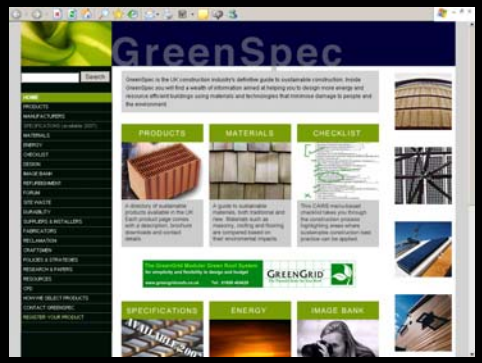


COMMENDED
The UK eWell-Being Awards 2004
www.sustainit.org

National Green Specification

www.greenspec.co.uk

Air movement in & about buildings 5 of 9 + Q&As

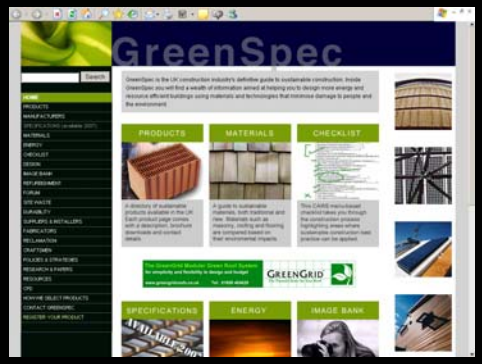
© NGS GreenSpec 2007 CPD in 10 parts

GreenSpec CPD Seminar Series

- Educational Objective:
  - Comprehensive introduction to subject: from wind to air-conditioning and a lot more in between
  - emphasis on environmentally sustainable solutions
  - design primer: addressing principles and solutions
  - technically rich: materials, construction, services & testing
  - Related GreenSpec CPD Seminars indicated
  - Questions and answers for each subtopic in file 10
- Audience:
  - Architecture Students Part 1 Year 2
  - CPD update for all levels of experience & knowledge
- Delivery:
  - 3 to 4 hours depending upon audience participation
  - Reading 1 hour
  - 26 subject breaks to enable subdivision

Air Movement in Buildings: 5 of 9 Sub-topics in 10 separate files

- Principles of Element Design
- Climate Change
- Wind
- Wind Tunnel Testing
- Wind Turbines
- Natural Ventilation
- Moisture Vapour & Condensation
- Thermal Insulation
- Breathing Construction
- Airtightness
- Wind & Airtightness Testing
- Building Elements
- Passive Ventilation
- Active Ventilation
- Stack Effect
- Atrium
- Solar Orientation & Solar Gain
- Conservatories
- Thermal mass
- Conduction, Convection, Radiation
- Solar Shading
- Thermal mass, Passive and active cooling
- Fluid dynamics
- Mechanical Ventilation
- Air-Conditioning
- Questions and Answers



National Green Specification

www.greenspec.co.uk

Airtightness & Testing

Off-site and on-site

Airtightness Testing

- Off-site:
  - Full scale mock-up
  - Weather, wind and structural distortion
- On-site:
  - Air leakage testing

Off-site full scale mock-up testing

- Test the design for appearance
- Test method & sequence of assembly and interfaces
- Test weather resistance of construction
- Sprague pipes: rain simulation
- WWII Merlin engine: wind simulation
- Air suction: to pull air and water in through leaky joints

Wind Simulation +ve pressure
OLYMPIC
TEL
Use ear protectors in this area
TEL
TEL

Mock-up of elevation

Rain Simulation

Back of chamber: -ve pressure

Deflection monitoring

Inspection for leaks

Detected Leaks: Windows went well
beyond design limit before leaking

Feedback into design/workmanship

- Observe, analyse, resolve
- Propose solutions, record
- Communicate, inform,
- Redesign if required
- Commit to improve workmanship where weak

