HEAVY GAS DISPERSION TRIALS
THORNEY ISLAND 1982-3

DATA FOR TRIAL 022

Research and Laboratory Services Division
Red Hill, Sheffield S3 7HQ. Tel: 0742 78141
SUMMARY INFORMATION AT THE TIME OF THE SPILL

Gas released at: 19:00:15 hrs
Freon 12/Nitrogen mixture: relative density 4.2
Number of smoke canisters discharged: 4

Mean Wind Speed at 10 m height:
  During main data collection period: 5.9 m/s
  From 5 minute cyclic data just before the release: 6.2 m/s

Mean Wind Heading ('A' station) -
  (relative to the centre line of the array) -7.6°

NB Positive angles are to the right (clockwise) of the centre line when looking downwind of the gas bag.

Relative Humidity (at 10 m height) 91.2%
Insolation 157 W/m²
Ambient Air Temperature (at 9 m height) 18.0°C
Treated Runway Surface Temperature 18.1°C
Grass Surface Temperature 18.0°C
Observed Cloud Cover 2/8

STABILITY CONDITION

D (From Observations)
E (From DT/DZ)
D (From Solarimeter)
D (From Heat Flux)
F (From Richardson No)
D (From Bulk Richardson No)
E (From Standard Deviation of Wind Heading)

Stability condition inferred from data during the release and just before the release: D/E.
HISTORY

Three hours before gas was released (at about 16:00 hours) the wind speed was about 7 m/s and blowing approximately 20° to the left of the array centre line. At this time insolation was strong and a relatively large temperature gradient existed between 2 and 9 m (about 2°C over this height). Conditions remained more or less the same until about 17:00 hours when the wind speed dropped to about 6 m/s. Insolation had also fallen and was then slight (about 130 W/m²); the air temperature was also noticeably lower and the temperature gradient between 2 and 9 m was markedly less than that observed earlier.

In the two hours leading up to the spill the wind speed remained more or less constant at about 6 m/s but the wind gradually swung round towards the array centre line. Insolation slightly increased between 17:00 and 18:00 hours but in the last hour before the spill decreased steadily. The air temperature increased at first but in the hour before the spill, remained more or less constant. These conditions then gave rise to an atmospheric stability judged to be on the stable side of neutral.
THORNEY ISLAND HEAVY GAS DISPERSION TRIALS

Notes on information presented in the Summary Sheets

1 ATMOSPHERIC STABILITY

The atmospheric stability during the period of the experiment was obtained from the following methods:

i) Visual Observation

This is based on the amount of cloud cover, or the judged level of incoming solar radiation and the value of the wind speed (see attached table provided by the Meteorological Office).

ii) Temperature Difference (DT/DZ)

This method is one of the two suggested by the US Nuclear Regulatory Commission and in the present exercise was calculated as:

\[ \frac{DT}{DZ} = \frac{T_{30}-T_{9}}{21} \times 100.00 \]

The NRC tables, see e.g. Sedefian and Bennett\([1]\) or McQuaid\([2]\) were then consulted to determine the appropriate stability.

iii) Solarimeter

The measured insolation, from the solarimeter, was used together with the wind speed to determine the stability based on the information presented in Pasquill\([3]\) (Figure 6.13).

iv) Heat Flux

Heat flux (H) was calculated from the insolation (R) by the formula \( H = 0.4(R-100) \) based on the suggestion by Smith\([4]\). Pasquill's\([3]\), Figure 6.13 was then consulted to determine the stability. This method therefore agrees generally with the previous method.

v) Richardson Number

The Richardson number is calculated according to Sedefian and Bennett\([1]\) as:

\[ R_i = \frac{g(D\theta/DZ)}{T(DU/DZ)^2} \]

where \( \theta \) is the potential temperature and \( T \) is the actual temperature; in this case, the temperature at 16 m above the ground. \( D\theta/DZ \) was calculated as:

\[ \frac{T_{30}-T_{9}}{21} + 0.00986 \]

