



European Radiocommunications Committee (ERC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

**INTERFERENCE FROM INDUSTRIAL,
SCIENTIFIC AND MEDICAL (ISM) MACHINES**

Luxembourg, June 2000

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INTERFERENCE TO RADIO USE FROM INDUSTRIAL, SCIENTIFIC AND MEDICAL (ISM) MACHINES

1 INTRODUCTION

This report primarily deals with problems of interference from out of band radiation from heavy duty Industrial, Scientific and Medical (ISM) equipment.

The aim of this report is to draw the attention of CEPT Administrations to the extent of such problems from information gained through a questionnaire issued to all CEPT Administrations.

Examples of sources and their operating characteristics are identified and methods of resolution are discussed.

2 ITU RADIO REGULATIONS

Certain frequency bands are set aside by international agreement for ISM use. They are written into the ITU Radio Regulations* and defined under RRS1.15 as "industrial, scientific and medical (ISM) applications (of radio frequency energy): Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications".

RRS15.13 of the Radio Regulations state that "Administrations shall take all practicable and necessary steps to ensure that radiation from equipment used for ISM applications is minimal and that, outside the bands designated for use by this equipment, radiation from such equipment is at a level that does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the Radio Regulations."

3 FREQUENCIES & STANDARDS

The following bands are designated for ISM applications in Region1 and also for some radiocommunications services in accordance with RRS5.150 of the Radio Regulations:

13 553 - 13 567 kHz	(centre frequency 13 560 kHz)
26 957 - 27 283 kHz	(centre frequency 27 120 kHz)
40.66 - 40.70 MHz	(centre frequency 40.68 MHz)
433.05 - 434.79 MHz	(centre frequency 433.92 MHz)
2 400 - 2 500 MHz	(centre frequency 2 450 MHz)
5 725 - 5 875 MHz	(centre frequency 5 800 MHz), and
24 - 24.25 GHz	(centre frequency 24.125 GHz)

The following bands are designated for ISM applications subject to special authorisation by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected.

6 765 - 6 795 kHz	(centre frequency 6 780 kHz)
61 - 61.5 GHz	(centre frequency 61.25 GHz)
122 - 123 GHz	(centre frequency 122.5 GHz), and
244 - 246 GHz	(centre frequency 245 GHz)

There are CISPR (Comite International Special Des Perturbations Radioelectronique) limits for the radiated field strength of harmonics, with tighter limits in broadcast and safety of life frequencies. Prior to 1996, the CISPR limits would apply to ISM equipment. New machines brought into service after 1 January 1996 within the EU must conform to the EC Directive on Electromagnetic Compatibility 89/336/EEC as implemented in national legislation, the standard for these purposes is EN55011. In practice, this standard is often applied in non-EU CEPT countries through their own legislation.

4 USES OF ISM EQUIPMENT

Industrial, Scientific and Medical (ISM) equipment is the use of high power radio frequency energy as heat in a wide range of processes. In medicine, ISM diathermy machines are used for deep heat treatment of injured muscles and ligaments. Of more concern is the use of ISM in industry. ISM machines are used by very small firms and by large ones who are market leaders. Workshop industries use the machines for quick woodglue drying in furniture making and boat building, and in plastic welding for the stationery industry. Short production runs of textile printing such as T-shirts for sporting events or rock concerts, are carried out in small factories using ISM machines. Larger firms carry out plastic forming to supply pre-formed fascias to the European motor industry. Major biscuit manufacturers rely on ISM batch and continuous processing to achieve crispness and browning of their products. In Europe the main manufacturers of ISM machines appear to be in the UK, Italy and Sweden. There are also some manufacturers in the Far East and USA.

5 METHOD OF OPERATION

ISM machines are relatively crude RF technology. Valves are used as oscillators, with the "oven" of the machine forming a tank circuit. The work itself is used as a dielectric, which changes during the process - some frequency drift is encouraged so that heat builds and falls away relatively slowly (perhaps over several seconds) as the tank circuit comes into resonance. While more modern methods of frequency generation and power control have been suggested to the industry it would appear that cost is the major factor in such choice.

