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BRITISH ORGAN BUILDING

CHURCH HEATING and the ORGAN

Advice for those who have the care of the organ
Any reference to the organ means a pipe organ

HEATING. A helpful short book, published in 1996 by the Council for the Care of Churches, is called **Heating Your Church** (ISBN 0 7151 7570 X). It explains in simple terms the general principles of creating a warmer atmosphere, how to get the best out of your system, how to avoid draughts, and so on. It also points out that no two churches are the same, and that the same system is not going to work in every church.

Organ builders are not heating engineers, and advice on heating should be sought from a specialist. But it is important to consult your organ builder as well, because not all heating engineers have experience of organs, and the recommended system may need re-planning to take account of the organ.

THE ORGAN. A good organ can last for centuries if well cared-for, and can be a great treasure for the music of the church. It is probably the single most valuable item in the building. But it can be permanently damaged by the heating, as can any other woodwork such as pews, panelling, carving or pictures.

Organs are constructed of wood and leather, both of which are affected by the moisture content in the atmosphere. These materials absorb moisture and swell if they are damp; they shrink and crack if the atmosphere is too dry.

TUNING. The church has an organ to make music, and the organ sounds best if it is in tune. Tuning varies with the temperature, and not all pipes are affected equally. If the church is colder or warmer than it was when the organ was tuned, the organ may sound “out of tune”. So it is best to tune the organ at its ‘Sunday’ temperature.

Heating systems which bring the building up to temperature slowly will create less air movement and disturbance than systems which heat the air quickly. Warm air rises, and in some churches the top of the organ can be many degrees warmer than the people in the pew. Draughts passing through the organ pipes will affect the tuning, causing different ranks of pipes to be at different temperatures.

THE BUILDING. Many of our finest churches are very old, and have lasted for centuries (without heating). Careful maintenance is important. Regular attention to guttering is a simple example. Water damage can be expensive to put right.

People will not want to be in church if it is cold and draughty, and conditions should be comfortable if the church is to feel welcoming. Gentle heating can be good for the building by preventing damp conditions from developing, but unsympathetic heating systems may encourage problems in woodwork, stone and roofing, as well as the organ.

For general information, see:
Sounds Good: A guide to church organs, for incumbents, churchwardens and PCCs (ISBN 0 7151 7594 7)
published by Council for the Care of Churches, Church House Publishing, Great Smith Street, London SW1P 3NZ

HEATING, HUMIDITY and related matters

A. BACKGROUND HEATING OVER AN EXTENDED PERIOD

Churches which are gently heated over a long period will feel warmer because the stonework (and pews) will be temperate, and the air will be drier than in churches which are heated quickly. The church fabric will act as a radiator.

- **Radiators spaced round the building, connected by hot water pipes**
  - a good system introduced during the 19th century. If an existing system is in need of improvement, it is usually more cost-effective to replace the boiler than to replace the system.
  Some firms recommend radiators placed near the walls. The aim is to use the brick or stone as a storage heater and to discourage downdraughts.
  Background heating is sometimes used in combination with localised heating (e.g. infra-red heaters or fan-assisted radiators) to boost the heating for short periods.
  Radiators and heating pipes should not pass through, beneath or round the organ. If this is unavoidable, very careful insulation of the pipes is essential.

- **Underfloor heating**
  This warms the fabric gently, giving a stable environment: high capital cost but lower running costs. *Heated surfaces should not be beneath any part of the organ*

A warm radiator, or storage heater, gives out warmth which we can feel when the air is cold. The opposite is also true: walls, floor and pews can radiate cold, and take the heat away from us even when the air has been heated.

Instead of heating the church just for Sundays, it is worth considering keeping the heating on at a low level throughout the winter. Continuous background heating is better for the fabric of the building. (A sudden increase in temperature causes materials to expand rapidly, with the surfaces nearest to the heat being the most affected.) Fuel costs may be 10% higher in a church which is continuously heated (say to 10ºC) when unoccupied, but the long-term cost of maintaining the building may be less.

Surveys of buildings with continuous heating have showed significantly fewer instances of dry rot than are normally found in those with intermittent heating.

B. RAPID HEATING WHICH DOES NOT WARM THE FABRIC OF THE BUILDING

- **Systems designed to heat the people without heating the building**
  Quartz and infra-red heating are cheap to instal. They do not affect the building, which remains cold and damp unless background heating is also installed.
  Quartz-ray heaters should be at least 5 metres from an organ.

