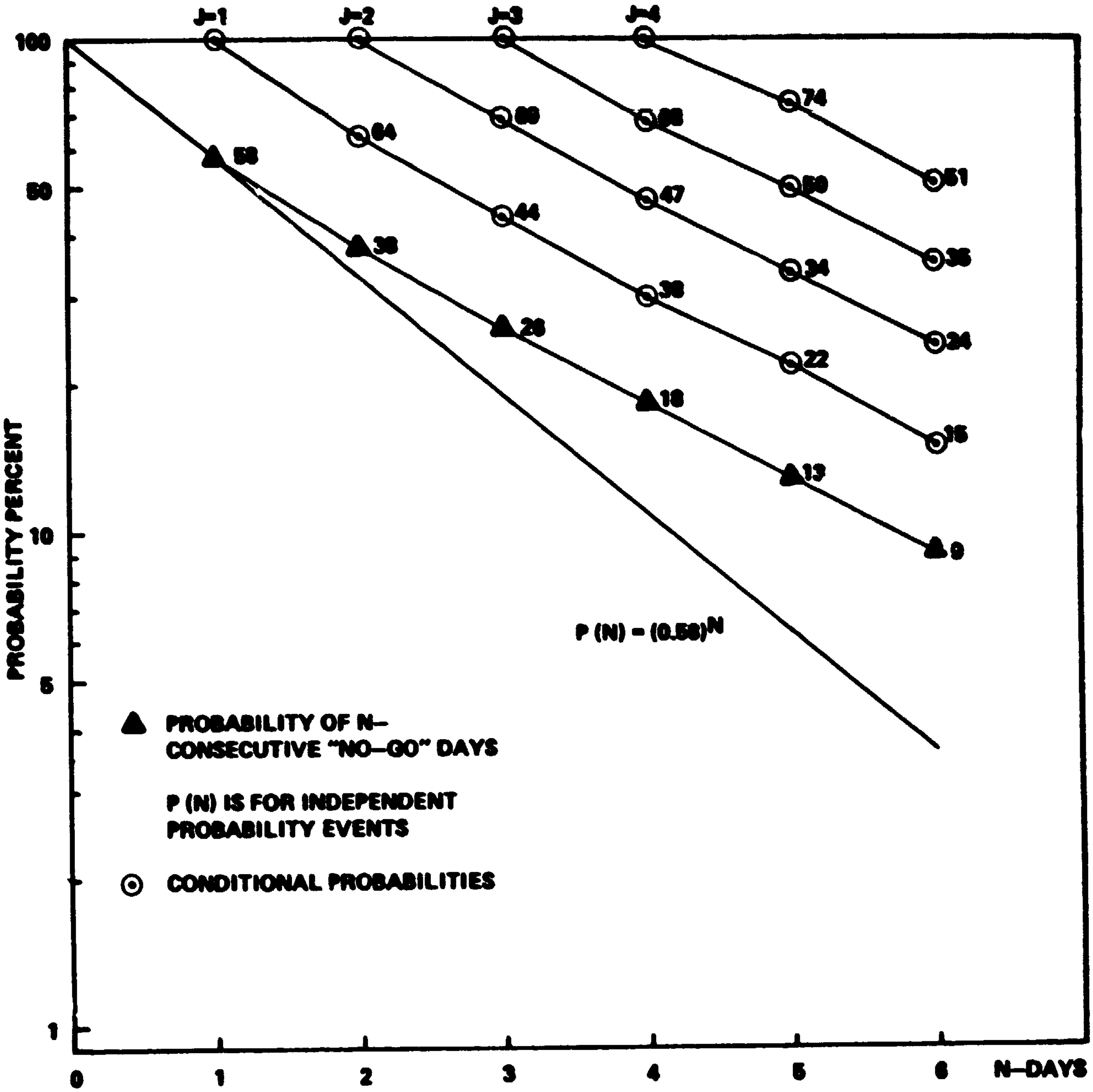

Figure 1. Conditional No-Go probabilities for Case I atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, January.

