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THE PRESENTATION AND AVAILABILITY OF THE DATA AND PLANS FOR FUTURE ANALYSIS

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Summary

The trials at Thorney Island have produced a considerable data base on the dispersion of heavier-than-air gas. This paper describes the data that have been collected during the trials and the forms in which they have been made available to sponsors of the trials. The Health and Safety Executive's (HSE) arrangements for releasing the data to organisations who were not sponsors of the trials are also described. Some pre-processing is planned in order to present the data in a more suitable form for subsequent analysis. An indication of plans for future analysis is given.

1. Introduction

The primary objective of the Heavy Gas Dispersion Trials has been the collection of data on the gas dispersion field resulting from large scale releases of heavier-than-air gas. Fast response instruments were also deployed with the secondary objective of learning more about the physics of heavy gas dispersion. The amount of data collected is considerable and its validation, documentation and distribution has become a major undertaking. For contractual reasons, data resulting from the trials have so far been made available only to sponsors of the trials but their release on a more general basis will commence during the latter part of 1984.

In response to an initiative by the Commission of the European Communities, HSE has approached all sponsors of the trials regarding their plans for analysis of the data with a view to encouraging cooperation between organisations carrying out similar analysis work. The results of this exercise are presented.

2. The collection of data

Over 200 field instruments were deployed on the site. The types of sensors used are shown in Table 1. The sensors were mounted on masts positioned in the now familiar 100 m grid, see Fig. 1. For convenience, the

TABLE 1

Instruments used during the Heavy Gas Dispersion Trials

Instrument type	No. deployed
Gas sensors (1 Hz)	170
Tri-axial ultrasonic anemometers	10
Gas sensors (10 Hz)	5
Cup anemometers	6
Wind vanes	5
Air temperature sensors	6
Humidity sensors	3
Solarimeter	1
Barometer	1

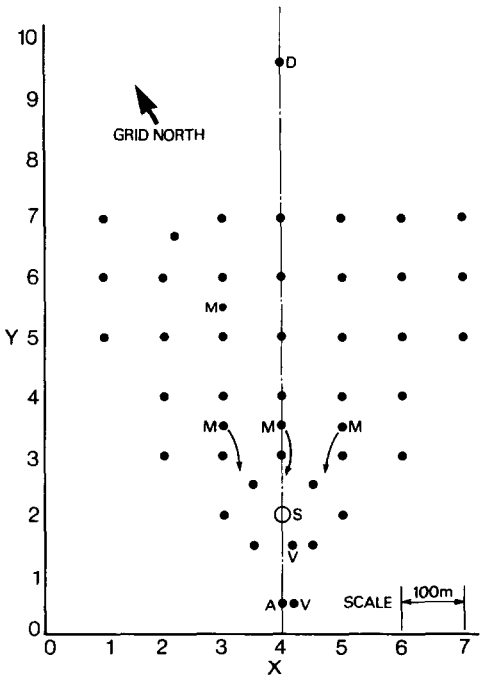

Fig. 1. Layout of masts.

instrumentation deployed will first be summarised prior to describing the forms in which the records from the instruments will be available.

The weather mast, marked A in Fig. 1, is a 30 m high mast positioned 150 m upwind of the gas release point (marked S). The following sensors were mounted on the weather mast:

(a) 5 air temperature sensors at heights of 2, 9, 16, 22 and 30 metres;
(b) 5 cup anemometers at heights of 2, 4.5, 10, 17.3 and 30 metres;

(c) 2 tri-axial sonic anemometers at heights of 2 and 10 metres;
(d) 1 solarimeter at a height of 0.4 metres;
(e) 1 barometric pressure instrument at a height of 0.4 metres;
(f) 1 wind vane at a height of 10 metres; and
(g) 2 relative humidity sensors at heights of 10 and 30 metres. (Prior to Trial 7 there was only one sensor at a height of 10 metres.)

A far field weather station (marked D) had single wind speed, wind direction, air temperature and relative humidity sensors mounted at a height of 10 metres. Potentiometric wind vanes were mounted on 2 masts (marked V) at heights of 10 metres for the purpose of eddy forecasting.

The remaining masts, including the far field weather station (D) and the mobile masts (M), generally held 4 standard 1 Hz gas sensors. Details of the gas sensor dispositions for each trial can be obtained from the trials records and are described in full in McQuaid and Roebuck [1].

Five sonic anemometer/fast-response gas sensor pairs were mounted on the mobile masts (M) at heights intended to be within the heavy gas cloud and on each mast an additional sonic anemometer was mounted at a height expected to be above the gas cloud. Exact details of their deployment can also be obtained from the trials records.