- **Individual heaters, turned on when required**
  Electric heat bars and gas heaters: low capital cost, but high running costs. They do not warm the building, and may cause condensation.
  The quick rise and fall of temperature is unfavourable for organ tuning.
  Any flueless gas heater, such as LPG (bottled gas), increases the moisture content significantly, making the building damp.
  This may have a bad effect on the organ mechanism.

We are grateful to many experts who shared their knowledge, including Colin Bemrose, Nick Carter of Giffords, Tobit Curteis, Christopher Dunphy Ecclesiastical Ltd, Julian Limentani, Michael Powell of ECC Consultants, and Robin Wright of Lightwright.

- **Fan-assisted radiators** raise the temperature quickly and can be noisy.
  Rapid changes of temperature can affect the organ tuning.

- **Hot-air systems: "forced-air heating"**
  Centralised hot-air systems should not be confused with fan-assisted radiators which may form part of the more traditional background heating using hot water pipes (see A above).
  Hot-air pressure heaters can raise the temperature from cold to 18°C in an hour or so. (The cooling period is also rapid.) The air becomes stratified, with higher temperatures at the upper level. Heat loss is huge (especially in the roof space). Generally noisy.
  These systems may cause condensation, with the walls and pews remaining cold and damp and radiating cold as they absorb heat from the air. Stone or marble surfaces (and the organ keyboard) may then be damp to the touch.
  Because of the rapid changes of temperature, the organ will be out-of-tune when the heating is on, because the separate parts of the organ will be at different temperatures. The organ may suffer long-term damage if close to the hot air vents.

DRAUGHTS

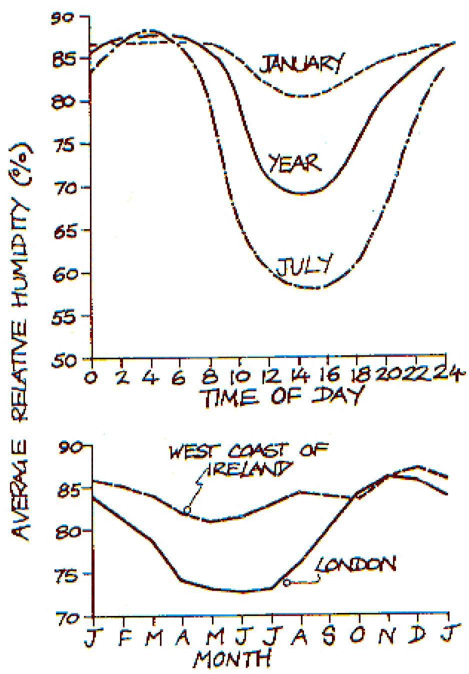
Warm air rises. Any space which is rapidly heated will draw in colder air (usually at ankle level) to replace the air which is rising.
Windows, especially large ones and clerestory windows, may cause downdraughts. The tower may cause an updraught, thereby losing heat.

HUMIDITY

In the UK the average outdoor humidity is about 80% relative humidity (RH), similar to that in an unheated church.
When the building is kept at 10-12°C, RH may drop to around 55%, especially in newer buildings. RH is likely to be higher in medieval churches, depending on the type of stone, some of which is very absorbent, acting like a sponge.
Any significant change in the dryness or dampness of the air in church affects all the woodwork: the roof, panelling, wall paintings, pews and organ.
No matter how well-seasoned, the timber will shrink or expand with changes in the atmospheric moisture content.

During the heating season, RH should not be allowed to fall for long below 55% or rise much above 75%. Readings below 50% are potentially dangerous because the dry air will draw moisture out of timber, and damaging stresses may develop in complex structures such as organ soundboards or pneumatic actions.