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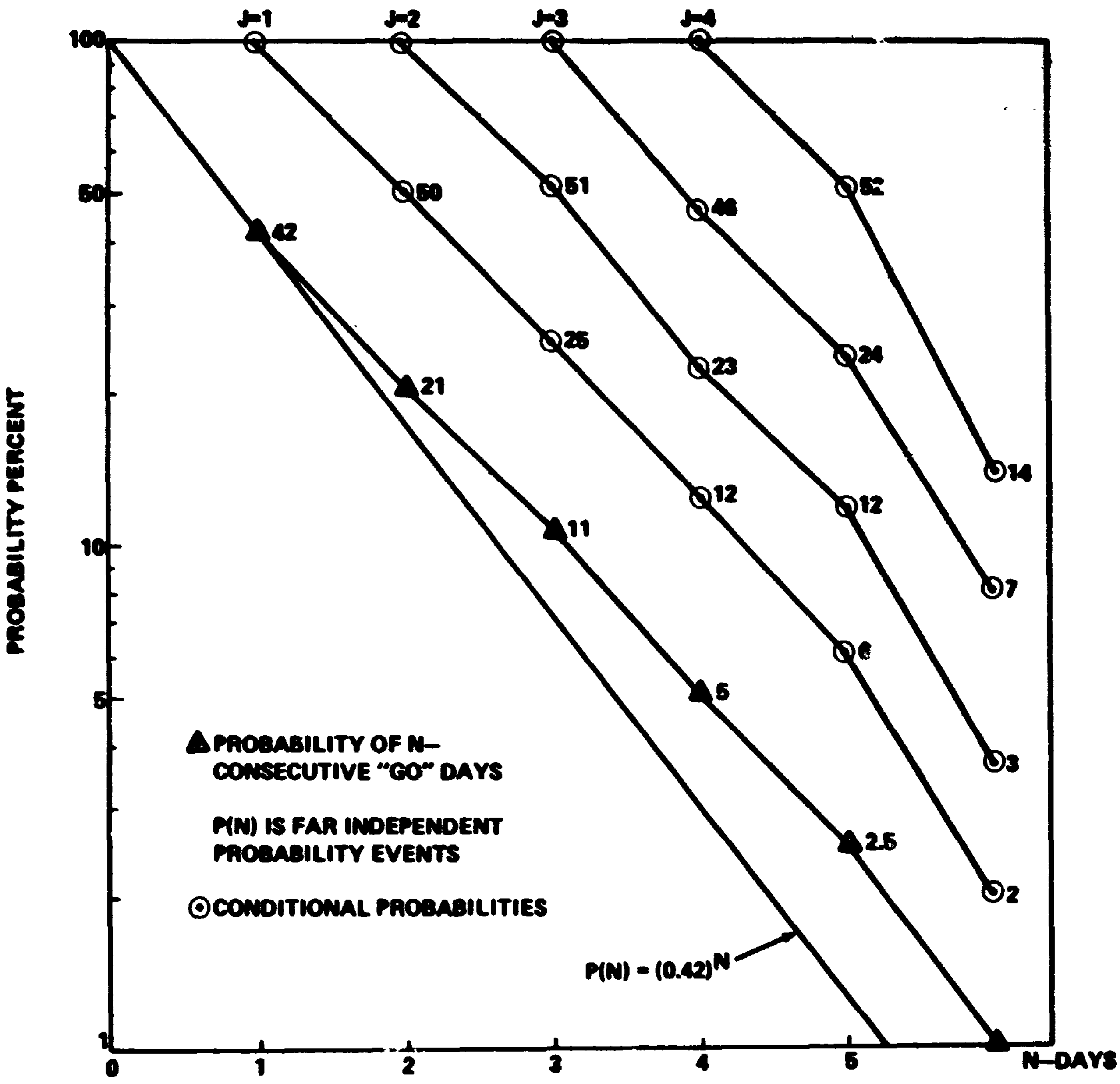

Figure 2. Conditional Go probabilities for Case I atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, January.