\( DU \) was calculated as \[ \frac{U_{30}-U_{10}}{20} \]
Sedefian and Bennett calculate the limits of Richardson number for the various stability categories, however the limits they presented were valid for measurements at heights whose geometric mean was 22 m. Since the measurement stations were at 30 m, 9 m and 16 m the limits of Richardson number for the various stability categories were recalculated to correspond to a geometric mean height of 16 m.

vi) Bulk Richardson Number

The bulk Richardson number was also calculated according to Sedefian and Bennett[1] as:

\[ R_i = \frac{g (D\theta/Dz)^2}{U^2} \]

where \( \overline{z} \) is the geometric mean height = \( \sqrt{9 \times 30} \)

\( T \) is the temperature at 16 m above the ground

and \( U \) is the mean wind speed at 30 m.

Here again the limits of \( R_i \) were recalculated to correspond to a geometric mean height of 16 m.

vii) Standard Deviation of Wind Heading

The standard deviation of wind heading was calculated from the Porton wind vane, which has a resolution bandwidth of 11°. The resulting accuracy is predicted to be around 2° or so, assuming a Gaussian distribution of wind direction. These estimates were compared with the simple assumption that the standard deviation is approximately 1/6 (maximum-minimum angle).

The NRC limits for \( \sigma_\theta \) are then used to determine the appropriate stability category.

2 WIND SPEED

Two values of wind speed are presented. The first is the mean value at the 10 m height for the first 10 minutes of the data collection period, which generally began about one minute before the gas bag was dropped.

The second wind speed is also a mean value obtained at the 10 m height, but corresponds to data taken over a five minute period just before main data collection began; data during this period is termed the 'cyclic' data.

REFERENCES


3 Pasquill F (1974) "Atmospheric Diffusion" 2nd Ed. Published by Ellis Horwood Ltd, Chichester.

## MODIFIED PASQUILL STABILITY CATEGORIES

<table>
<thead>
<tr>
<th>Wind Speed (kt)</th>
<th>DAYTIME (excluding 1 hour after sunrise and 1 hour before sunset)</th>
<th>Withing 1 hour before sunset or after</th>
<th>NIGHT-TIME</th>
<th>Cloud Amount (oktas)</th>
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<td>Inoing Solar Radiation (W m⁻²)</td>
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### Notes

1. Night was originally defined to include periods of one hour before sunset and after sunrise. These two hours are always categorised here as D.

2. Pasquill said that in light winds on clear nights the vertical spread may be less than for category F but excluded such cases because the surface plume is unlikely to have any definable travel. However, they are important from the point of view of the build up of pollution and category G (night-time, 0 or 1 okta of cloud, wind speed 0 or 1 kt) has been added.

3. 1 kt = 0.52 m/s.
1 AVERAGING TIME

Length of the time window over which mean values have been calculated for the purpose of the plots. Since the full record contains 20 samples per second, an averaging time of 0.6 seconds gives the arithmetic mean of 12 samples of the original signal. Note that it is not a running average but a 'box' window which is moved through the data in increments of the averaging time.

2 X:Y:Z

The location in metres of the sensor on the trials site. The (X,Y) axes are defined by the grid of fixed masts, the release point is at X = 400 metres, Y = 200 metres. The Z axis defines the height of the sensor on the mast at location (X, Y) - see mast array. Note that the Z axis is defined by measurement from the mast base and is not absolute in the sense that it takes no account of any slope of the trials site.

3 TYPE

Defines the type of sensor which generated the data shown in the plots.

GAS: Standard oxygen deficiency sensor
  Frequency response 1 Hz (at - 3 dB point).

HGAS: High speed oxygen deficiency sensor
  Frequency response 10 Hz (at - 3 dB point).

SMOK: High speed light scattering smoke sensor
  Frequency response 10 Hz (at - 3 dB point).

WSPD: Wind speed as indicated by cup anemometer in metres/second.

WHDG: Wind heading as indicated by wind vanes in degrees relative to the site axis. Positive values are to the right of the site axis (looking 'downwind' from the source) and negative values to the left.

AIRT: Air temperature in degrees centigrade.

SOLA: Solar radiation as measured by solarimeter in watts/square metre.

BROM: Barometric pressure measured in millibars.