6 INTERFERENCE PROBLEMS

Many machines continue in use for 20 or 30 years and give good service for their intended purpose. Smaller users often rely on single, second hand, refurbished machines. While all machines can continue to work well, RF maintenance may be poor and lost covers, poor earthing and other faults allow spurious radiation, above the limits, to escape. Some refurbishment simply consists of new paint that often is no more than coating over essential base metal to base metal joints without regard for electrical and RF continuity.

The radiation of harmonic, and hence interference, is not a new phenomenon. However while the spectrum was less crowded it was often possible to treat cases by a small change in frequency. Today with heavier spectrum use this is no longer possible. The 5th and 9th harmonics of 27MHz and 13MHz machines respectively fall in the air traffic control band 108-136 MHz and as the band is intensively used interference is frequent. Interference is also caused to private business radio bands and to domestic TV reception.

7 CEPT QUESTIONNAIRE

In order to gauge the level of ISM problems, a questionnaire at annex A was sent in September 1999 to all 43 CEPT Administrations. 15 Administrations returned completed forms, representing a 35% response.

Of those returned:

8 indicated very little or Nil reports during the last 5 years.

5 indicated an average of 3 cases per year.

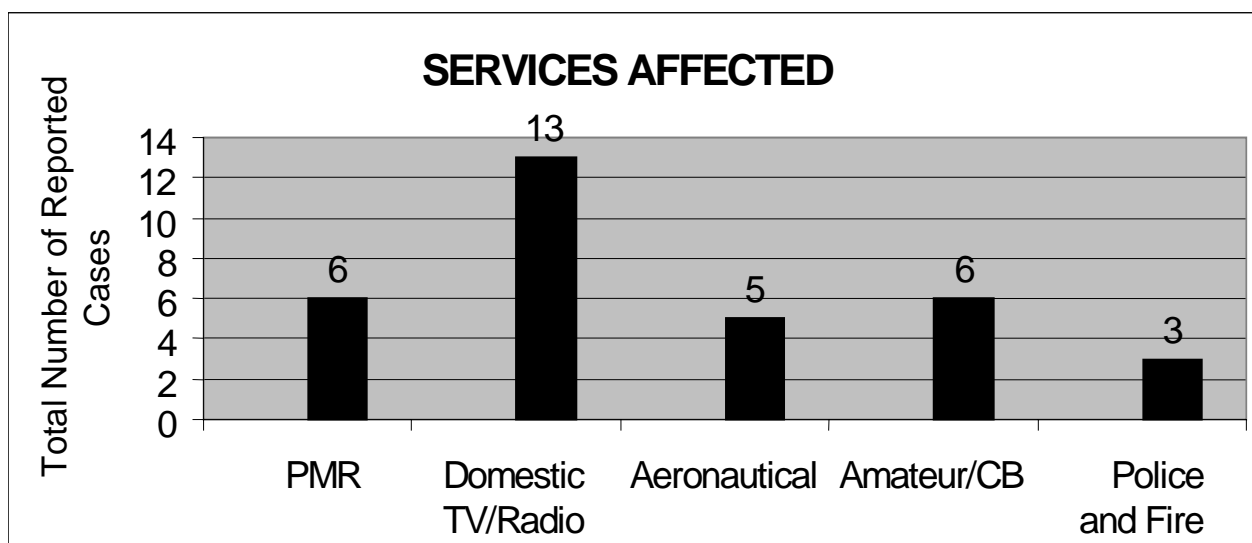
2 indicated between 4 and 16 cases per year.