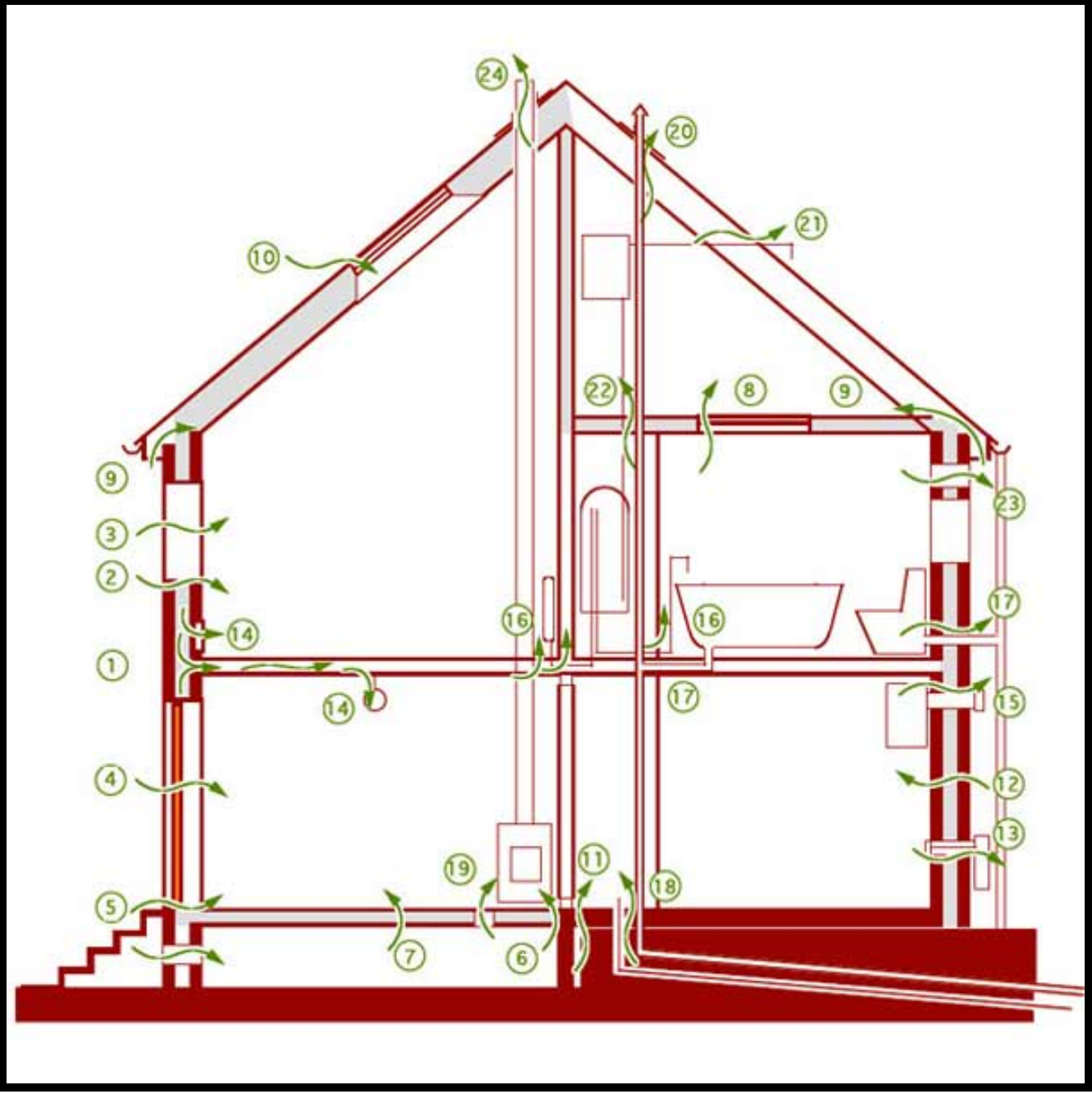
www.greenspec.co.uk

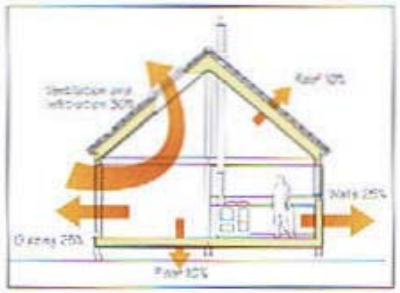
Airtightness

Regulation, Energy loss, Testing, Sealing, Construction

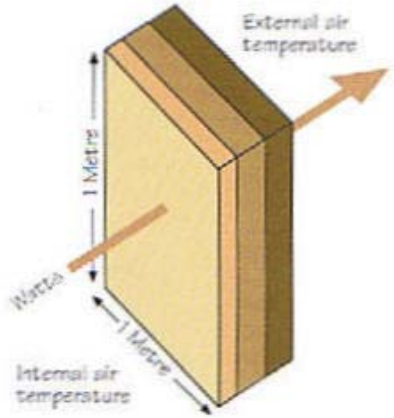
Another CPD seminar to consider

Leaky Buildings





8.8



8.9

Fabric, ventilation and infiltration losses

Fabric losses – the U-value

Heat is conducted through the fabric of the house and lost to the outside air b radiation and convection. The U-value is a measure of how many watts (rate of flo of energy) pass through one square metre of construction for every degre difference in temperature between the inside and the outside. So a U-value 6.0W/m²K (that of a single-glazed window) will mean that six watts will be escapin through each square metre of glass when the temperature difference is on degree. If it is 20°C in the house and 0°C outside, then the heat loss is 20x6=120W p square metre. Double-glazing roughly halves the heat loss, and so has a U-value 3.0W/m²K. The lower the U-value, the better the insulation.

Location	Construction	U-value (W/m²K)
Roof	Uninsulated loft	2.00
	with 100m insulation	0.30
	Room in the roof 200mm (2002 UK)	0.20
	Loft with 250mm insulation (2002 UK)	0.16
	Superinsulated 300mm insulation	0.12
Wall	Solid brick 225mm	2.20
	Uninsulated cavity brick	1.30
	Uninsulated cavity lightweight block	0.96
	Cavity of timber frame wall with 50mm insulation	0.45
	with 100mm insulation (2002 UK)	0.35
	Superinsulated 250mm insulation	0.14
Floor	Timber floor uninsulated	0.83
	with 150mm insulation (2002 UK)	0.25
	Superinsulated 250mm insulation	0.14
	Solid floor uninsulated (average house)	0.70
	with 100mm insulation (2002 UK)	0.25
	Superinsulated 200mm insulation	0.15
Timber window	Single-glazed	4.80
	Double-low-E 12mm airspace (2002 UK)	2.00
	Double-low-E Argon fill 16mm airspace	1.70
	Triple-low-E Argon fill or double super low-E	1.30

8.10

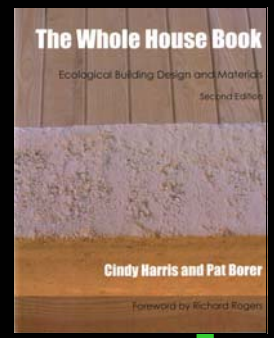
Terms used for U-value

W = watts, the rate of energy loss
m² = square metres
K = temperature in degrees Kelvin, each degree being the same as the familiar degrees Celsius or centigrade.

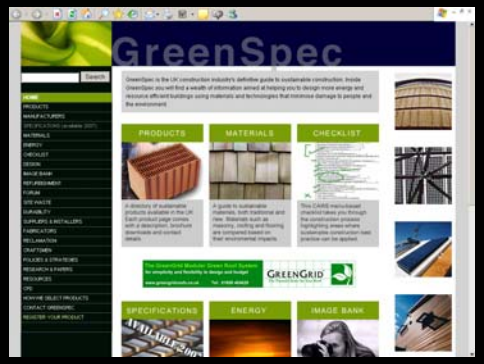
Fig 8.8 The proportions of heat loss from a typical house.

Fig 8.9 U-value is the rate of heat loss in watts per square metre of construction multiplied by the temperature difference.

Fig 8.10 Some typical U-values.



50% of heat loss is through the insulating building fabric and 50% through air leakage



Air Tightness

National Green Specification

www.greenspec.co.uk

- In past related to:
  - Windows and doors
  - Ground Floor Floorboards
  - Roof spaces (except Scotland, boarded)
- Now relates to:
  - Inadequately designed buildings
  - Badly built building fabric
  - Due to lack of understanding or training

© NGS 2004-7 Air Movement In Buildings

On-site Airtightness Testing

- Seal up the building openings
- Pump air in
- Reach a preset +ve pressure
- How much air is needed to maintain the pressure?
- = Air leakage rate
- Building Regulations permit 10 we struggle to achieve it
- 8 is a leaky building unusable in windy weather, due to air noise and drafts
- Europeans aim for 0.1-0.3

Airtightness Testing: Big buildings

8.12

8.13

Airtightness Testing: Small buildings

Panel in door opening includes fan, sucks air out

air infiltration through leaks

Smoke wand highlights leaks

ventilation, and are followed by a section on breathable co

Airtightness

beneficial energy saving measures available, both in financ

windows and how effective they are – at least until the glue

construction. To create a low-energy house, great care mus

through air infiltration. Having achieved airtightness, it is th

odours – 'build tight...ventilate right'.

