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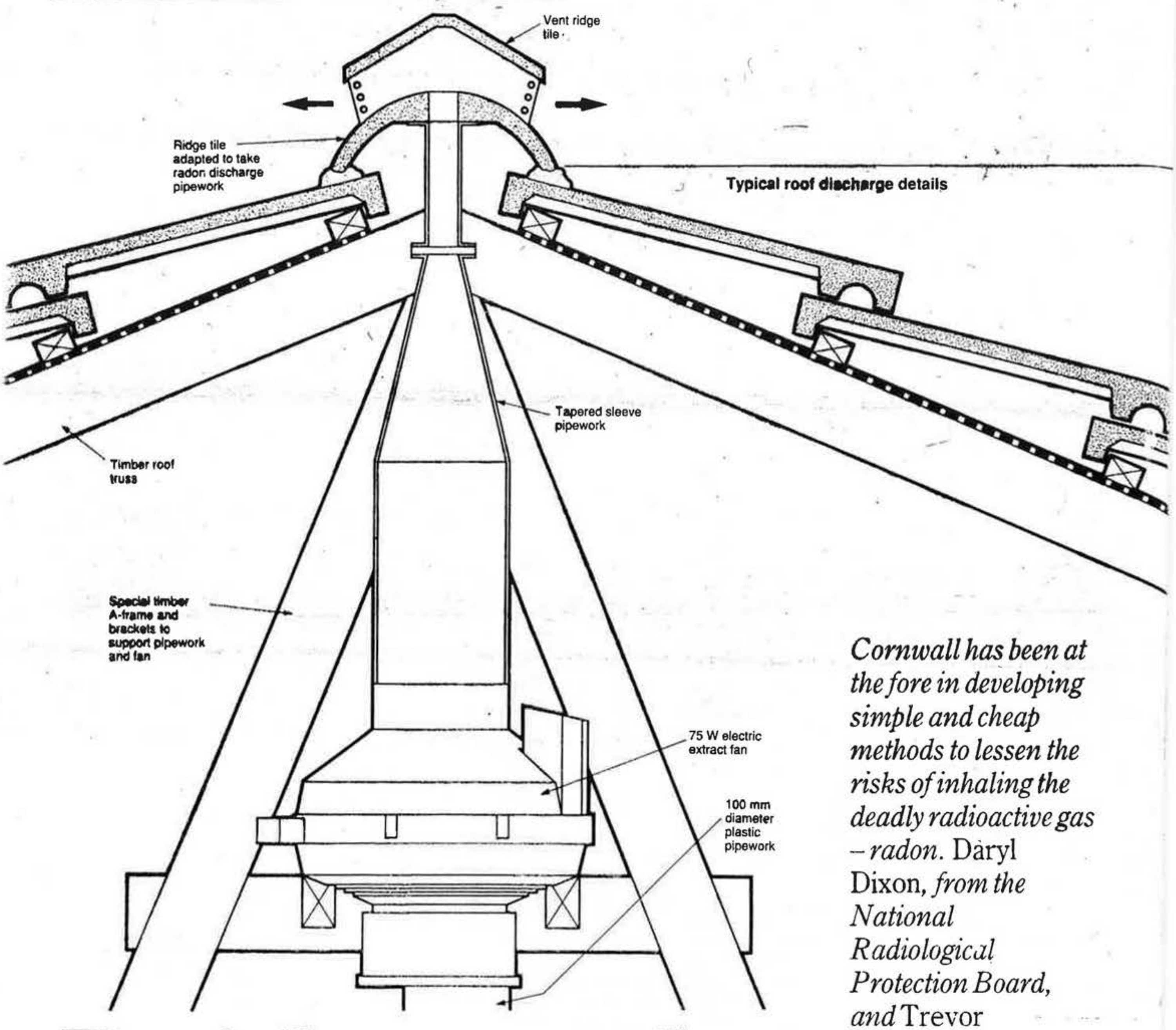
TECHNOLOGY



Raid on radon

Cornwall has been at the fore in developing simple and cheap methods to lessen the risks of inhaling the deadly radioactive gas – radon. Daryl Dixon, *from the National Radiological Protection Board, and* Trevor Gregory, *from Cornwall County Council's architects department, report.*

CORNWALL has the highest levels of radon gas in the UK with an average concentration of about 110 becquerels/m^3. One-fifth of all Cornish homes infringe the Government's action level of 200 Bq/m^3.