TEMP: Rapid response platinum resistance thermometer.
  Frequency response 10 Hz approximately.

UANA: Velocity component A of tri-axial anemometers in the horizontal (X Y) plane.

UANB: Velocity component B of tri-axial anemometer in the horizontal (X Y) plane.
Velocity component \( W \) of tri-axial anemometer in the vertical (Z) direction.

Temperature, as measured by tri-axial anemometer with this facility.

The mean value of the appropriate sensor output averaged over the run up period i.e. in the period -10400 to -10100 seconds before the gas container release.

The mean value of the appropriate sensor output averaged over the run down period i.e. in the period 809 to 1110 seconds after the gas container release.

4 GAS SENSORS

The readings of the GAS and HGAS sensors are in terms of the % concentration of the released gas mixture with an associated error band of either 10% of reading or as determined by calibration checks with a standard gas mixture. An estimate of the accuracy of each sensor for each test will be sent out separately. Note that the SNUK sensors have no absolute calibration in terms of gas concentration but have been included because of the potential high frequency information their outputs contain. An approximate calibration may be obtained by comparing their output to that of the nearest oxygen deficiency sensor.

5 SONIC ANEMOMETERS

Prints of the sonic anemometer outputs are included for completeness but it will be appreciated that analysis of records can only be performed using the data tapes. The three wind velocity components \( A \), \( B \) and \( W \) can be transposed into components corresponding with the X, Y and Z coordinates of the mast array as follows:

\[
X = \frac{1}{\sqrt{3}} (A - B)
\]

\[
Y = A + B
\]

\[
Z = W
\]

RMS turbulence values measured at 10 m height on 'A' mast are given below. The values are non-dimensionalised i.e. original values have been divided by \( U_{10} \), the mean wind speed at 10 m height during the main data collection period which was 5.5 m/s.

Turbulence intensity (U) = 12.0 (component in the wind direction)
Turbulence intensity (V) = 9.3 (crosswind component)
Turbulence intensity (W) = 6.5 (vertical component)

6 RUNNING MEANS

In order to assist analysis, a three minute running mean has been superimposed on all environmental records except the sonic anemometers. The points plotted represent the mean of 300 values (0.6 second averages) and are plotted at 0.6 second intervals.
NOTES ON VALIDATION OF GAS SENSOR DATA FOR TRIAL 022

1 Standard gas sensors at 2.4 metre height and higher on the mast at (300, 500), at 6.4 metre height on the mast at (325, 725) and at 10.4 metre height on the mast at (450, 250) were functioning correctly but did not detect gas.

2 Standard gas sensors at 2.4 metre height on the masts at (300, 600) and (400, 703) and at 10.4 metre height on the mast at (325, 275) were malfunctioning.

3 The plots at pages G55, G56 and G57 suggest a fault in the data collection system e.g. a bit missed during the A/D conversion. These plots should therefore be interpreted with caution.

4 Plots obtained from standard gas sensors sited inside the gas container are included at pages GB1 to GB3. It should be noted that these sensors are intended to assist NMI Ltd in determining the release conditions and do not form part of the dispersion field. Any interpretation of the output from these sensors should take account of the following:

   a) no validation of the gas bag sensor data has been carried out and no corrections have been made to take account of offset or drift before and after release;

   b) the sensors are mounted within the central gantry of the gas container which has horizontal platforms at various heights;

   c) sensors in the lower and central part of the gas container are always in 100% gas immediately before release;

   d) the performance of the sensors is adversely affected by exposure to high concentrations (in the region of 30%) of Freon 12. Specifically, the presence of the high concentrations of Freon 12 reduces the sensitivity of the electrochemical cells in the sensors to oxygen. The cells recover in about four minutes and the effect is manifested by a zero undershoot and slow recovery after the gas has been released.

5 The gas bag sensors at 12.0 m and 13.5 m height did not detect significant quantities of gas. The plots have not been included for this reason.

NOTES ON RAPID RESPONSE PLATINUM RESISTANCE THERMOMETERS FOR TRIAL 022

1 The rapid response platinum resistance thermometer at positions (475, 275, 2.4) and (475, 275, 5.0) were not functioning correctly. The plots at pages E53 and E58 should consequently be ignored.