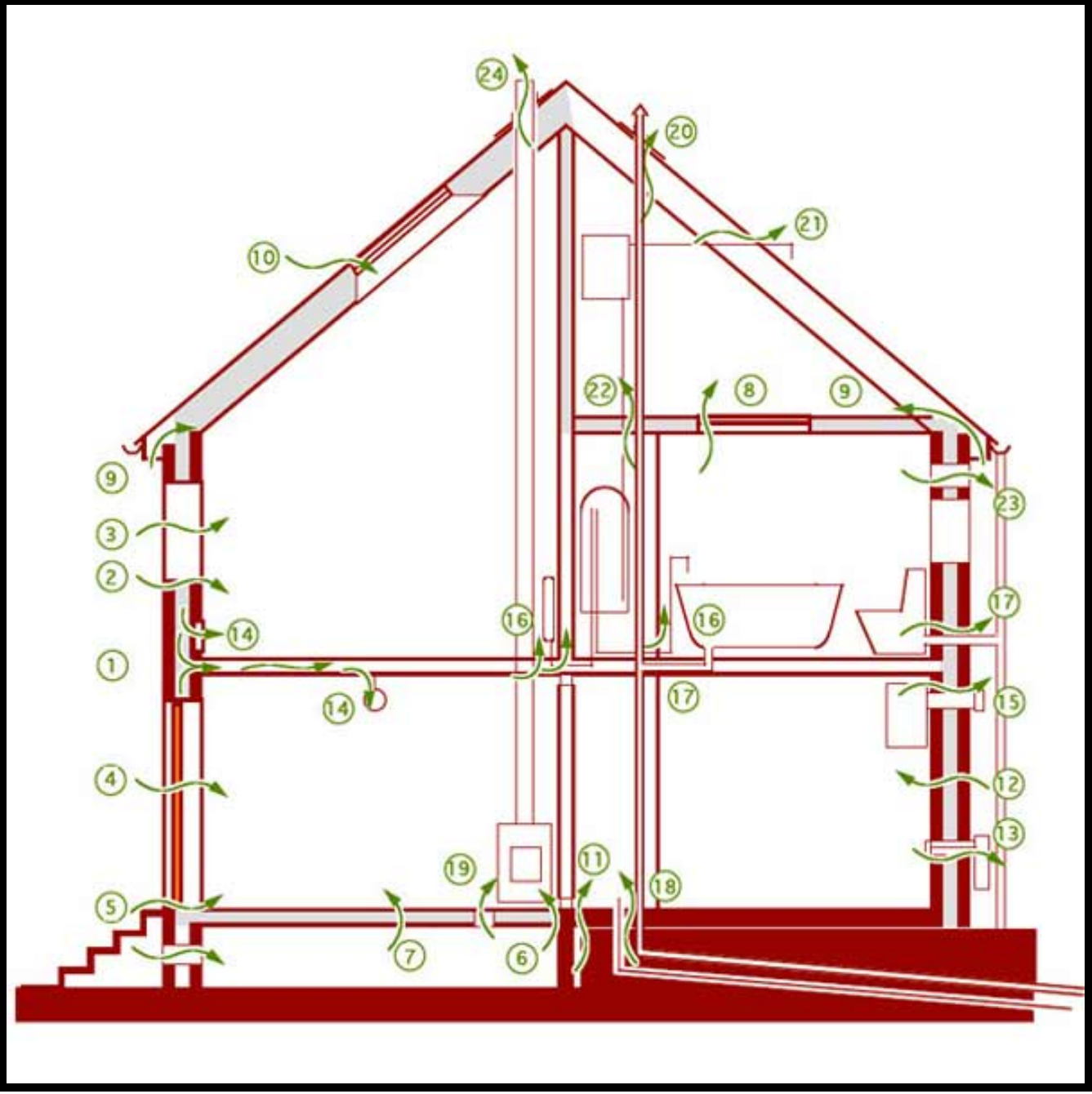
All new houses should be pressure tested for air infiltration

to a temporary front door and de-pressurising the ho

atmospheric pressure. It is then very instructive to walk around

construction: under the skirting boards, through cracks betw

Leaky Buildings

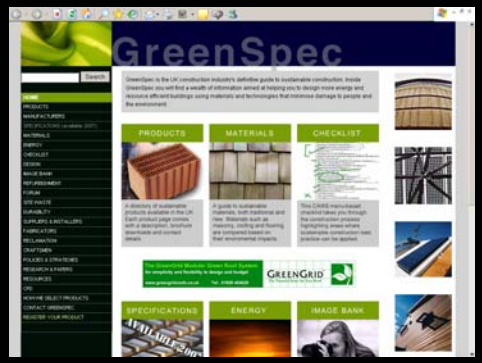


Vulnerable details

- Skirting:
  - Where are the slip layers and vapour barriers?
  - Do they lap and are they bonded?
- Floor level:
  - Do joists bear in walls how are they sealed?
  - mortar shrinks, consider joist hangers
- Light fittings:
  - Are they sealed or just a hole?

Timing of testing

- Has an impact on construction sequence and programme
- Test building structure and building fabric
- Envelop substantially complete
- No finishes yet
- No cavities behind linings to complicate leak finding
- Test and fix leaks in the structure and fabric
- Then complete the finishes
- All sealants hidden behind finishes



Sealants?

National Green Specification

www.greenspec.co.uk

- Use to seal the leaks?
- Benign type of sealant?
- Linseed oil putty is natural plant extract but not appropriate
- Oils will leach out into absorbent materials

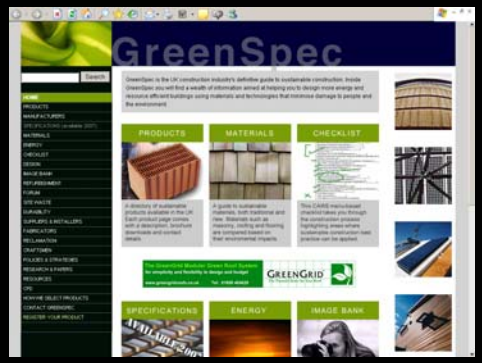
© NGS 2004-7 Air Movement In Buildings

Foamed insulation?