8 RESULTS OF QUESTIONNAIRE

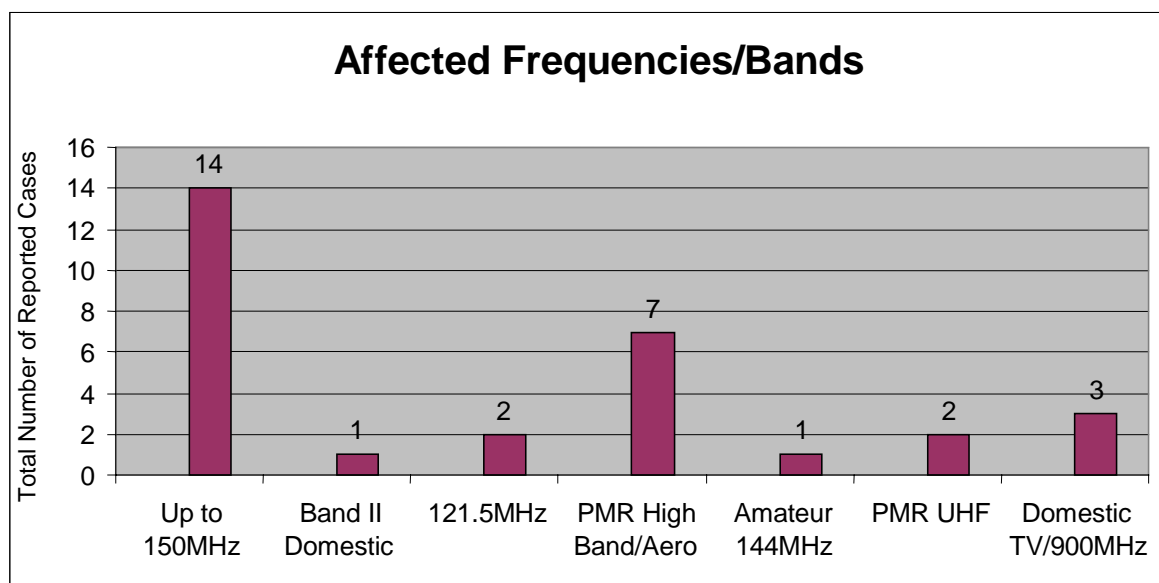
The following graphs and comments indicate the replies to the following questions:

- (a) Details of the parts of the spectrum experiencing interference problems and the services affected.
- (b) Breakdown of the frequency ranges affected
- (c) Fundamental frequency of the ISM source
- (d) Purpose for which the ISM equipment was being used
- (e) Standards used by Administrations
- (f) Methods adopted to resolve problems

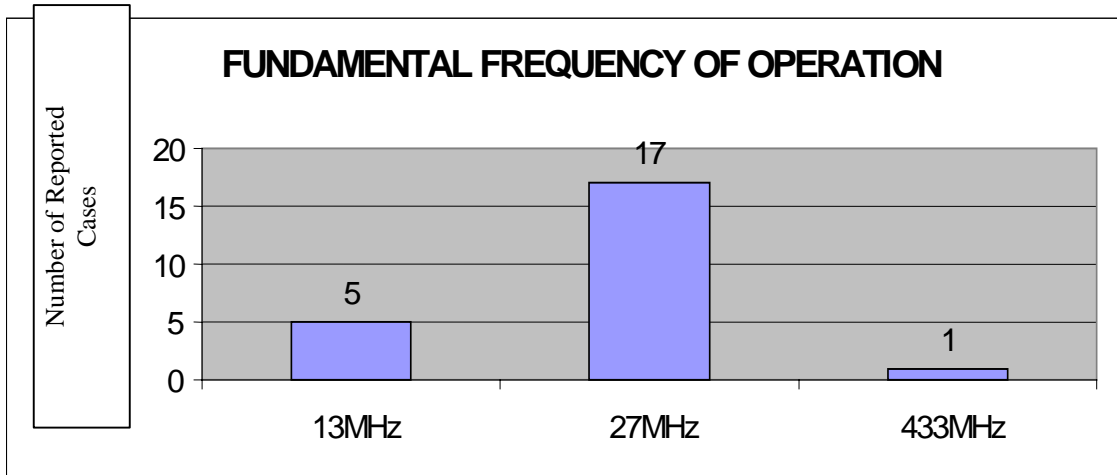
(b) Details of the Parts of the Spectrum Experiencing Interference problems.