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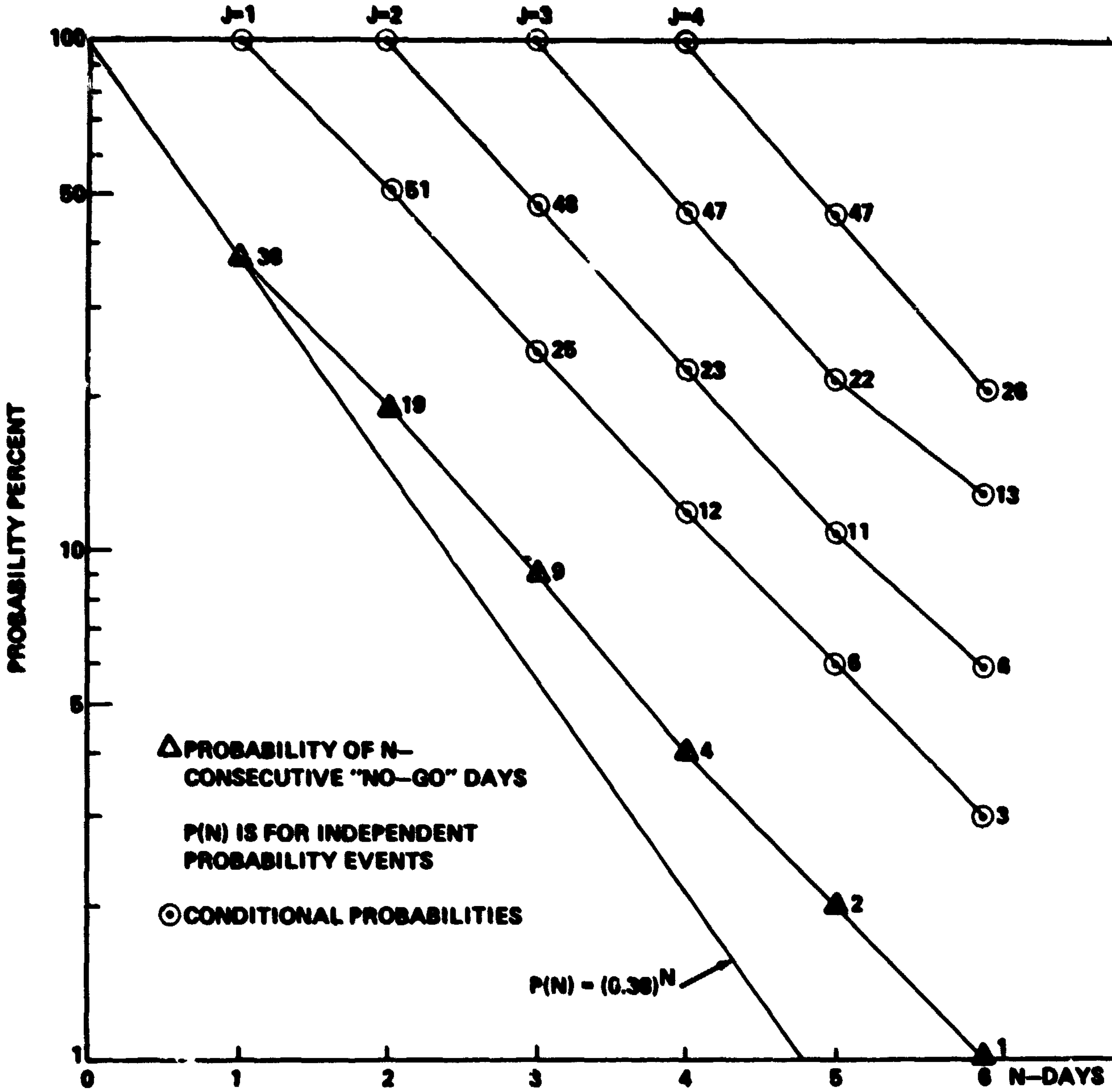

Figure 3. Conditional No-Go probabilities for Case I atmospheric constraints for EOM at 090(' ST, landing at KSC, Florida, July.