B G Bullock
Special Instruments and Techniques Section
Safety Engineering Laboratory
22 August 1984
### Instrument Stations and Distributions (Effective for Trial 022)

Note: The location coordinates are the X, Y coordinates in metres at 1/100 scale. The source is at (4.0, 2.0). The table scans the layout by successive rows (i.e., at constant Y) of masts.

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<th>Type of MAST</th>
<th>Terminal Number</th>
<th>Channel Number</th>
<th>Height Above Ground (m)</th>
<th>Type of Sensor</th>
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</table>
TRIAL No. - 022      DATE - 24/7/83      83 SENSORS SAW GAS
WIND SPEED (U_10)    5 m/sec          PASQUILL CATEGORY D

Y
4
7
0

17
0

17
4

3
9
4

10
0

16
3

16
0

25
0

24
0

23
0

23
5

15
0

15
4

30
0

30
6

16
6

16
0

4
6

4
3

4
0

5
3

5
0

34
0

34
6

Fence

SCALE  100m

\frac{21}{4} = \text{DATA TERMINAL CHANNEL NUMBER OF GAS SENSORS AT 0.4m HEIGHT}

\bigcirc = \text{SENSORS AT 0.4m HEIGHT VERIFIED TO HAVE SEEN GAS}
TRIAL No. - 022  DATE - 24/7/83  83 SENSORS SAW GAS
WIND SPEED (U_{10}) 5 m/sec  PASQUILL CATEGORY D

GRID NORTH

\[ \frac{21}{4} = \frac{\text{DATA TERMINAL \_}}{\text{CHANNEL NUMBER}} \text{ OF GAS SENSORS AT 0.4m HEIGHT} \]
\[ \bigcirc = \text{SENSORS AT 0.4m HEIGHT VERIFIED TO HAVE SEEN GAS} \]
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 386 M  Y: 214 M  Z: 2.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 386 M  Y: 214 M  Z: 4.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 414 M  Y: 214 M  Z: 2.4 M
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 414 M  Y: 214 M  Z: 4.4 M

G09
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 372 M  Y: 228 M  Z: 0.4 M
TRIAL: 022  TYPE:  GAS  AVERAGING TIME:  0.6 SECS

X: 372 M  Y: 228 M  Z: 2.4 M
TRIAL: 022  TYPE:  GAS  AVERAGING TIME:  0.6 SECS

X:  350 M  Y:  250 M  Z:  0.4 M
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 450 M  Y: 250 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 450 M  Y: 250 M  Z: 6.4 M
Trial: 022  Type: Gas  Averaging Time: 0.6 secs
X: 325 M  Y: 275 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 325 M   Y: 275 M   Z: 2.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 325 M  Y: 275 M  Z: 4.4 M
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 371 M  Y: 269 M  Z: 2.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 371 M  Y: 269 M  Z: 10.4 M
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022   TYPE: HGAS   AVERAGING TIME: 0.6 SECS
X: 400 M    Y: 275 M    Z: 2.0 M
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 275 M  Z: 2.4 M

G41
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 275 M  Z: 4.4 M

G42
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 275 M  Z: -6.4 M

G43
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 429 M  Y: 269 M  Z: 4.4 M
CONCENTRATION

TIME FROM RELEASE (SECS x 10^-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 362 M   Y: 292 M   Z: 0.4 M

G50
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 362 M  Y: 292 M  Z: 2.4 M
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 362 M  Y: 292 M  Z: 4.4 M
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 362 M  Y: 292 M  Z: 6.4 M

G53
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 362 M  Y: 292 M  Z: 10.4 M
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 300 M  Z: 4.4 M

G57
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 400 M  Y: 300 M  Z: 6.4 M

G58
CONCENTRATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 300 M  Z: 10.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 438 M  Y: 292 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 438 M  Y: 292 M  Z: 2.4 M
CONCENTRATION (%)

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 438 M  Y: 292 M  Z: 4.4 M

G62
TRIAL: G22  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 400 M  Y: 350 M  Z: 6.4 M
Trial: 022  Type: Gas  Averaging time: 0.6 secs