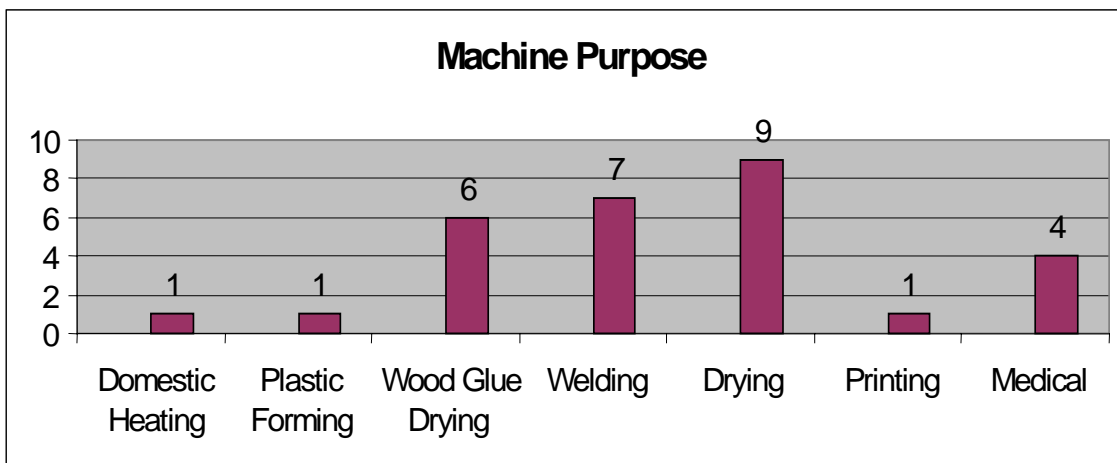
(c) Breakdown of the Frequency Ranges affected.



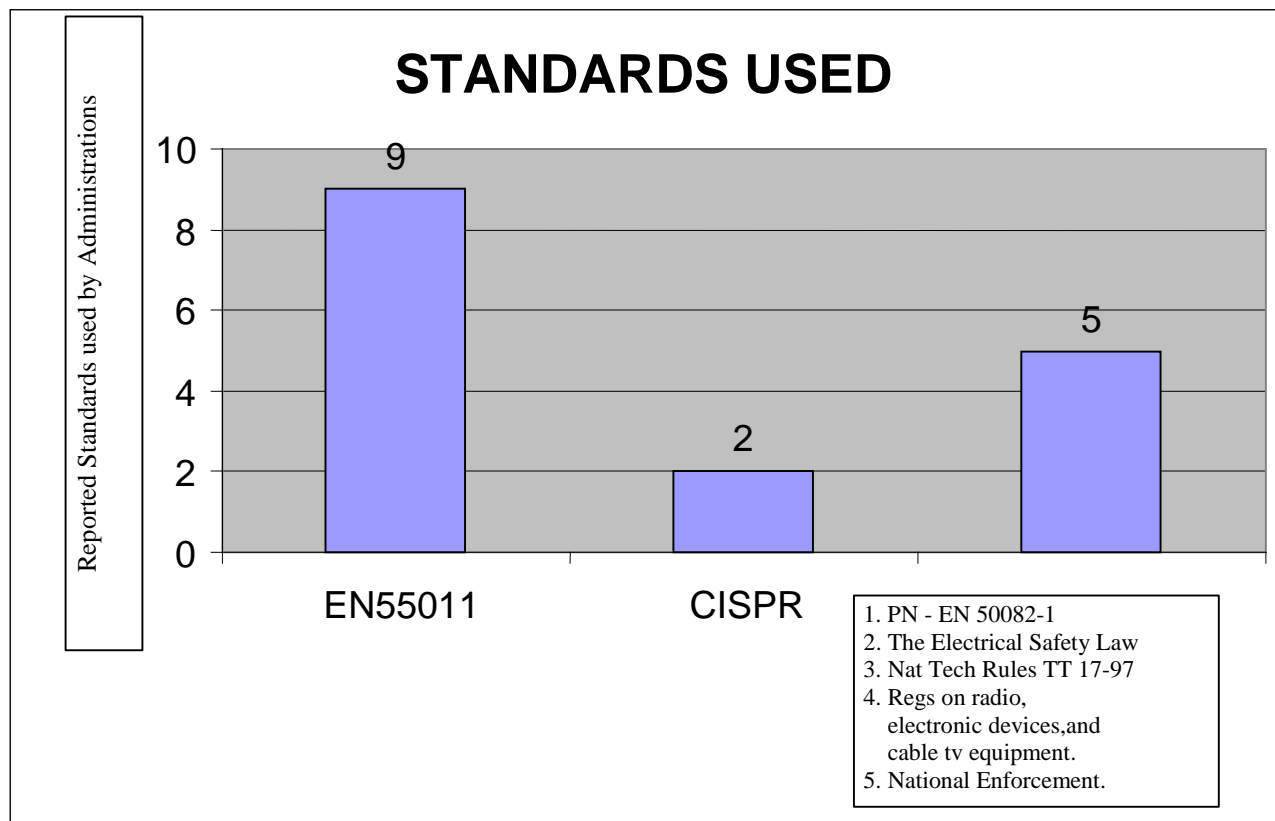
(c) Fundamental Frequency of the ISM Source