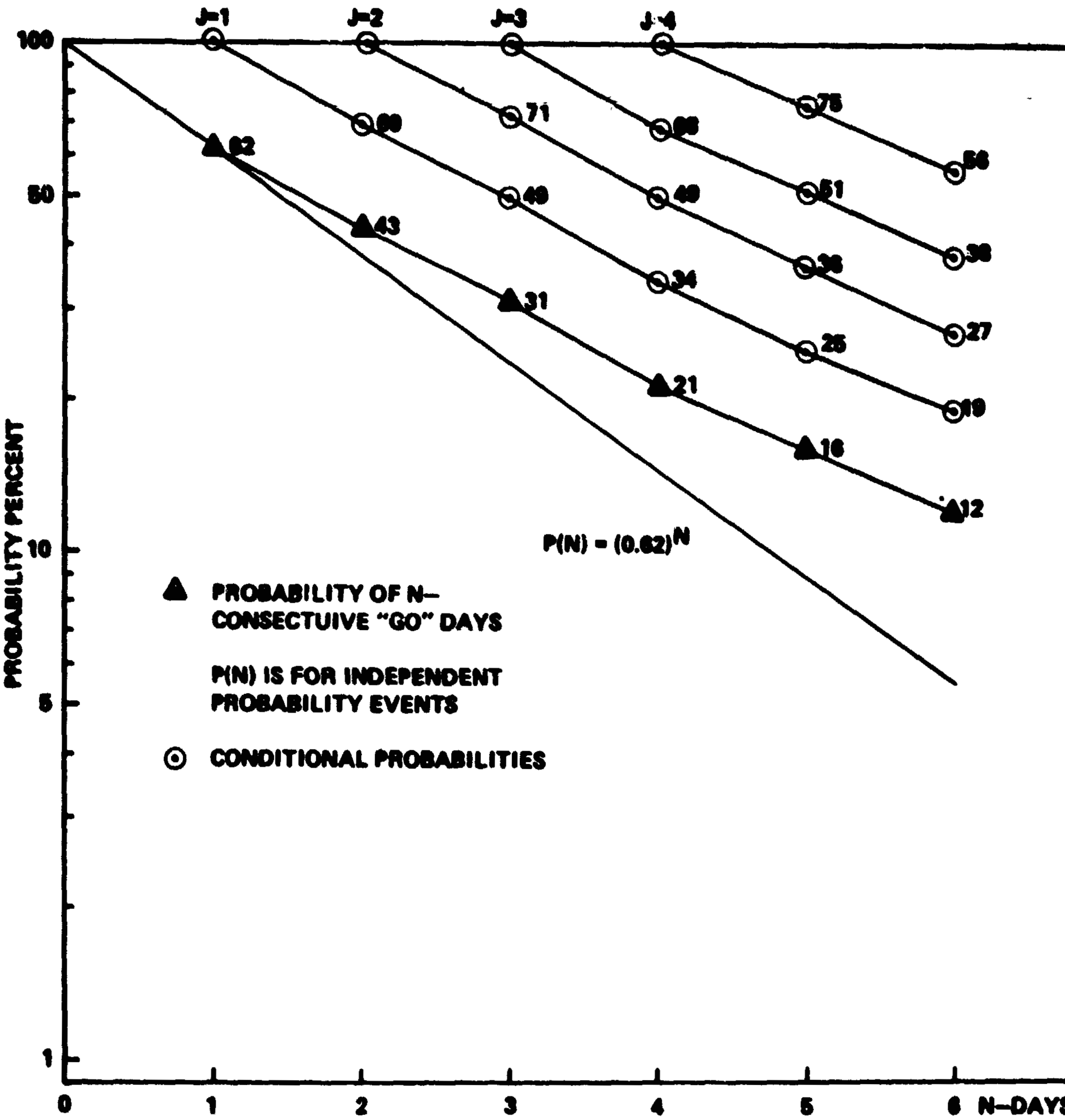

Figure 4. Conditional Go probabilities for Case I atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, July.