- Use to seal the leaks?
- Petrochemical: non-renewable
- Blowing agent: ZODP Zero Ozone Depletion Potential essential

Air leakage

- Building Regulations Approved Document:
  - L1A, L1B, L2A, L2B Thermal Insulation
    - Robust Details
    - Thermal insulation avoiding Cold bridging
    - Airtightness? Possibly
  - E Acoustic Insulation
    - Robust Details
    - Acoustic detailing
    - (contributes to airtightness if addressing external walls)

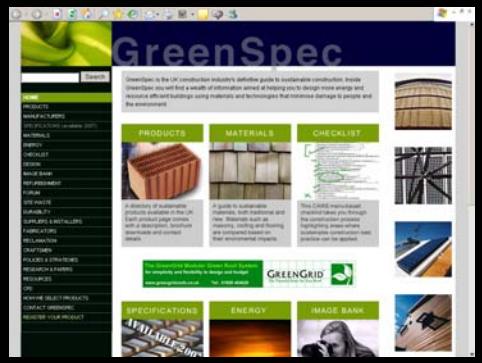


Cold bridges

National Green Specification

www.greenspec.co.uk

- Not normally an air passage out through construction but a thermal conduction route
- Usually solid materials with low insulation performance in contact with each other
- Forming a chain from inside to outside
- Usually load-bearing elements
- E.g. Foamglas Perinsul load-bearing recycled glass thermal insulation into base of walls



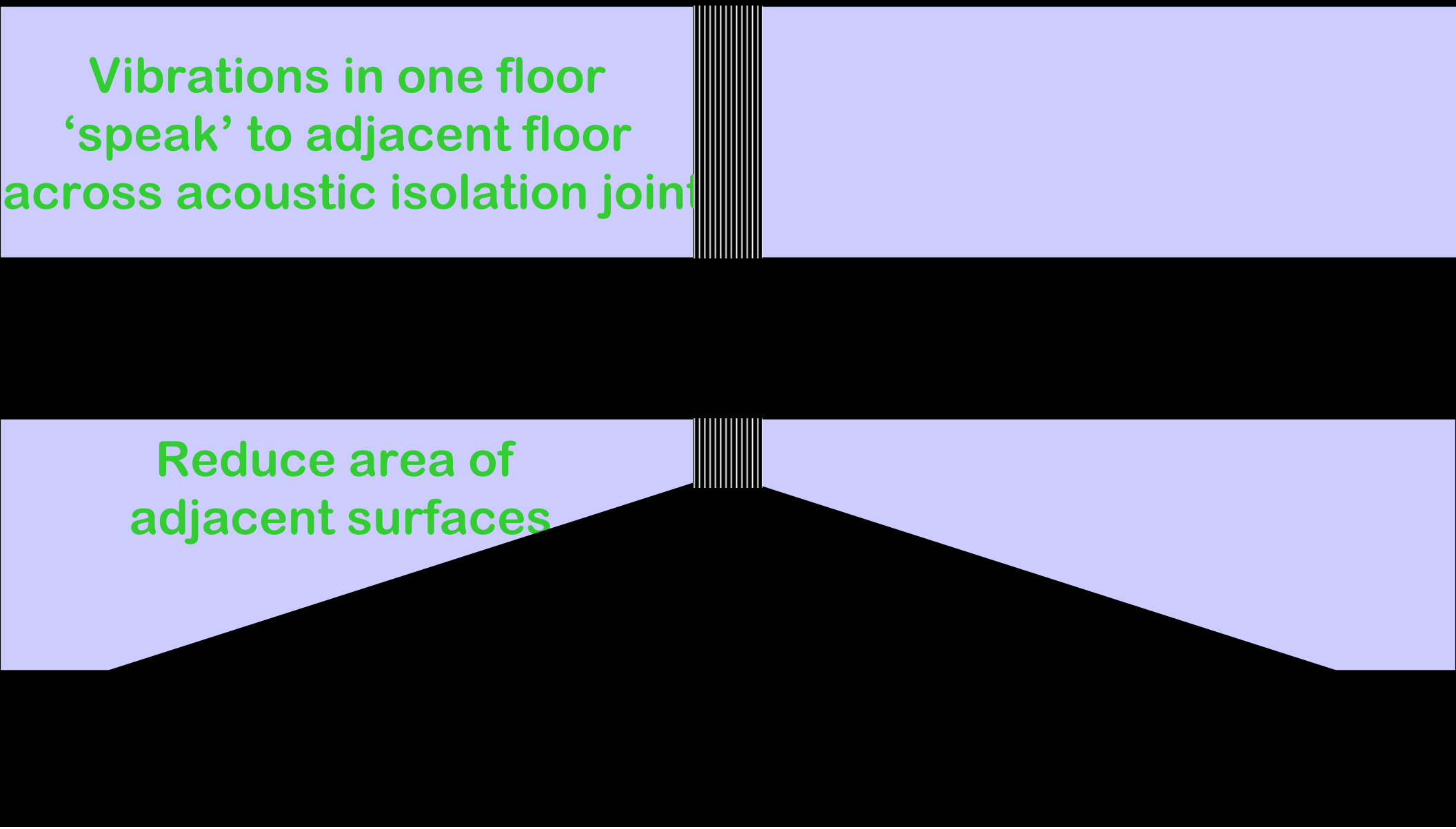
Acoustic bridges

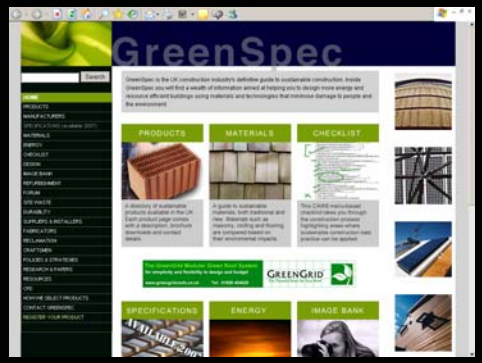
www.greenspec.co.uk

- air passage through construction linking between rooms or from inside to outside
- Acoustic conduction route
- Surfaces either side of a gap can also talk to each other
- Reduce floor edge thickness at isolation joints

