

WEATHER RADAR  
AND FLOOD WARNING  
SERVICES



NRA



The Met. Office

## 1. WHAT IS WEATHER RADAR?

Weather Radar pictures are now being seen regularly on television. The radar image which the forecasters use helps describe the current situation before they give the forecast. A single Weather Radar can detect the rainfall over a large area, seeing approximately 150 miles in all directions. It is calibrated to determine how much rain is falling as well as where it is falling. By combining the outputs of several strategically placed radars, the results are equivalent to having the whole of the UK and surrounding sea areas covered with rain-gauges.

This method of measuring rainfall has several advantages over established methods:

- a It can give total coverage of the area.
- b It can measure snowfall as well as rainfall  
(conventional rain-gauges do not measure snow).
- c It can measure over the sea as well as over land.
- d It can give the information in less than 5 minutes.

## 2. WHAT CAN IT DO AND HOW CAN IT HELP?

The overall cover of the UK Weather Radar network is given by combining information from several radar sites, as shown on the map on the back page. Recording pictures of the rainfall position say every half hour and replaying those recorded images gives the progression of rain as it moves across the British Isles.

## 3. COMMON USES OF WEATHER RADAR

Weather Radar helps with very short-period weather forecasts – up to about six hours ahead. These forecasts help the NRA in their flood defence work, as well as being applicable to a wide range of services as follows:

### Transport

For transport, Weather Radar data and satellite imagery are combined with road temperature sensors to provide very accurate short-period forecasts.

For example, Councils taking the OpenRoad Service are advised where and when freezing conditions will be combined with rain and snow, and therefore likely to affect road surfaces seriously.

Snow clearance and salting operations can begin at appropriate times keeping roads open longer.

Weather Radar can also help with forecasting for shipping, aviation and air/sea rescue.

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### Agriculture

It is important for farmers to know if lambs will get wet, when the conditions are also cold and windy, as new-born lambs are very prone to the effects of wind-chill. Crop-spraying can be an expensive waste of time if rain falls too soon and washes the chemicals off the plants. Conversely, it may help to know that the chemical will be washed into the soil fairly quickly.

### Power and Construction Industries

Electrical engineers can avoid working on power pylons when there is rain and lightning imminent. The power industry wishes to know where lightning may strike. Builders will not lay concrete if there is a possibility of it getting saturated before it sets.

### Pollution

The Chernobyl disaster caused a cloud of radioactive material to be blown over the British Isles. The radioactivity was only washed down into the soil when the radioactive cloud coincided with the rain. It was important to know when and where this happened, as food produced in these areas (especially lambs) may have contained unacceptable levels of radioactivity.

### Leisure

We all like to know where and when rain is expected, to help us plan our leisure activities. The Weather Radar picture is easily interpreted so that forecasters can give this information for special events like Wimbledon and Royal Ascot.

### 4. HOW IT WORKS

Since radar was first invented, it has been able to detect rainfall. Initially this was a nuisance in the tracking of aircraft during and after the Second World War. It is still a nuisance to the Civil Aviation Authority who spend a lot of money and effort to remove rainfall echoes from their radar screens. However, the Met. Office has, for many years, had screens with the rainfall left on them.

The principle is very simple in that a pencil beam of radio energy is swept in a full circle around the radar site. The beam is refracted and reflected back by the drops of water giving an echo which varies in strength according to the intensity of the rainfall.

To make sense of all the varying echoes, the Met. Office has developed a computer program which converts them into meaningful figures and then presents them as a picture image. At each radar site there is both a radar and a computer. The latter is connected to telephone lines and transmits the information to the Met. Office and the National Rivers Authority.



Weather forecasting can help the Construction Industry



National Rivers Authority  
Information Centre  
Head Office  
Class No. NRA Flood  
Accession No. AHNR/2

This information is shown on the screens as minute squares, colour-coded to give the intensity of the rainfall.

The perspective line drawing shows a typical Weather Radar station, through the cut-away skin, and the various pieces of equipment that are needed. The aerial inside the plastic dome rotates at approximately one revolution per minute about a vertical axis, scanning just above the horizon to detect the rainfall.