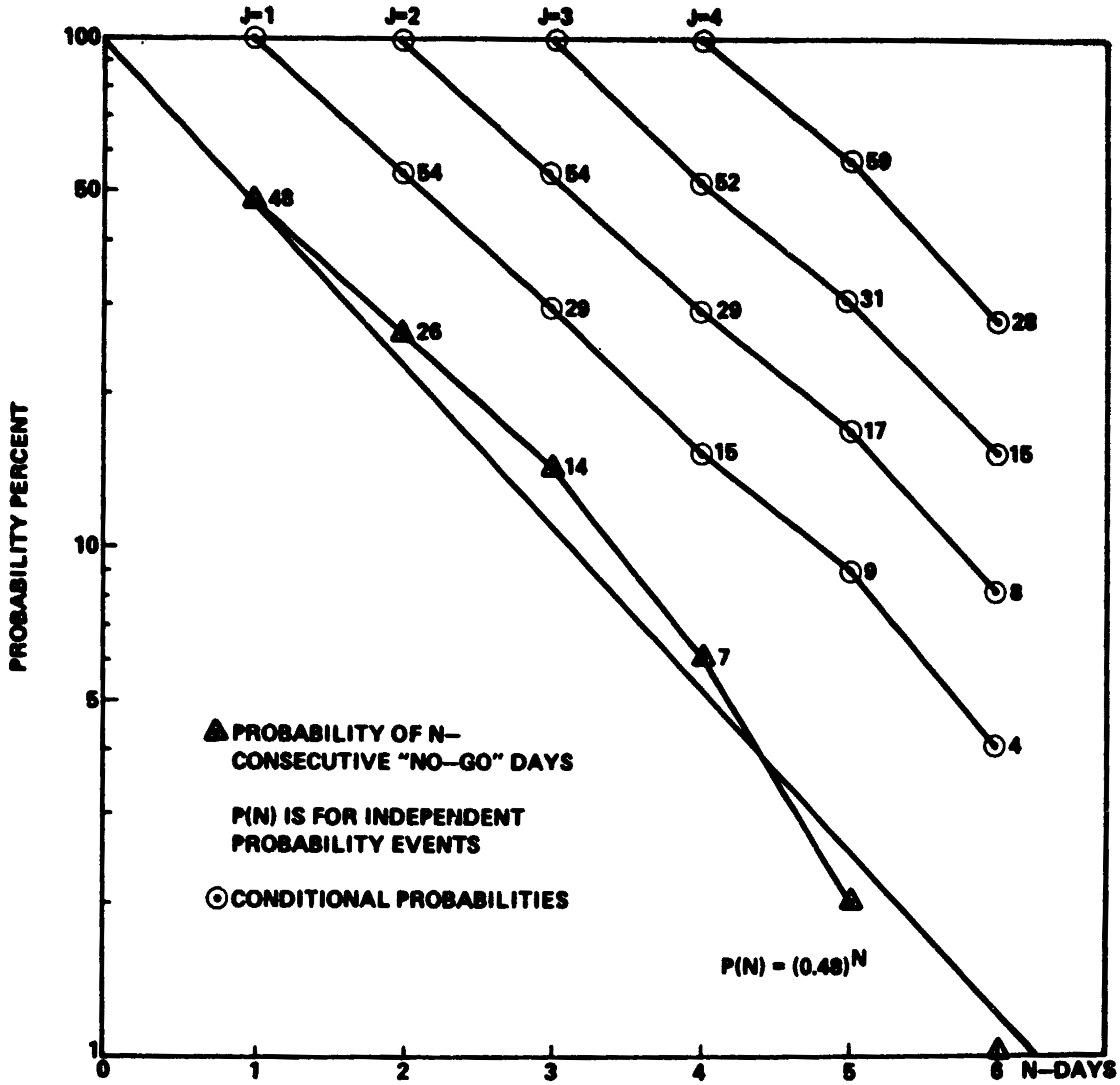

Figure 5. Conditional No-Go probabilities for Case II atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, January.