© NGS 2004-7 Air Movement In Buildings

Airborne sound transmission





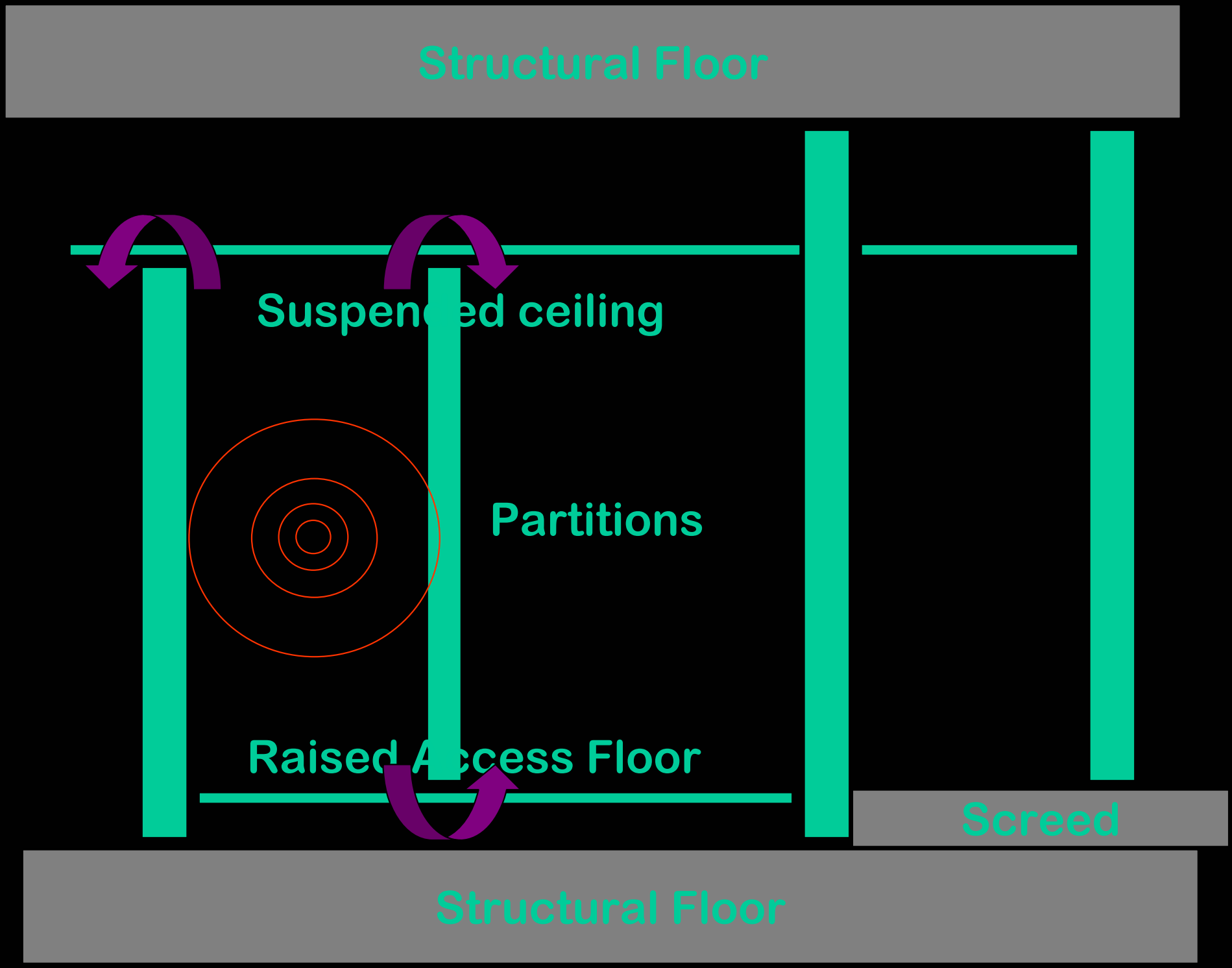
Flanking Sound

National Green Specification

www.greenspec.co.uk

- Air paths around barriers
- Partitions are barriers, but sound can flank around them behind wall linings, over ceilings and below floors
- Barriers are needed in those cavities, aligned with the partitions
- They usually need density or air tightness to be effective

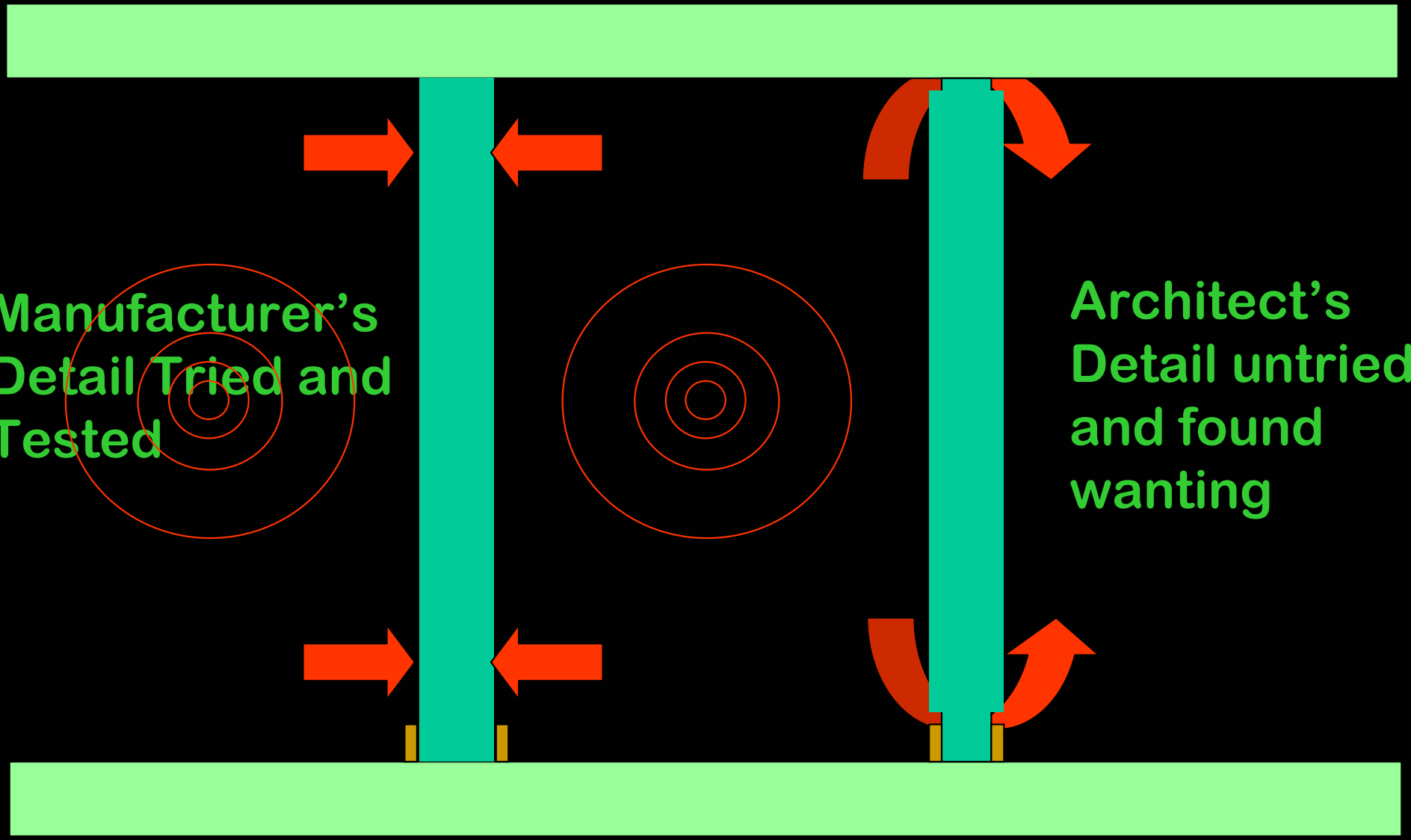
© NGS 2004-7 Air Movement In Buildings


Structural Floor
Suspended ceiling
Partitions
Raised Access Floor
Screed
Structural Floor