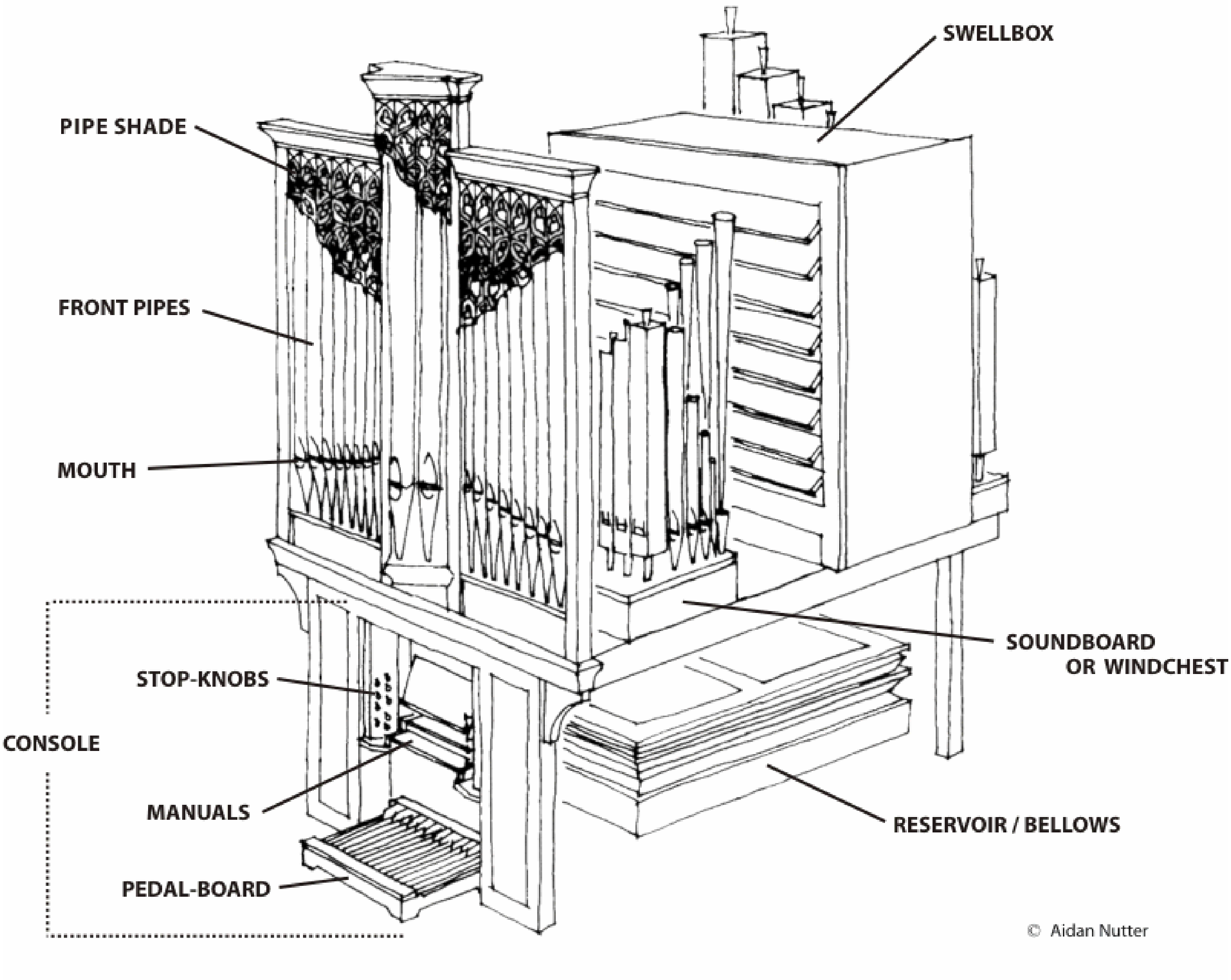
When outdoor humidity levels are lower (in summer and in frosty weather) the atmosphere inside the building will normally become drier.
When it is wet or misty outdoors, RH in the building will rise.
RH can be high in an unheated church at the end of a very cold period when outdoor temperatures rise and indoor temperatures remain cold; walls may become noticeably damp.
Outdoor RH drops significantly in March. Normal heating in the church combined with the lower humidity outside may cause RH in the church to drop by a noticeable %.
Old organs often show signs of distress towards Easter.



The National Trust aims at conservation heating, governed not by temperature, but by humidity (between 55% - 65%). [The aim is to preserve the artefacts and fabric of the building, rather than people's comfort.]

THERMOSTAT
For economic and practical reasons, every heating system should have an accurate thermostat (or sensor).
Its position needs to be chosen with care and should take account of the organ.
It should be tamper-proof (requiring a tool for adjustment) and should be controlled only by an authorised official who understands the implications.

VENTILATION
There is more than one opinion on ventilation: it depends who you consult.
Increased ventilation will encourage air movement, drawing in wetter, colder air (thereby losing heat) and possibly creating draughts.
Ventilation may be useful, especially in closed roof spaces, reducing the risk of condensation and its attendant problems of corrosion and fungal attack.
If church doors are left open on an unseasonably warm day, the surfaces inside the church become damp. (Warm air condenses on cold surfaces.) Best avoided.