X: 300 M  Y: 500 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 400 M  Y: 500 M  Z: 6.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 400 M  Y: 600 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS

X: 300 M  Y: 700 M  Z: 0.4 M
TRIAL: 022  TYPE: GAS  AVERAGING TIME: 0.6 SECS
X: 300 M  Y: 700 M  Z: 2.4 M
INSULATION

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: SOLAR  UNITS: W/M**2
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 0.4 M
MEAN OF RUN UP: 603.63  MEAN OF RUN DOWN: 139.56
PRESSURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: BROM  UNITS: MBAR
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 0.4 M
MEAN OF RUN UP: 1003  MEAN OF RUN DOWN: 1003
TRIAL: 022    TYPE: WSPD    UNITS: M/S
AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 50 M    Z: 2.0 M
MEAN OF RUN UP: 5.05    MEAN OF RUN DOWN: 3.91
TEMPERATURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022 TYPE: AIRT UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC X: 400 M Y: 50 M Z: 2.0 M
MEAN OF RUN UP: 19.62 MEAN OF RUN DOWN: 18.65
TRIAL: 022  TYPE: RHUM  UNITS: PER CENT
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 2.0 M
MEAN OF RUN UP: 86.19  MEAN OF RUN DOWN: 92.28
TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 2.0 M
MEAN OF RUN UP: 0.97  MEAN OF RUN DOWN: 1.70
WIND VELOCITY

-10.0 -8.0 -6.0 -4.0 -2.0 0.0 2.0 4.0 6.0 8.0 10.0

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANB  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 2.0 M
MEAN OF RUN UP: 3.89  MEAN OF RUN DOWN: 2.04
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022   TYPE: UANW   UNITS: M/S
AVERAGING TIME: 0.6 SEC   X: 400 M   Y: 50 M   Z: 2.0 M
MEAN OF RUN UP:  -0.48   MEAN OF RUN DOWN:  -0.49
TEMPERATURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANT  UNITS: DEGREES C

AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 2.0 M

MEAN OF RUN UP: 20.11  MEAN OF RUN DOWN: 19.40
TRIAL: 022    TYPE: WSPD    UNITS: M/S
AVERAGING TIME: 0.6 SEC   X: 400 M   Y: 50 M   Z: 4.5 M
MEAN OF RUN UP: 6.51    MEAN OF RUN DOWN: 4.98
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022      TYPE: AIRT      UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC      X: 400 M      Y: 50 M      Z: 9.0 M
MEAN OF RUN UP: 17.83      MEAN OF RUN DOWN: 18.11
TRIAL: 022  TYPE: WSPD  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 10.0 M
MEAN OF RUN UP: 6.89  MEAN OF RUN DOWN: 5.36
TIME FROM RELEASE (SECS\times10^{-2})

TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 10.0 M
MEAN OF RUN UP: 1.79  MEAN OF RUN DOWN: 2.64
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANB  UNITS: M/S

AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 10.0 M

MEAN OF RUN UP: 4.47  MEAN OF RUN DOWN: 2.20
TRIAL: 022  TYPE: UANW  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 10.0 M
MEAN OF RUN UP: 0.10  MEAN OF RUN DOWN: 0.18
TRIAL: 022    TYPE: UANT    UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 50 M    Z: 10.0 M
MEAN OF RUN UP: 17.53    MEAN OF RUN DOWN: 17.98
TRIAL: 022  TYPE: RHUM  UNITS: PER CENT

AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 10.0 M

MEAN OF RUN UP: 90.43  MEAN OF RUN DOWN: 89.93
Trial: 022  Type: WHDG  Units: Degrees

Averaging time: 0.6 sec  X: 400 m  Y: 50 m  Z: 10.0 m

Mean of run up: -21.34  Mean of run down: -5.95
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: WSPD  UNITS: M/S

AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 50 M  Z: 17.3 M

MEAN OF RUN UP: 7.19  MEAN OF RUN DOWN: 5.61
TEMPERATURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022    TYPE: AIRT    UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 50 M    Z: 22.0 M
MEAN OF RUN UP: 18.02    MEAN OF RUN DOWN: 18.45
TRIAL: 022    TYPE: WSPD    UNITS: M/S
AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 50 M    Z: 30.0 M
MEAN OF RUN UP: 7.25    MEAN OF RUN DOWN: 5.83
TRIAL: 022  TYPE: WHDG  UNITS: DEGREES
AVERAGING TIME: 0.6 SEC  X: 425 M  Y: 50 M  Z: 10.0 M
MEAN OF RUN UP: -22.14  MEAN OF RUN DOWN: -6.20
TRIAL: 022   TYPE: WHDG   UNITS: DEGREES
AVERAGING TIME: 0.6 SEC   X: 400 M   Y: 150 M   Z: 10.0 M
MEAN OF RUN UP:  -22.05   MEAN OF RUN DOWN:  -5.05
TRIAL: 022  TYPE: AIRT  UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 200 M  Z: 12.0 M
MEAN OF RUN UP: 23.00  MEAN OF RUN DOWN: 18.14
TRIAL: 022  TYPE: UANB  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 2.0 M
MEAN OF RUN UP: 3.45  MEAN OF RUN DOWN: 2.16
TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 2.0 M
MEAN OF RUN UP: 1.49  MEAN OF RUN DOWN: 2.04
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANW  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 2.0 M
MEAN OF RUN UP: 0.16  MEAN OF RUN DOWN: 0.10
TRIAL: 022    TYPE: UANT    UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC    X: 325 M    Y: 275 M    Z: 2.0 M
MEAN OF RUN UP: 21.44    MEAN OF RUN DOWN: 21.20
TEMPERATURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022 TYPE: TEMP UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC X: 325 M Y: 275 M Z: 2.4 M
MEAN OF RUN UP: 19.31 MEAN OF RUN DOWN: 19.10
Trial: 022  Type: UANB  Units: M/S

Averaging Time: 0.6 SEC  X: 325 M  Y: 275 M  Z: 5.0 M

Mean of Run Up: 4.04  Mean of Run Down: 2.35
TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 5.0 M
MEAN OF RUN UP: 2.03  MEAN OF RUN DOWN: 2.59
TRIAL: 022  TYPE: UANW  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 5.0 M
MEAN OF RUN UP: 0.44  MEAN OF RUN DOWN: 0.28
TEMPERATURE

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: TEMP  UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 5.0 M
MEAN OF RUN UP: 18.85  MEAN OF RUN DOWN: 18.97

E36
Trial: 022  Type: UANA  Units: m/s
Averaging Time: 0.6 sec  X: 325 M  Y: 275 M  Z: 14.5 M
Mean of run up: 1.82  Mean of run down: 2.58
TRIAL: 022  TYPE: UANW  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 325 M  Y: 275 M  Z: 14.5 M
MEAN OF RUN UP: 0.37  MEAN OF RUN DOWN: 0.17
TRIAL: 022  TYPE: UANB  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 250 M  Z: 2.0 M
MEAN OF RUN UP: 1.49  MEAN OF RUN DOWN: -0.97
Trial: 022  Type: UANA  Units: m/s
Averaging time: 0.6 sec  X: 400 m  Y: 250 m  Z: 2.0 m
Mean of run up: -0.75  Mean of run down: 1.63
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022    TYPE: UANW    UNITS: M/S
AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 250 M    Z: 2.0 M
MEAN OF RUN UP: -0.09    MEAN OF RUN DOWN: -0.24
TIME FROM RELEASE (SECS*10**-2)

TEMPERATURE

Trial: 022    Type: UANT    Units: Degrees C
Averaging Time: 0.6 sec    X: 400 M    Y: 250 M    Z: 2.0 M
Mean of Run Up: 21.18    Mean of Run Down: 20.42
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022      TYPE: TEMP      UNITS: DEGREES C