Hiccup Details

- Flash-gaps
- Usually happens when we modify the manufacturer's standard details
- Diminish the performance of elements
- Hiccups meeting hiccups can lead to problems and have been know to make holes through elements
- Fire, Acoustics, Airtightness

Hiccup Details (flash gaps)



Fire, Acoustics and Airtightness

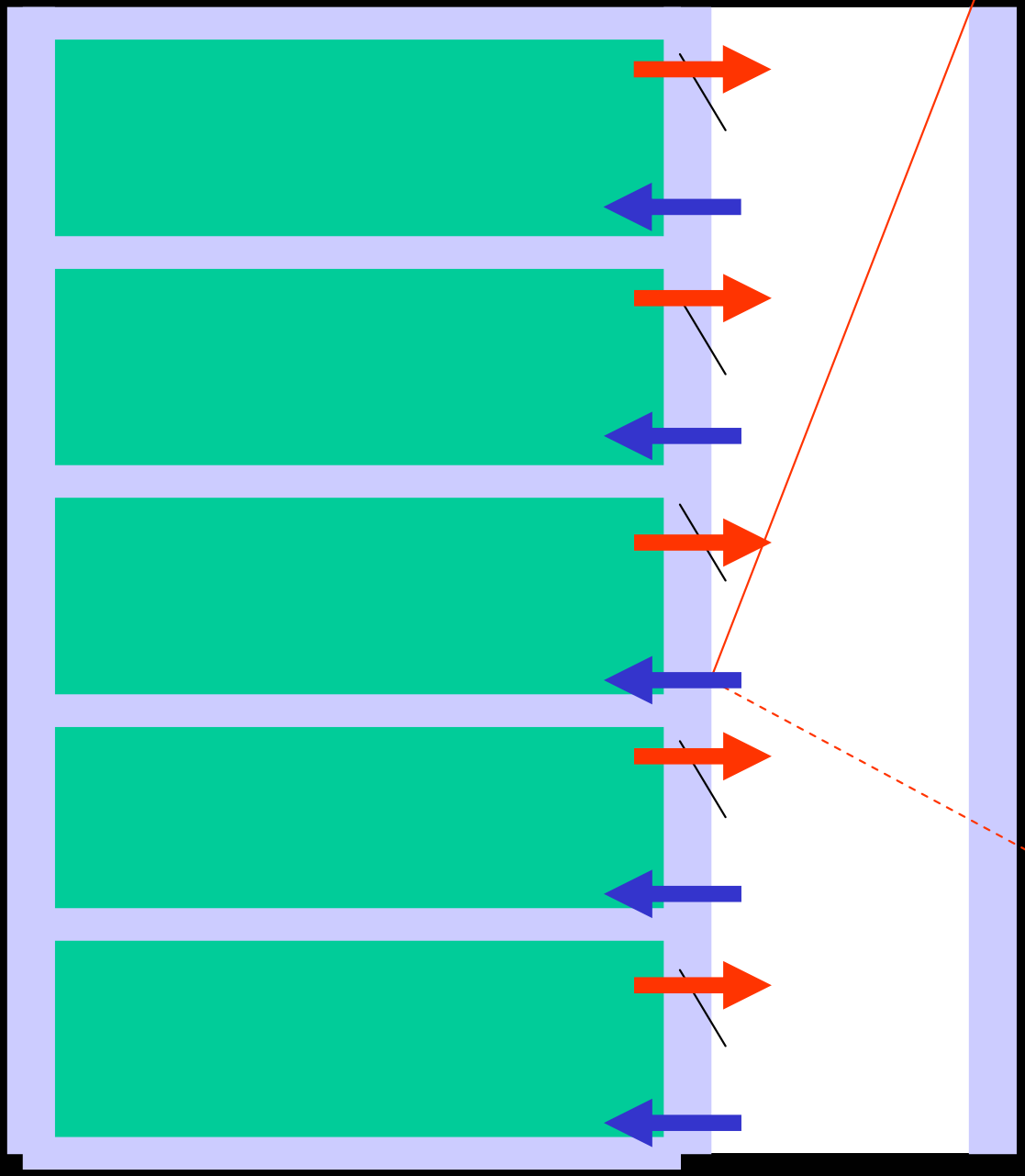
Robust Details v Airtightness

- Address thermal cold bridging
- Address acoustic bridging & flanking
- But do not address airtightness specifically
- Buildings complying with Robust details fail Airtightness testing
- BRE recently tested many buildings complying with Robust Details
- 30% failed airtightness test

Nat Vent/Acoustic Wells

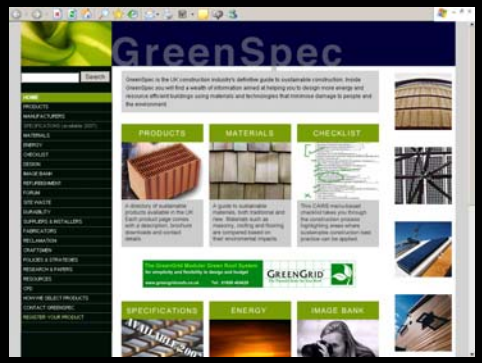
- Urban areas with high traffic noise create problems for natural ventilation of buildings
- Wells within the building offer long air path difference acoustic performance and an opportunity for natural ventilation from rooms to the well
- The well may include staircases
- Discourage them as smoking places

Light/Acoustic/Vent Well



Air path difference

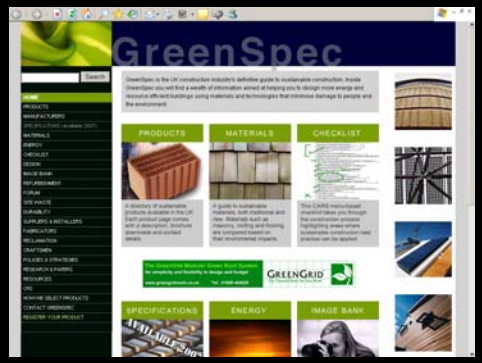
Noise Source



National Green Specification

www.greenspec.co.uk

Building Elements



Doors

National Green Specification

www.greenspec.co.uk

- Victorian buildings: leaky including doors
- 10 air changes per hour (1ac every 6 minutes)
- Trickle venting and no control
- Can be upgraded or refurbished
- Modern doors are higher performance
- Door with 10,000 mm2 opening e.g. letter flap = Window (B Regs)