A TYPICAL ORGAN

THE ORGAN

and what to expect if the organ is unhappy

The organ is a complex structure of wood and leather, with the following components:

- casework and framework of wood
- pipes of metal or wood. Even a small organ can have several hundred pipes.
  - All organs have flue pipes, which resemble a recorder in their construction.
  - Larger organs also have reed pipes, which are more complex, with the wind oscillating a brass 'reed' or tongue, controlled by a tuning spring.
- console
  - one or more keyboards covered in ivory (or a modern substitute)
  - pedalboard, and
  - drawstops, or stop keys, to control ranks of pipes (known as 'stops')
- soundboards / wind chests on which the pipes stand. Wind is admitted to the pipes by valves (pallets) connected to the keyboards; the ranks of pipes are selected by long wooden (or PVC) sliders connected to the drawstops. Soundboards are complex wooden structures: older soundboards can be damaged by excessively high or low humidity which may cause the components to swell or split.
- mechanism ['action']
  - *either* (a) mechanical [tracker] action: with a direct mechanical connection between console and pipes, using rods ['trackers'] and levers
  - *or* (b) pneumatic action: with many lead tubes connecting the console to the pipes, and a mechanism consisting of hundreds of fine leather components ['motors' and 'purses']
  - *or* (c) electric or electro-pneumatic action: with a low-voltage electric cable connecting the console to the pipes, and a mechanism actuated by electro-magnets
- swellbox (optional) enclosing one or more sections of pipes, with wooden louvres operated by a pedal
- reservoirs [bellows], to store the wind provided by the blower

NEW ORGANS are designed to withstand the normal variations due to heating.

OLD ORGANS are vulnerable to damage by excessive heat and low humidity and must be treated with special care. They will last for centuries in the correct conditions.
The organ is a complex construction of timbers. Variations in atmospheric humidity bring about unequal movements in timbers. It is the speed of change which causes shrinkage and shifting of timbers. If the heating is raised gently and restricted to moderate levels, the organ should suffer no damage.

Peterborough Cathedral is heated continuously in winter; the difference from floor to ceiling is only about 2°C. When trays of water were added to the base of two heaters for a month, it greatly eased the organ mechanism.

If the organ is subjected to overheating the following may occur:

- Soundboards may crack internally, causing runnings or murmurs; these can imply serious damage, expensive to correct
- Sliders may stick, so that stops will not pull out
- Trackers may dry out and crack, causing silent notes
- Leather will dry and split, causing cyphers or silent notes (in organs with pneumatic mechanism) or leaking bellows. Expensive to put right.

Sources of heat should never be located beneath or adjacent to the organ.

HEAT RISES: the top half of an organ may be hotter than the bottom half.
(Organ tuners normally check the temperature. One measured a difference of 15°C between the player at floor level and the Swell division 15ft above; another noticed a difference of 11°C between Great and Swell divisions).
An organ in a gallery is likely to be hotter than the people in the pews.

If the organ is above the source of heat, or if hot air is delivered close to the organ, the external parts may become dried out by the hot air and cause the timbers to split.
If the church is heated quickly, there may be a problem of condensation with warm air against cold surfaces, including walls, floors and metalwork.
"The organ is in an organ chamber some 25 feet above the only outlet from the forced-air heating. Six months after the heating was installed, every soundboard split, slides stuck, runnings everywhere, and tuning almost impossible. The difference between floor level and the organ was at least 20 °F (11 °C). Remedial work to the organ cost more than £55,000."

HUMIDITY levels in the church can be checked with a hygrometer (available from garden centres or suppliers such as Machine Mart or Farnell) or the more old-fashioned hygrograph. (A note of caution: some cheap hygrometers are very inaccurate.)
Levels of RH may change dramatically with rapid-heating systems:
"Humidity fell from 60% to 30%RH so fast that the recording barrel of the hygrograph did not have time to move, making it thus a vertical line drop over about half an hour."

PITCH
Generally rises with temperature. Contrary to popular opinion, the flue stops are affected more than the reeds. (Reed stops are more readily upset by dirt.) The reason that tuners often adjust the tuning of the reeds (rather than the flues) is that there are fewer reed stops and therefore the organ can be brought into tune more easily.

TUNING
All organs may sound out of tune when the temperature changes.
In summer, all departments of the organ will usually be at the same temperature (unless affected by heat from the sun).
In winter, when the heating is on, it is likely that the upper levels of the organ will be warmer than the lower levels.
The tuning of any organ is affected by the temperature. An organ should be tuned under normal Sunday heating conditions.

- If the church is heated quickly, the heat will not easily reach departments in the recesses of the organ chamber or behind other departments.
- With any system which uses fans to circulate hot air, the tuning will vary as the hot air moves through the organ. The pipework heats up rank by rank, sharpening the pitch as the heat moves through from the front. The Swell pipework, enclosed in a wooden box, will remain cooler for longer.
- If the organ is close to the main entrance of the church, cold draughts from the door may affect the tuning

ORGAN BLOWERS
The electric blower needs a source of air. If this air is drawn from outdoors, it is likely to be colder and damper than the air inside the building in winter.
The position of the blower may be relevant: it is important to avoid drawing in hot air from the boiler room.
Most blowers are designed for long running, but a blower which is left on for excessively long periods (e.g. overnight) may blow warm air into the organ (with the effect of a hair-dryer). Leather may dry out and crack, and in the worst cases the soundboard may split. A well-placed warning light will indicate if the blower has not been switched off.