AVERAGING TIME: 0.6 SEC    X: 400 M    Y: 250 M    Z: 2.4 M

MEAN OF RUN UP: 20.86    MEAN OF RUN DOWN: 19.54
TRIAL: 022  TYPE: UANB  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 250 M  Z: 15.0 M
MEAN OF RUN UP: 4.23  MEAN OF RUN DOWN: 2.26
TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 250 M  Z: 15.0 M
MEAN OF RUN UP: 2.62  MEAN OF RUN DOWN: 2.65
TIME FROM RELEASE (SECS*10**2)

TRIAL: 022   TYPE: UANW   UNITS: M/S

AVERAGING TIME: 0.6 SEC   X: 400 M   Y: 250 M   Z: 15.0 M

MEAN OF RUN UP:   -0.48   MEAN OF RUN DOWN:   -0.45
Trial: 022  Type: UANB  Units: m/s
Averaging Time: 0.6 sec  x: 475 m  y: 275 m  z: 2.0 m
Mean of run up: 3.57  Mean of run down: 1.82
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANW  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 2.0 M
MEAN OF RUN UP: $-0.01  MEAN OF RUN DOWN: 0.08
TRIAL: 022  TYPE: UANT  UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 2.0 M
MEAN OF RUN UP: 18.00  MEAN OF RUN DOWN: 17.59
Trial: 022  Type: UANB  Units: m/s
Averaging Time: 0.6 sec  X: 475 m  Y: 275 m  Z: 5.0 m
Mean of Run Up: 4.15  Mean of Run Down: 2.30
TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 5.0 M
MEAN OF RUN UP: 1.91  MEAN OF RUN DOWN: 2.31
Trial: 022  Type: UANW  Units: M/S

Averaging Time: 0.6 SEC  X: 475 M  Y: 275 M  Z: 5.0 M

Mean of Run Up: 0.10  Mean of Run Down: 0.15
TIME FROM RELEASE (SECS*10**2)

TRIAL: 022     TYPE: UANT     UNITS: DEGREES C

AVERAGING TIME: 0.6 SEC     X: 475 M     Y: 275 M     Z: 5.0 M

MEAN OF RUN UP: 20.86     MEAN OF RUN DOWN: 20.97
TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: TEMP  UNITS: DEGREES C

AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 5.0 M

MEAN OF RUN UP: 5.31  MEAN OF RUN DOWN: 5.07
WIND VELOCITY

TIME FROM RELEASE (SECS*10**-2)

TRIAL: 022  TYPE: UANB  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 14.5 M
MEAN OF RUN UP: 4.59  MEAN OF RUN DOWN: 2.68
WIND VELOCITY

TIME FROM RELEASE (SECS*10**2)

TRIAL: 022  TYPE: UANA  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 14.5 M
MEAN OF RUN UP: 2.02  MEAN OF RUN DOWN: 2.75
TRIAL: 022  TYPE: VARK  UNITS: M/S
AVERAGING TIME: 0.6 SEC  X: 475 M  Y: 275 M  Z: 14.5 M
MEAN OF RUN UP: -0.22  MEAN OF RUN DOWN: -0.12
TRIAL: 022  TYPE: SOLA  UNITS: W/M**2
AVERAGING TIME: 0.6 SEC  X: 700 M  Y: 500 M  Z: 0.4 M
MEAN OF RUN UP: 626.98  MEAN OF RUN DOWN: 125.38
trial: 022  type: wspd  units: m/s
averaging time: 0.6 sec  x: 400 m  y: 950 m  z: 10.0 m
mean of run up: 6.52  mean of run down: 4.67
TRIAL: 022  TYPE: RHUM  UNITS: PER CENT
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 950 M  Z: 10.0 M
MEAN OF RUN UP: 82.09  MEAN OF RUN DOWN: 85.05
TRIAL: 022  TYPE: AIRT  UNITS: DEGREES C
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 950 M  Z: 10.0 M
MEAN OF RUN UP: 18.32  MEAN OF RUN DOWN: 18.53
TRIAL: 022  TYPE: WHDG  UNITS: DEGREES
AVERAGING TIME: 0.6 SEC  X: 400 M  Y: 950 M  Z: 10.0 M
MEAN OF RUN UP:  -29.33  MEAN OF RUN DOWN:  -13.58

TIME FROM RELEASE (SECS*10**-2)