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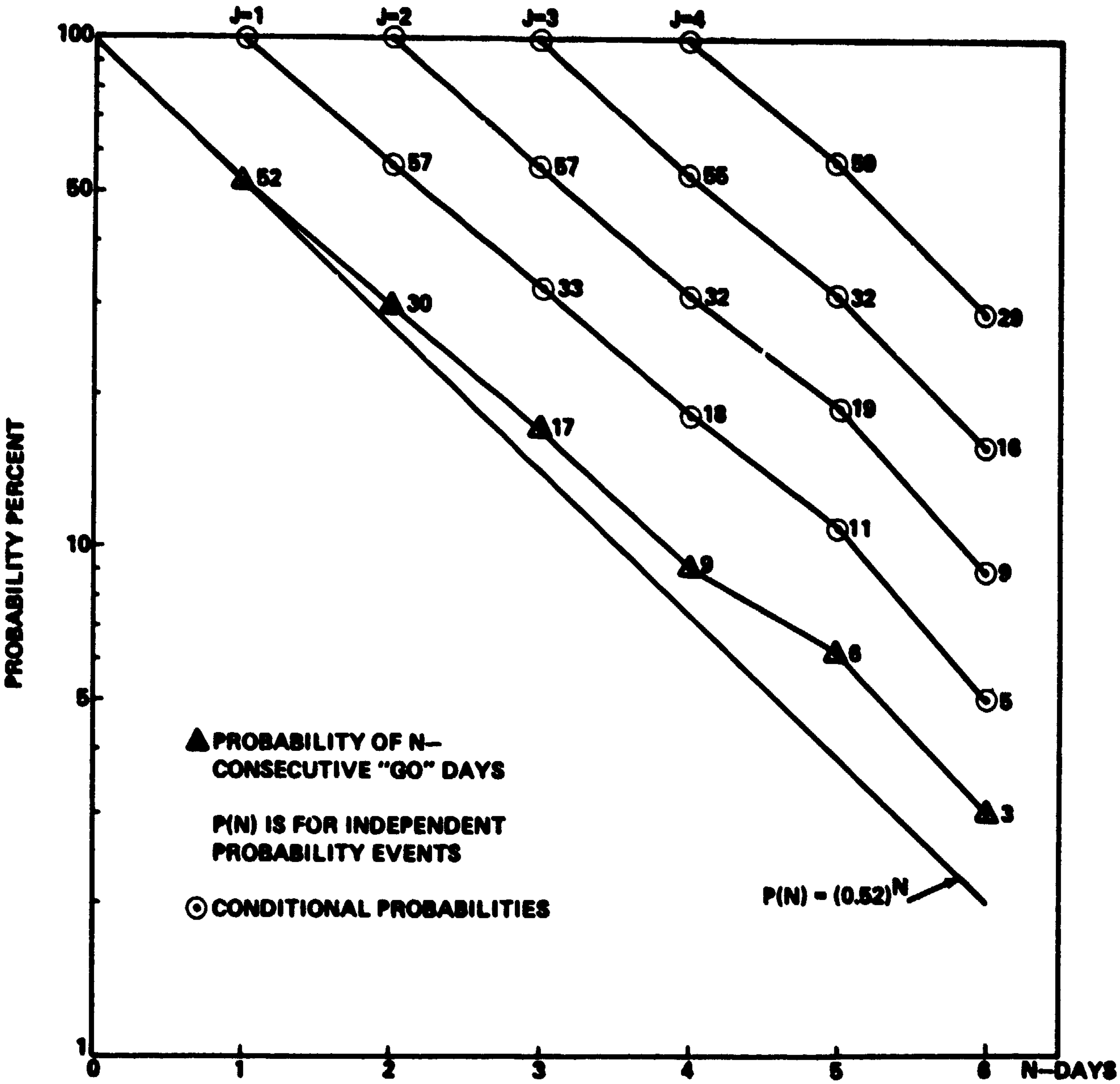

Figure 6. Conditional Go probabilities for Case II atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, January.