HUMIDIFIERS

A humidifier can help to alleviate problems caused by dryness, but proper control of the heating system remains important.

Humidifiers supply damp air which circulates within the wind system of the organ when the wind is turned off. This can be of particular benefit to the leatherwork of electro-pneumatic or pneumatic organs.

Humidified air will only reach the parts of the organ to which blower-wind is delivered: it has no effect on external woodwork.

Unless correctly calibrated, the humidifier can cause damage by delivering too much damp air. Then magnet armatures may corrode. In the worst cases, leather and glue become saturated, requiring the reservoir to be releathered or the soundboard re-palletted (both costly and time-consuming operations).

Regular servicing of the humidifier is essential.

In ideal circumstances, a humidifier is not necessary, and it is of very limited benefit to organs with mechanical action.

DAMP CHASERS

Many organs suffer from damp. In some cases it is beneficial to instal a damp chaser (low-powered heater) to encourage circulation of the air and reduction of humidity in the organ, thereby trying to keep action parts from swelling.

Before any humidifier or damp chaser is installed, measurements of temperature and humidity should be recorded, and an assessment made by someone who understands the significance.

SHRINKAGE: drying of timbers caused by low humidity. Wood shrinks less longitudinally than it does across or round the grain. This is why some timber warps more than others (see drawings).

SOME SYMPTOMS, and possible solutions

- Stops won't come out, or stick half-way (causing acute problems with the tuning). The sliders may be binding in the soundboards due to shrinkage or dampness in the timber.
- Silent notes or cyphers (sounding notes) may be caused by dryness, e.g. the leather of the pneumatic motors cracking or the pneumatic tubing connections shrinking and causing leakage.
- Notes cyphering or whimpering: this could be a soundboard problem (caused by shrinkage).
- Runnings - unwanted notes which play when another note or a chord is held - can be a sign of splitting at the soundboard.
- Wind leaks may be caused by cracks or shrinkage in the wooden trunks.
- Coupling systems can get out of adjustment due to movement within the mechanism.
- Depth of key touch significantly reduced through movement within the mechanism. The organ-builder can adjust this, given time, but should not need to do so frequently.

If there is any possibility that the organ is suffering from shrinkage:

1. moderate the heating
2. place buckets of water (regularly topped up) in and around the organ
3. check the humidifier if there is one (and make sure it is serviced regularly)

SUMMARY

<table>
<tr><td colspan="3">BEST CONDITIONS FOR THE ORGAN during the heating season.
General guidelines, most particularly for old organs.</td></tr>
<tr><td colspan="3">Heating systems need to be carefully regulated to avoid the danger posed by low levels of humidity. A safe humidity range is as follows:</td></tr>
<tr><td>Relative humidity (RH)</td><td>55% - 75%</td><td>Readings below 50% are potentially dangerous</td></tr>
<tr><td colspan="3">Heating systems which heat up and cool down slowly are best for the fabric of the building, and for the organ.</td></tr>
<tr><td>Temperature (weekdays)
when church is not being used</td><td>Not above 10°C = 50°F</td><td>Cold conditions will not harm the organ unless the church is damp</td></tr>
<tr><td>Temperature (Sundays)
when church is being used</td><td>Not above 20°C = 68°F</td><td>High temperatures may cause damage to the organ (through low humidity) if sustained for long periods</td></tr>
<tr><td></td><td colspan="2">NB the temperature in the organ may be higher than in the pews if the organ is tall, or in a gallery.</td></tr>
<tr><td>Temperature (for tuning)</td><td colspan="2">Normal Sunday temperature</td></tr>
<tr><td colspan="3">RH levels inside the church will reflect <u>outdoor</u> RH.
In frosty weather, outdoor RH is low.
Extra heating is needed to maintain ‘normal’ temperatures,
resulting in lower indoor RH and possible problems with the organ.
In wet or misty weather, outdoor RH is high.
The woodwork of the organ will absorb moisture.

A building heated from cold to 20°C within a few hours makes a sudden transition to a different climate, sometimes called ‘thermal shock’.</td></tr>
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Telephone & Fax: 01359 233433 e-mail: administrator@ibo.co.uk web site: www.ibo.co.uk
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