The detailed deployment of the sensor field was varied during the trials to cope with the varying requirements of the trials programme and in response to the knowledge gained from the earlier trials. The main changes were:
(a) the movement of the near-field mobile masts closer to the release point after Trial 14 as indicated by the arrows in Fig. 1, and the removal of the far field mobile mast. The reason for these changes was to increase the probability of the high-speed sensors being within the gas cloud.
(b) around 30 standard gas sensors were moved from the far field in order to reinforce the near field during the Phase II trials. This enabled the inves-

TABLE 2

The number of gas sensors which detected gas in each trial

Trial	No. of sensors	Trial	No. of sensors
4	22	17	62
5	26	18	60
6	46	19	67
7	57	20	72
8	73	21	99
9	62	22	83
10	11	23	77
11	26	24	65
12	65	25	26
13	47	26	101
14	50	27	29
15	38	28	59
16	45	29	72

tigation in more detail of the effects of the obstructions on the dispersion of the gas cloud. An additional 10 masts were deployed and gas sensors were also mounted at a height of 10.4 metres on those masts immediately downwind of the obstructions.

Data from all field instruments was collected at a rate of 20 Hz and stored on magnetic tape in Hewlett—Packard real-time format.

The success of the gas sensor dispositions used is illustrated in Table 2. In 16 of the 26 trials over 50 gas sensors detected gas and in only one case did this number fall below 20. Data from both gas and environmental sensors have proved highly self-consistent and the number of failed or suspect transducers per trial has been very low.

In addition to the data collected from instruments in the field, the trials have been comprehensively covered by photography. 22 of the 26 trials were

TABLE 3

Visual coverage of Thorney Island trials

Trial	Overhead video	Overhead stills	Ground level video	Ground level stills	Cine
4	+	+	+	partial	+
5	+	+	+	+	+
6	+	X	+	+	+
7	+	+	+	+	+
9	+	+	+	+	+
10	+	X	+	partial	+
11	+	+	+	+	+
12	X	X	+	+	+
13	+	+	+	+	+
14	+	+	+	partial	+
15	+	+	+	partial	X
16	+	+	+	+	X
17	+	+	+	+	X
18	+	+	+	+	X
19	+	+	+	partial	X
20	limited	limited	+	+	X
21	+	+	+	+	X
22	limited	+	+	+	X
23	+	+	+	+	X
25	X	X	+	+	X
26	+	+	+	+	X
27	X	X	+	+	X
28	+	+	+	+	X
29	after dark	X	after dark	after dark	X

Key

X	No record
partial	Some record but not all cameras operated
limited	Timing problem — full trial not recorded
after dark	Records obtained but not good quality

filmed and photographed from a helicopter hovering directly over the trials field, including one trial carried out after sunset. Ground video and stills photography was undertaken in all trials. Table 3 shows that, although there was an occasional failure of individual stills cameras, extensive photographic coverage was achieved.

Ground level cine film of the initial gas container drop and collapse of the gas cloud under gravity was obtained in the first 11 trials but was discontinued when it was considered that sufficient information on this aspect had been obtained.

3. Data validation

Before data tapes are issued by the trials management the data are subjected to the following validation procedure:

(a) Data points which are clearly defective are flagged by being set to the value 9999.9.
(b) The voltages recorded are converted into the engineering units appropriate to each instrument.
(c) Gas sensor data are plotted and examined in order to determine which sensors detected gas. Where a signal above the lower limit of resolution of the gas sensors (0.1% released gas) cannot be detected, sensor data are set to zero.
(d) Slope and offset corrections are applied to those gas sensors judged to have detected gas in order to compensate for zero drift.

Flagging of defective data points and conversion to engineering units is carried out by NMI Ltd. prior to sending the data tapes to HSE for validation of the gas sensor data. The application of slope and offset corrections to gas sensor data is illustrated in Fig. 2.

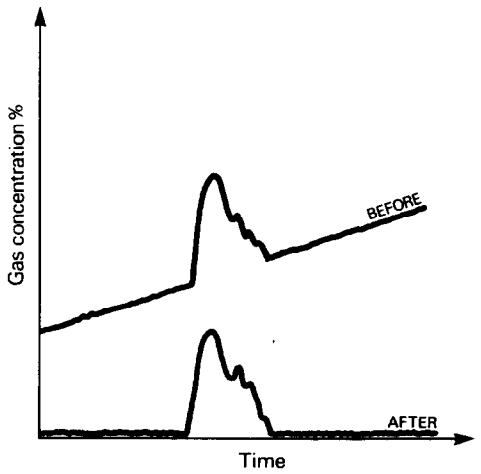

Fig. 2. The application of slope and offset corrections to gas sensor data.

4. Availability of data to sponsors

Data resulting from the trials have been made available to sponsors in the following forms:

(a) magnetic data tapes containing validated data in Hewlett—Packard real-time format and at the original 20 Hz sampling rate;
(b) hard copy plots of the validated data averaged over periods of 0.6 seconds;
(c) visual records in the form of video film and photographic film strips.

The magnetic data tapes contain three blocks of data:

(a) that collected during a five minute "run-up" period about 30 minutes before the release;
(b) the main data block covering the five minutes immediately prior to release and a period of up to 25 minutes after release;
(c) that collected during a five minute "run-down" period approximately 30 minutes after release.

The purpose of the "run-up" and "run-down" data is to provide information on any trends in environmental conditions. The data tapes are headed by files in ASCII format which contain details of the trial, instrument deployment in the field and the trials countdown log.