The Cobbacombe Cross radar in Devon has an updated design which includes 'Doppler' processing and sensing. This gives a measure of the movement of the rainfall at an instant. Up to now, it has only been possible to detect movement using a series of time-lapsed frames. This new system can produce single frames that show all the relative movements that are contained within an area of rain.

It is hoped that this new facility will also provide useful information for the detection of squalls and wind shears. These are both potentially dangerous conditions for aviation, which are otherwise difficult to locate. It can also process data from a greater range of elevations than previously to provide three dimensional views of the atmosphere. This means that the upper air can be reviewed, to gain more insight into the depth of the precipitation and the potential volumes of water falling. More effective removal of ground echoes will improve the rainfall intensity information which will remain the main operational application of the radar.

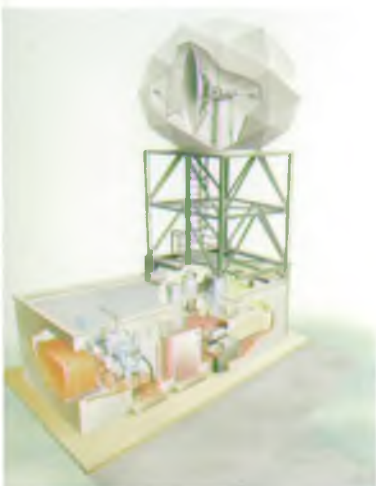
Should the facility prove to be effective then it is planned to introduce it at other stations within the network.

## 5. WEATHER RADAR IN COVERAGE

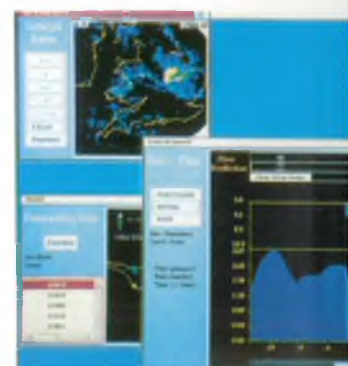
Because of the curvature of the earth, one radar is not able to cover the whole country. The Met. Office, with the help of the National Rivers Authority, Department of the Environment, The Ministry of Agriculture, Fisheries and Food, the Scottish Office, Northern Ireland Departments, Devon County Council, The Water Research Centre and the Greater London Council has equipped 12 stations and joined the outputs of these with the outputs from 3 stations in the Irish Republic and Jersey, to give coverage of the whole of the British Isles. Siemens Plessey Plc have produced all the Radars in the UK network.

## 6. WEATHER RADAR DISPLAYS

For its own purposes, the Met. Office has displays of Weather Radar data at virtually all of its operational stations. There are also several other organizations who take the data and display it. Data are broadcast from either Met. Office Headquarters at Bracknell or from one of the radar sites via telephone links to the customer. It is then processed by computer. The computer can store the pictures, display a sequence of pictures or a single image or a running total. A variety of background maps can be added and the display zoomed to an area of interest by the user.



Layout of a Weather Radar Installation. The dish is protected and the building houses the on-site processing facility.



A Weather Radar Processing Facility screen.

## FLOODING

Rivers have evolved to carry rainfall safely from the land to the sea, but at times of heavy rainfall, they can rise above their banks, flooding surrounding low-lying areas. These areas – called floodplains – may include towns, villages and industrial areas as well as farmland. Many parts of the coastline of England and Wales have also been developed and during severe stormy weather, these areas can be threatened by flooding from the sea.

## THE NRA AND FLOOD DEFENCE

Under the Water Resources Act 1991, the National Rivers Authority has a general supervisory duty, and other statutory powers, for flood defence throughout England and Wales.

It is the role of the NRA to:

- provide effective defence for people and property against flooding from rivers and the sea
- provide adequate arrangements for flood forecasting and warning.

To achieve these aims, the Authority spends over £250M each year and employs over 3,000 staff throughout its ten regions on flood defence work. This work includes:

- providing and operating a flood warning service
- maintaining river channels, sluices, pumping stations and other flood defence structures
- building new flood defences where justified.

## THE NRA FLOOD WARNING SERVICE

The NRA Flood Warning Service operates throughout England and Wales.