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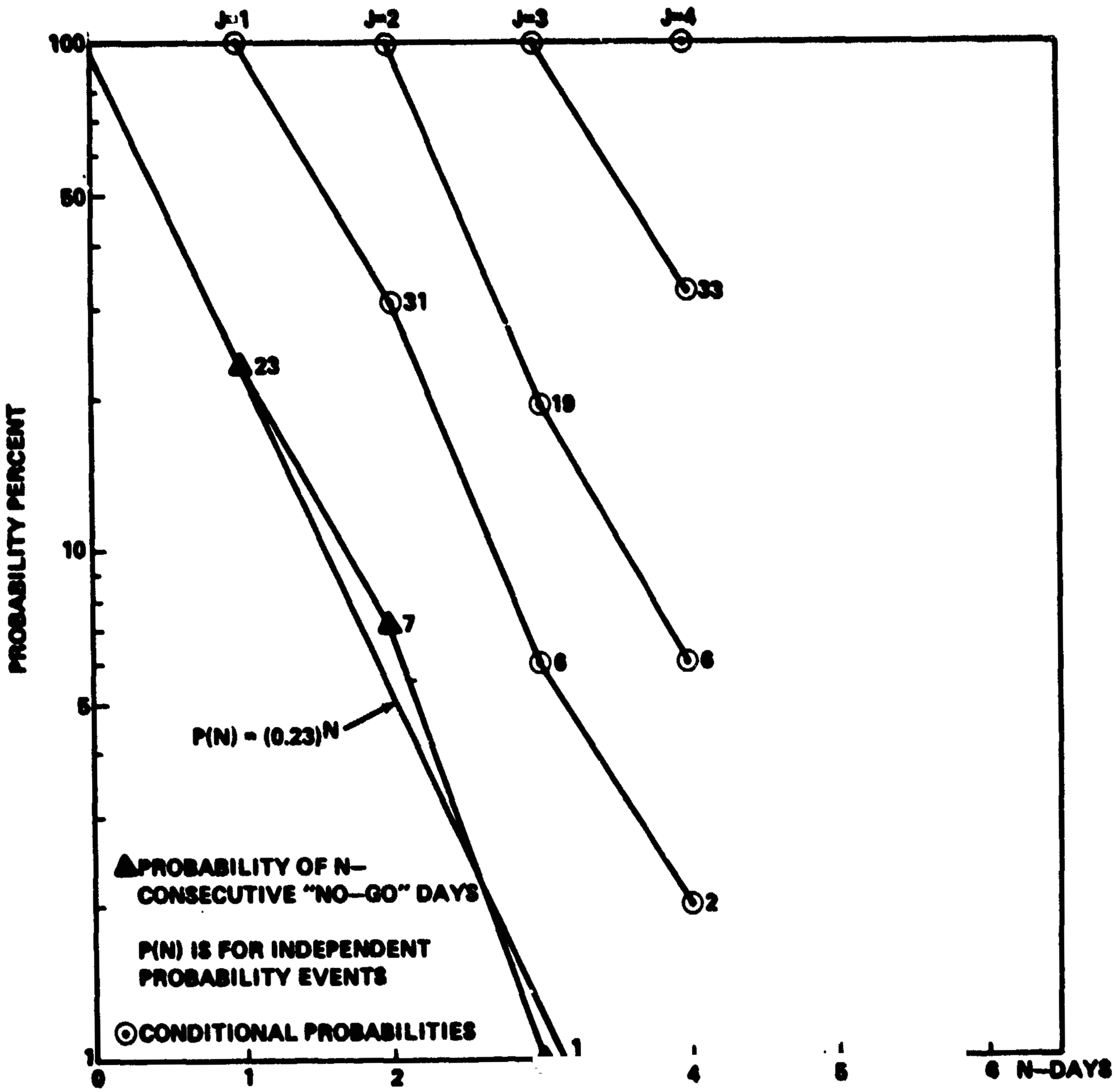

Figure 7. Conditional No-Go probabilities for Case II atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, July.