Hard copy plots are presented as a single volume for each trial which also contains a summary of the conditions under which the trials took place and details of instrument deployment.

At the time of writing, data tapes for trials 5 to 22, hard copy plots for trials 6 to 19 and visual records for all trials are available to sponsors of the trials. All remaining data tapes and hard copy plots should be available by late summer 1984.

5. Availability of data to other organisations

In order to carry out analysis of the data resulting from the Thorney Island trials it is necessary to carry out various processing operations in order to convert the data into a more compact and manageable form. Since HSE has already developed methods for doing this as a preliminary to its own analysis work, it proposes to make available magnetic tapes containing ready processed data. The main differences will be:

(a) the data will be in ASCII rather than Hewlett—Packard format;
(b) data collected during the "run-up" and "run-down" periods will be replaced by a file giving mean values only;
(c) the data will be sorted from its real-time format into data blocks associated with each instrument;
(d) data from all sensors other than sonic anemometers, fast-response gas sensors and fast-response temperature sensors will be averaged over periods of 0.6 seconds;

(e) data from gas sensors which were not in the gas cloud or judged not to have detected gas will be omitted.

In addition to the benefits of using a format compatible with most computers, the data compaction will allow the data from each trial to be stored on a single magnetic tape.

The general release of data tapes, hard copy plots and visual material will begin in August 1984. The release will be phased over a period of nine months to provide a reasonable period of preferential access by sponsors of the project. The planned cost schedule, applicable in 1984, is given in Table 4.

TABLE 4

Estimated costs of Thorney Island data

Magnetic data tapes (HP format)	£150 per trial
Magnetic data tapes (ASCII format)	£300 per trial
Hard copy plots	£25 per trial
Video tapes	£50 per trial
Composite video tapes	£100
Film strips	£100 per trial

6. Plans for future analysis

Clearly with a project of the size of the Thorney Island trials it would be a massive undertaking for any single organisation to undertake a full and comprehensive analysis of the data. With the prospect of several years of data analysis ahead it would be wise to make plans which include some element of cooperation between the many organisations involved. Following a proposal by the Commission of the European Communities that an attempt be made to coordinate analysis work, HSE approached all sponsors of the trials with a view to collating their plans for analysis work and encouraging coordination of their efforts where this was possible. Eighteen sponsors responded positively and their plans for data analysis are outlined in Table 5. CEA, EDF and GDF gave a coordinated response and are therefore listed together. ENEA DISP Italy responded positively but have not yet provided details of the plans. For this reason they have not been included in Table 5.

Many of the organisations listed, including HSE, have already made arrangements to exchange information and coordinate their efforts. It is hoped that this paper will stimulate participation by other organisations in these ventures.

7. Concluding remarks

This paper has been concerned with the trials performed in Phases I and II of the HGDT project. In all these trials, a fixed volume of gas was released

TABLE 5

Plans for analysis

	Shell	USCG	TNO	IAR Norway	CEA/ GDF/ EDF	BP	NDRI Sweden	SRD (UKAEA)	Britoil	VKI	NMI	HSE	TCPL	Battelle Institute	AES
Tape translation	+	+		+	+	+	+	+	+	+	+	+		+	+
Data compaction		+	+	+		+	+	+	[a]	+		+		+	
Sorting data into time variation for each transducer	+	+	+	+	+	+	+	+	[a]	+		+		+	+
Analysis of meteorological data	+	+	+	+			+	+	[a]		+			+	+
Gas concentration field interpolation routines		+	+	+	+		+	+	[a]			+		+	
Fast response transducer, variances, covariances, etc.	+	+	[a]	+				+	[a]	+	+	+		+	
Manual processing of visual data	+	+	[a]		+		+	+			+				
Digital processing of visual data										+		+			
Validation of own models	+	+	+	+	+			+		+				+	
Validation of other models		+	+		+	+	+		[a]				+	+	+
Comparison with wind tunnel simulations			+								+	+			

[a] Plans for work under consideration.

Key to Table 5

Shell	Shell U.K.
USCG	United States Coast Guard
TNO	Division of Technology for Society, TNO, The Netherlands
IAR, Norway	Norwegian Institute for Air Research
CEA	Commissariat de l'Energie Atomique, France
GDT	Gaz de France
EDF	Electricité de France
BP	British Petroleum
NDRI	National Defence Research Institute, Sweden
SRD (UKAEA)	Safety and Reliability Directorate, UK Atomic Energy Authority
BRITOIL	Britoil plc
VKI	von Karman Institute, Belgium
NMI	NMI Ltd.
TCPL	TransCanada Pipelines
Battelle	Battelle Institute, Frankfurt
AES	Atmospheric Environment Service, Canada

quasi-instantaneously. At the time of writing, plans are in hand for carrying out some further trials with a continuous release mode. It is expected that the data from these trials will not be available until 1985.

Reference

1 **J. McQuaid and B. Roebuck, Final Report on Heavy Gas Dispersion Trials at Thorney Island, Health and Safety Executive, Sheffield, 1984.**