### Phase 1 – Flood Forecasting

NRA staff monitor weather, rainfall and tidal and river levels continuously so that they know where flooding may occur, determine the severity of the flood, and the extent of areas that may be affected.

### Phase 2 – Flood Warning

Flood warnings are issued to the public via the police. (Each year, over 100 flooding incidents occur and many more warnings are issued). The NRA aims to issue warnings for key areas four hours in advance of a potential flood, where it is feasible to do so.

### Phase 3 – Emergency Response

The Police and Local Authorities are responsible for ensuring that flood warnings reach those in threatened areas and for assisting them in relief from actual flooding. NRA flood defence teams ensure that rivers and culverts are kept clear to minimise the impact of the flood.



Information of rainfall allows the NRA to predict and warn of likely flooding.

## FLOOD FORECASTING

Flood warning systems had been in operation in England and Wales for over 30 years before warning systems for tidal flooding were introduced following serious flooding along the East Coast of England in 1953. The main impetus for the development of flood forecasting and warning arrangements for inland rivers was the flooding in Southern England in 1968.

The provision of an effective flood warning service is a top priority for the NRA. Improvements are constantly being sought and a major programme of research and development has been established.

During the 1970s and 1980s, universities and research institutions increased research into flood forecasting. Their work ranged from determining how to measure rainfall by radar to developing hydrological models for use in forecasting river flows. Other research is investigating how the measurement of rainfall, ground wetness and rainfall running-off the land can be developed with modelling to help forecasting. Advances in modelling techniques are offering opportunities to provide more exact flood predictions. An evaluation of the different systems operated by the NRA regions is being carried out to identify the range of options.

### Weather Radar Data

With the exception of Northumbria, all NRA regions are now equipped with weather radar displays showing the intensity and distribution of rainfall. Most regions receive data from a local site, and information from the network of weather radar sites throughout the country, at their flood forecasting centres. In some regions, NRA staff have access to radar displays when monitoring from home. Radar-based estimates of rainfall can be used to model how rivers will react and together with raingauge readings, can be used to provide early forecasts of flooding.

The NRA has improved the reliability of radar rainfall estimates by increasing the accuracy and consistency of measurements taken from its extensive raingauge network. Under certain weather conditions it can be difficult to forecast rainfall accurately by weather radar and NRA research is looking at practical methods of improving reliability in these cases.



**Flooding can cause widespread damage, as seen here in Truro.**



**NRA staff in action to minimise the effects of flooding.**

## **Frontiers**

The 1980s saw the expansion of the use of weather radars in the UK, along with the availability of data from a wider European network. By 1990, the Meteorological Office FRONTIERS project was able to produce high quality network data and distribution of quantitative rainfall forecasts.

The FRONTIERS system makes it possible to see rainfall patterns developing and moving by incorporating information from satellites. This helps to provide even earlier warnings of flooding. The system is to be developed further to improve forecasting of showers and thunderstorms which can grow and change direction fairly rapidly.

The National FRONTIERS rainfall forecasting system is being supplemented by a local radar-based forecasting system developed by the NRA and the Institute of Hydrology. This will be used in particular to track the movement of storms on a local scale.

## **Flood Warning**

Warnings of flooding on rivers are issued when river flows reach specified levels at points upstream of flood risk areas. A tidal warning is issued when weather forecasts predict that a surge on top of the normal high tide range is likely to overtop sea defences.

The National Flood Warning Service uses three flood warning codes, each one associated with the type of area and the flood risk. These are briefly summarised below:

### **Yellow Warning**

Agricultural land and minor roads are likely to be flooded, but flooding of property is not expected.

### **Amber Warning**

Agricultural areas and isolated properties are likely to be flooded.

### **Red Warning**

Residential and commercial properties are likely to be flooded.

NRA flood warnings are issued to the police. They become increasingly detailed as surveys of areas which may potentially be flooded are completed and subsequent police warnings to the public will specify which areas are likely to be affected. The police are responsible for assessing the impact of the flood against a number of categories including public safety, flooding of property and agricultural damage.



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FOR FURTHER INFORMATION  
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or

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