© NGS 2004-7 Air Movement In Buildings

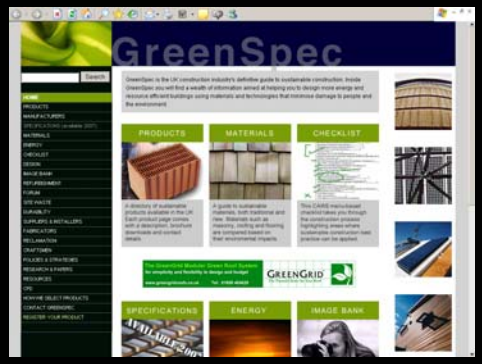
Reclaimed Timber Doors

www.greenspec.co.uk

L20 Doors/sets BWF-Certifire & FIRAS

Warrington Fire

Another GreenSpec CPD seminar to consider



Lobby or Porch

National Green Specification

www.greenspec.co.uk

- A second line of defence at doors
- External Porch of Internal Lobby
- Wind shelter, airlock (rarely effective) solar trap,
- Retrofit to buildings

Windows

- Victorian Buildings: leaky including windows
- 10 air changes per hour (1ac every 6 minutes)
- Trickle venting and no control
- Vertical sliding sash (unique to UK)
- Le Corbusier was impressed by them
- Heat out at top
- Cool in at bottom
- Half open at top or bottom
- Can be upgraded or refurbished

Vertical Sliding Sash Windows
Conservation
Quality
Refurbishment
Reading Oracle Site 2-4 London Rd. 7 Bridges Hs. Architect: Haskoll & Co.

Window and door refurbishment

- Victorian timber windows and doors 100 years old, why stop now?
- If in good state of repair consider upgrading with new DGSU and modify beads or frame
- If the Conservation Officer permits it
- Companies specialise in timber window refurbishment/upgrade
- Insitu or at factory
- Phased working to suit programme

Draft proofing VS Sash

Modern alternative

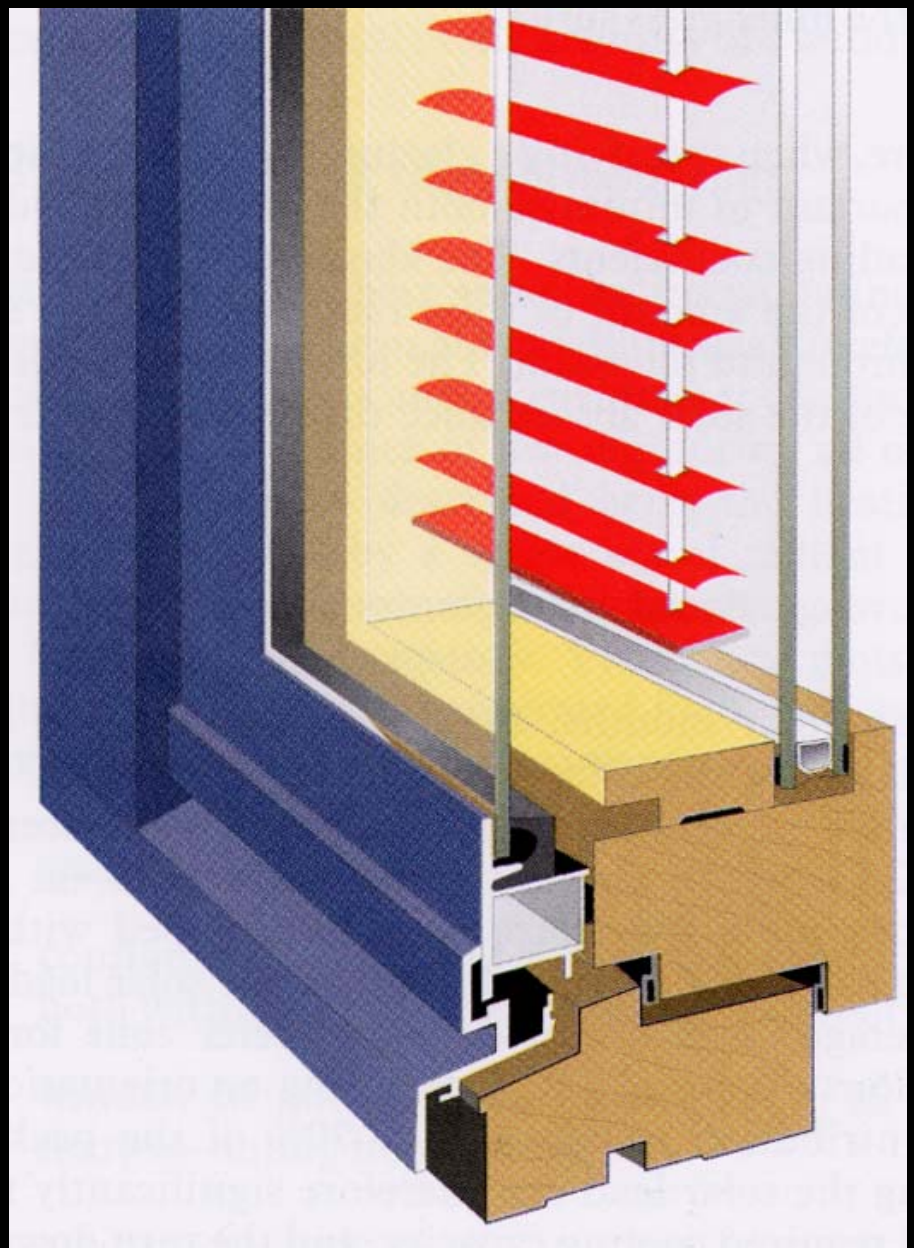
- Timber: 60 years with maintenance regime
- Timber/Aluminium composite:
- Vulnerable bottom bead and sills or outer casement in aluminium
- 60 years with maintenance regime
- Usually Scandinavian manufacture

High performance windows (and doors):

- < 1.0 W/m2K
- Low E coatings
- Gas filled DGSU & TGSU
- Double casement
- Solar shading blinds in cavity
- Trickle ventilation
- Controllable by occupant

High Performance Windows

- Aluminium outer casement
- Timber inner casement
- Treble glazed
- Dust free sun blinds



Reduce demand for all resources used by building

- Envelope Airtightness (build tight)
  - < 1 ach @ 50 Pa
- Appropriate ventilation (ventilate right)
  - 0.5 – 1.0 ac/h air change per hour
  - Heat recovery
  - Wind driven
  - Well controlled

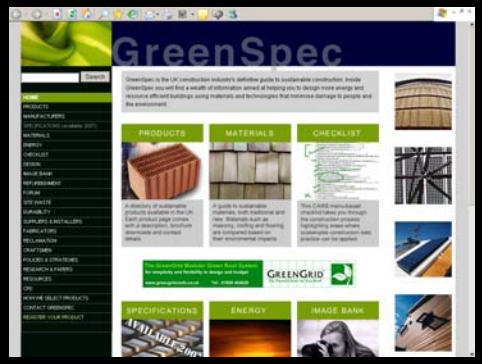
Vertical
Sliding Sash &
Sunscreens
Modern
interpretation
at Arup
Solihull
Office

www.greenspec.co.uk

L10 Windows

Hardwood (Oak?)