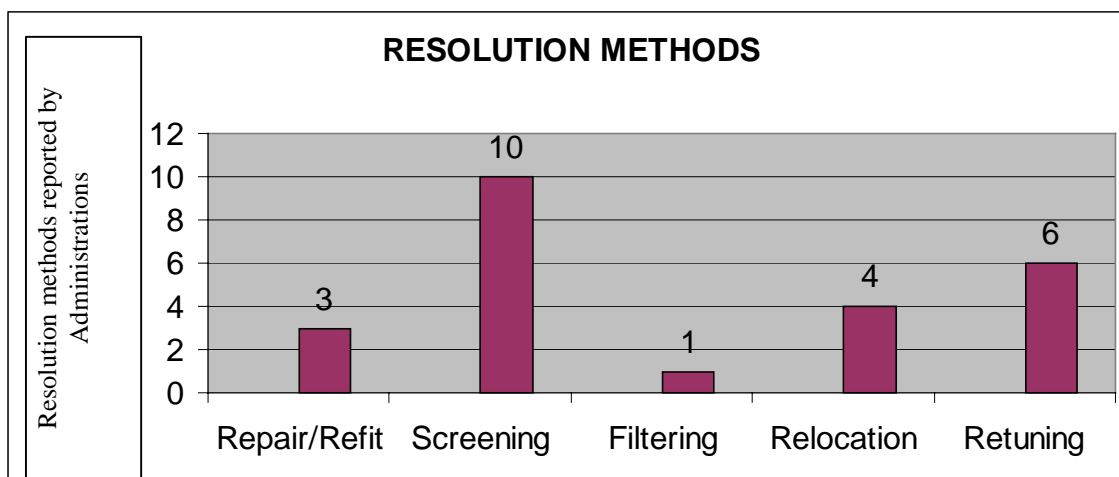
(d) Purpose for which the ISM Equipment was being used.



(e) Standards Used by Administrations



(f) Methods adopted to resolve problems.



9 CONCLUSIONS OF QUESTIONNAIRE

- The radio services affected by interference cover a broad spectrum of users including private mobile radio, domestic TV and radio, as well as safety of life users, such as aeronautical, police and fire services.
- The affected frequencies extend from the fundamental up to UHF indicating a high level of harmonic radiation.
- The most widespread source frequency is in the 27MHz band.
- Screening is the most common used method of resolving the problem.
- This survey attracted a relatively low response rate although the extent of the problem may be underestimated due to this area of work being dealt with in some countries by authorities other than the radio Administration.
- Problems mainly come about due to the heavy use of the spectrum for radio services and may increase as the demand for spectrum grows. Additionally, these types of cases can be very difficult and time consuming to resolve so the number of cases do not reflect the actual amount of work involved in reaching a satisfactory conclusion.