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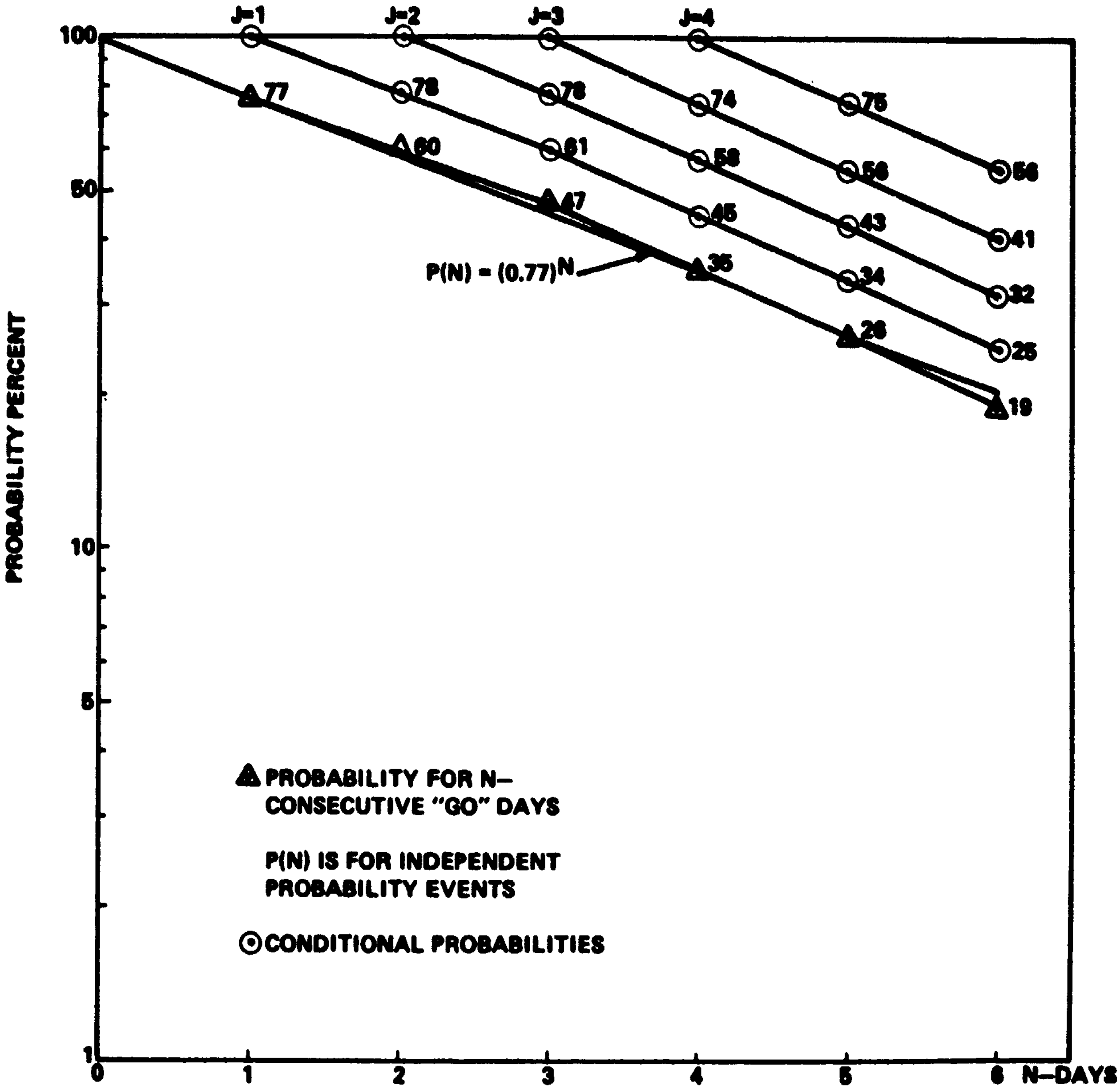

Figure 8. Conditional Go probabilities for Case II atmospheric constraints for EOM at 0900 LST, landing at KSC, Florida, July.

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