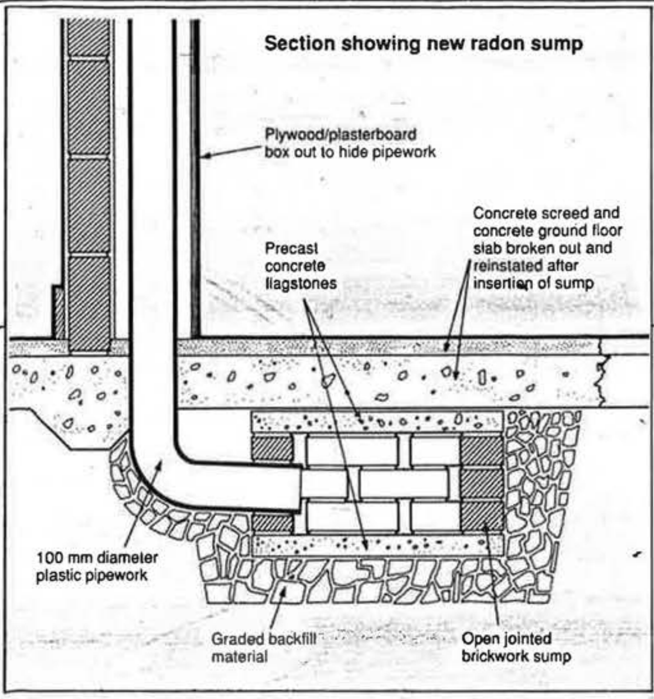
So it is not surprising that Cornwall County Council has been at the forefront in developing cheap and easy remedial measures to curb ingress of the deadly gas.

CCC has pioneered three methods for reducing radon penetration into buildings: constructing radon sumps; underfloor extraction; and creating internal pressures higher than those outside to lessen gas ingress. Of the trio, the insertion of radon sumps beneath solid floors has proved the most encouraging.

A radon sump consists of a small pit excavated through the floor to the underlying permeable layer of aggregate or fill. At its simplest, it can be constructed by putting a precast concrete paving slab at the base of the excavation, laying three courses of open perpend brickwork to form a square sump and resting another flagstone on top. Plastic underground drainage pipes run from the sump to vent outside the building.

Radon is drawn into the sump by a low-powered fan, fitted near the end of the pipework, and then discharged harmlessly into the outside air. Air drawn from the ground may be damp so all rigid sections of the pipe are laid with a generous fall towards the sump to limit the amount of condensation that can collect inside the pipe. For the same reason, flexible connections are mounted as near as possible to the vertical, and the fan rotors are fitted within 15° of the vertical to prevent water collecting in the casing.

Fans rated at 75 W produce a pressure difference of about 100 pascals and, operating continuously, cost about £40 a year to run at current electricity prices. The fans used by CCC



Section showing new radon sump

were obtained from Roof Units Group of Dudley for about £80 each, but any fan with a similar specification is likely to be effective.

A single sump, with a volume of around 1 m^2, has been found to draw radon from an area of about 230 m^2 and reduce indoor concentrations to as little as 6% of their former level in both old and new buildings (see table 1).

In buildings where radon appeared to be coming uniformly through the whole area of floor, particularly with old and fractured concrete floors, sumps were placed in the centre of the buildings to gain maximum effect. In large buildings, several sumps were used, one for each area of 250 m^2.

If the main source of radon in a building was localised (near floor edges, slabs or around service entry points), sumps were set near the suspected source to improve efficiency. Generally, however, source information was unavailable and sumps were placed centrally.

Research experiment

A very small sump was installed in one house simply by boring a 100 mm diameter hole through the floor and manually removing loose material around the hole. The sump was then filled with pea gravel and the end of the extract pipe covered with mesh to prevent movement of the fill. The small fan sump proved effective.