10 SOLUTIONS

- The simple answer, for 13MHz and 27 MHz machines that exceed the limit and cause interference is to take the enforcement steps provided under national legislation. In the event of interference to safety of life services, Administrations should have the power to enforce close down immediately. That procedure protects the spectrum, and for safety of life cases, typically interference to air traffic control, machines can be shut down temporarily. However, this does not help the wider industrial scene where the loss of a single machine to a small company could mean curtailment of business while to large firms a market lead or important orders could be lost. Moreover, enforcement could lead to aggrievement by users who often have no idea of RF engineering and for whom their machines work perfectly well. It is preferable to work with ISM users and machine manufacturers to solve interference problems without resorting to close down.
- The replies from Administrations indicates that screening is the most common method of resolving problems as indicated in graph 8(f) above and there are a variety of screening, bonding and earthing methods which can be attempted. Experience shows that in some cases these have not always proved successful - cases where a 20 or 30 dB reduction has been needed (even allowing for measurement uncertainties) can be hard to achieve. In some cases achieving a reduction of emissions to legal limits may be prohibitively expensive. The second most common method of resolving problems as detailed in graph 8(f) is by re-tuning. However, this method may not be a realistic option as it just shifts the problem to another part of the spectrum, often causing difficulties to other channels/users.
- In an effort to find novel solutions independent research* has yielded original, workable proposals. One of these is the use of a framework of vertical and/or horizontal polarising wires placed on the external walls of factories. These are simple to construct and highly effective, giving sometimes 30dB attenuation. They are also more effective than expensive screening placed round machines which also makes them difficult to operate. A second, innovative idea is the construction of vestibules on batch and continuous process machines to direct unwanted emissions to a low impedance matched load.
- The establishment of a register of heavy-duty ISM users may assist with the identification of interference sources, subject to each Administrations local practical arrangements. However, as this could only be on a voluntary basis, the realistic success of this would depend on the level of response from users.
- As it is possible that the RF radiation from ISM equipment could be above the acceptable Health and Safety limits, Administrations may wish to co-operate with their H&S body to give an added dimension to help to bring the machine to within the required tolerances.

*References:

ERA Report Radiocommunications Agency website:
www.radio.gov.uk

ITU website:
www.itu.int
Annex A Questionnaire

ANNEX A

ANNEX A: INDUSTRIAL, SCIENTIFIC and MEDICAL EQUIPMENT (ISM)

To assist in determining the level of problems associated with interference attributable to ISM equipment would you please complete the following questionnaire.

This questionnaire is intended to be easily completed and therefore, as an initial survey, only a maximum of up to five of the most recent cases are required. It is suggested that only basic information be supplied to the following questions. Example answers are given.

Further information can be obtained from either of the following PT11 members:-

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Tel +44 1942 528200

Doug Raynes
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Tel +44 020 7211 0463

Additional information is available on the Radiocommunications Agency Web site at <http://www.radio.gov.uk>

Q1. Name of administration and contact details.

Q2. Have you had any experience of the difficulties described in the attached documents?

Yes No → (Please return Questionnaire.)

Q3. If 'Yes', approximately how many **cases per year** have been dealt with?

Q4. Please give basic details of the five most recent cases your administration has dealt with:

Which part of the spectrum experienced the interference?
e.g : Domestic TV, Aeronautical, Private mobile radio, etc

Case 1:
Case 2:
Case 3:
Case 4:
Case 5:

What was the approximate frequency of the affected equipment?

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

What was the approximate operational frequency of the ISM source?
e.g. 13MHz; 27MHz; 900MHz?

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Which standards were used for measurement purposes? E.g EN55011; BS4809

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Who was the manufacturer? E.g Radyne, Strayfield etc

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Were you able to resolve the problem? If 'Yes', how?

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Q4 Continued...

What process was the ISM source used or? E.g Drying; printing; forming etc

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Which standards were used or measurement purposes?
E.g EN 55011

Case 1:

Case 2:

Case 3:

Case 4:

Case 5:

Were you able to resolve the problem? If 'Yes'; how?

Case 1:

Case 2:

Case 3:


Case 4:

Case 5:

Q5. Has any additional research been completed on behalf of your administration similar to the ERA Ltd (UK) described in the attached documents?

Yes

No

 If 'Yes' please give details:

Q6. Any additional comments?

Thank you for completing this questionnaire.

Please return the completed form by an e-mail (attachment) to either

Mr Alan Clayton claytona@ra.gtnet.gov.uk or **Mr Doug Raynes** raynesd@ra.gtnet.gov.uk,

or by post to:

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