Radon extraction systems installed by CCC have been arranged with as much of the pipework as possible at reduced pressure, so that any leakage from mechanical damage or at joints only allows room air into the system rather than radon out into occupied areas of the building. Fans are normally mounted at the end of the pipework furthest from the sump, either outside the building or in the roof void, but not above rooms where their noise may be intrusive.

Outlets from radon sumps have been taken successfully through slates and wall grilles, ensuring in all cases that the outlet runs clear of the building and is carefully sealed to avoid gaps where radon might re-enter the building. Outlets are often fitted with cowls or meshes to keep out rain, birds or insects, and positioned, where possible, at least 1 m from windows and air intakes.

In another case, the council experimented by placing the sump outside the external wall of a bungalow. Radon-polluted air from under the floor is drawn through holes formed in the foundation wall next to the sump. Nevertheless, the sump was effective for an area of about 100 m^2 under the building. Care was taken to ensure that outside air was not drawn through the disturbed ground by placing a sheet of heavy-gauge polythene over the sump and covering it with soil or concrete for at least 1 m around the excavation.

Apart from the sump methods for solid floors, CCC has increased ventilation under buildings with suspended floors. Natural ventilation under suspended floors was increased in some buildings by increasing the number of air bricks or with larger grille sizes, but this produced only small reductions.

Much better results have been produced by fitting fans below floor level to provide mechanical assistance. The increased flow of fresh air drawn through the underfloor space from the inlets dilutes radon to much lower concentrations before it enters the building proper (see table 2).

To avoid air being drawn from the rooms above, which would lessen the efficiency of subfloor ventilation and aggravate energy loss, 1000 gauge plastic sheeting can be used as a membrane across the whole floor. The sheeting is fixed behind skirting boards and sealed with mastic. Hardboard panels are placed over the membrane to provide a durable surface and fixed to existing floorboards at regular intervals with a staple gun.

An efficient through-draught for sweeping radon from under the floor was obtained by fitting air bricks with large and unobstructed openings at points furthest from the fan in opposite and neighbouring walls. Any air bricks that could have deflected the air flow were sealed, and steps were taken to avoid stagnant areas.

The third method that has met with some success has been to use commercial ventilation equipment which blows air from the loft space into the occupied space. The increase in pressure tends to help stem the ingress of radon and provides increased ventilation which dilutes the radon. Maximum benefit from such equipment is obtained in buildings with low natural ventilation, and the equipment is less suitable for well ventilated buildings where substantial radon reduction is required.

The killer gas in 100 000 homes

RADON GAS occurs in all buildings at concentrations that vary from below 20 Bq/m^3, the national average for UK homes, to more than 100 times this value. The National Radiological Protection Board has recommended an action level of 200 Bq/m^3 for homes (see page 29).

The lifetime risk of contracting lung cancer for persons occupying houses at the action level is about 3%.

Exposure to radon in workplaces is subject to the Health and Safety at Work Act.

NRPB surveys to date of radon in homes have led to the identification of 3000 properties at the action level. This number is increasing steadily. The total number of homes in the UK at the action level is estimated to be about 100 000. Geographical distribution is very uneven, with about two-thirds of the total in Cornwall and Devon.

Table 1: Reduction in radon levels using sumps

Building	Sumps	Ground floor area (m^2)	Radon concentration (Bq/m^3) Before	After	Reduction factor
College	1[a]	500	1640	140	12
Medical centre	1	100	1290	70	18
School	3	200	730	80	9
School	4	450	970	120	8
Bungalow	1[b]	75	860	70	12
School	1	650	530	50	11
Offices	2	100	1150	150	8
School	5	500	770	70	11
Commercial	2	50	1480	90	16

[a] Whole basement used as sump; two fans
[b] External sump

Table 2: Reduction in radon levels using underfloor ventilation

Building	Ground floor area (m^2)	Radon concentration (Bq/m^3) Before	After	Reduction factor
School	400	750	160	5
School	250	1770	370	5
Commercial	90	4240	90	47