Another GreenSpec CPD seminar to consider



National Green Specification

www.greenspec.co.uk

GreenSpec Image bank

NGS GreenSpec Homepage - Windows Internet Explorer
http://www.greenspec.co.uk/index.html
Google
Bookmarks Popups okay Check AutoLink AutoFill Send to Settings
NGS GreenSpec Homepage
Page Tools

GreenSpec

Search

HOME
PRODUCTS
MANUFACTURERS
SPECIFICATIONS (available 2007)
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHMENT
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS & INSTALLERS
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & STRATEGIES
RESEARCH & PAPERS
RESOURCES
CPD
HOW WE SELECT PRODUCTS
CONTACT GREENSPEC
REGISTER YOUR PRODUCT

GreenSpec is the UK construction industry's definitive guide to sustainable construction. Inside GreenSpec you will find a wealth of information aimed at helping you to design more energy and resource efficient buildings using materials and technologies that minimise damage to people and the environment.

PRODUCTS

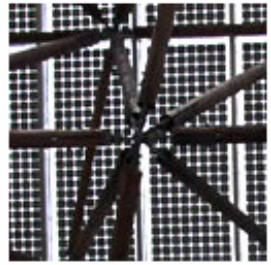
A directory of sustainable products available in the UK. Each product page comes with a description, brochure downloads and contact details.

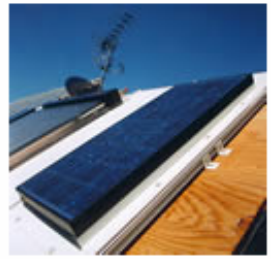
MATERIALS

A guide to sustainable materials, both traditional and new. Materials such as masonry, roofing and flooring are compared based on their enviromental impacts.

CHECKLIST

This CAWS menu-based checklist takes you through the construction process highlighting areas where sustainable construction best practice can be applied.





The GreenGrid Modular Green Roof System
for simplicity and flexibility in design and budget
www.greengridroofs.co.uk Tel: 01698 464620
GREENGRID
The Natural Choice for Your Roof

SPECIFICATIONS

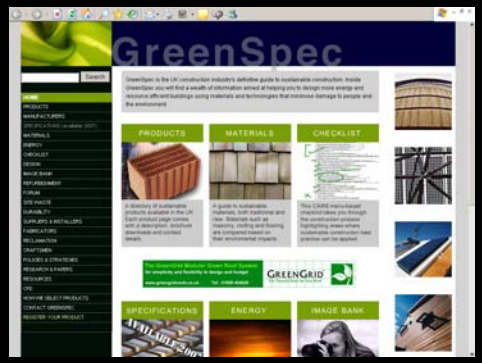
ENERGY

IMAGE BANK

• generous ceiling heights and roof pods for natural ventilation and maximised daylighting • occupant control • excellent air-tightness • exposed thermal mass for passive cooling • visual and direct links between all floors and with the surrounding landscape • internal spatial flexibility

The bespoke timber facade consists of cladding with louvre timber shutters in Western Red Cedar controlling solar gain. Members of staff have manual and motorised control of the shutters and windows.

© National Green Specification 2006



www.greenspec.co.uk

GreenSpec Window Frame Material Comparison

Window frame materials compared

Key issues

Heat loss v Manufacturing impacts on the environment

• Heat lost through the window frame in its use phase (operational energy) is likely to have a much greater environmental impact in the frame's life cycle than any impact generated through its production phase.

• It is important to choose a material with the least conductivity.

• Wood is the least conductive material followed by PVC and metal.

Wood, durability and environmental impact

The choosing of wood, its treatment and maintenance are crucial in reducing a window frame's environmental impact:

• Specify FSC sourced timber

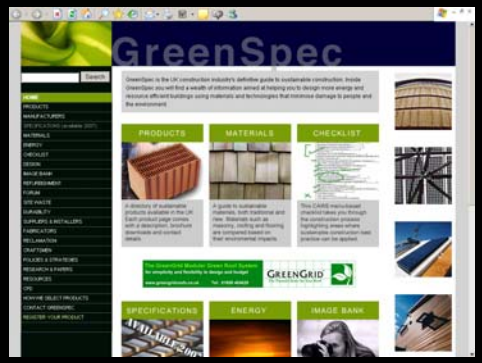
• Transport adds embodied energy. Try and source UK timber whenever possible.

• For both hard and softwoods ensure that the specification explicitly excludes the use of sapwood.

• Painting wood adds significantly to its environmental impact. Either specify a naturally durable species that doesn't need treating or select a treatment with low impact.

• If the wood is to be treated/painted, ensure that this is done in the factory prior to site. Factory painted frames double the period before the need to repaint.

• Be careful to avoid damage to frames on site. Ensure that they are not used as formwork in wall openings.



National Green Specification

www.greenspec.co.uk

GreenSpec
Durability & WLC
Window Ventilation

NGS GreenSpec Homepage - Windows Internet Explorer
http://www.greenspec.co.uk/index.html
Google
Bookmarks Popups okay Check AutoLink AutoFill Send to Settings
NGS GreenSpec Homepage
Page Tools

GreenSpec

Search

HOME
PRODUCTS
MANUFACTURERS
SPECIFICATIONS (available 2007)
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHMENT
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS & INSTALLERS
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & STRATEGIES
RESEARCH & PAPERS
RESOURCES
CPD
HOW WE SELECT PRODUCTS
CONTACT GREENSPEC
REGISTER YOUR PRODUCT

GreenSpec is the UK construction industry's definitive guide to sustainable construction. Inside GreenSpec you will find a wealth of information aimed at helping you to design more energy and resource efficient buildings using materials and technologies that minimise damage to people and the environment.

PRODUCTS

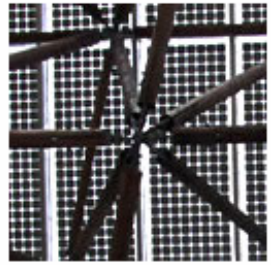
A directory of sustainable products available in the UK. Each product page comes with a description, brochure downloads and contact details.

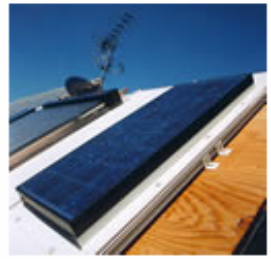
MATERIALS

A guide to sustainable materials, both traditional and new. Materials such as masonry, roofing and flooring are compared based on their enviromental impacts.

CHECKLIST

This CAWS menu-based checklist takes you through the construction process highlighting areas where sustainable construction best practice can be applied.





The GreenGrid Modular Green Roof System
for simplicity and flexibility in design and budget
www.greengridroofs.co.uk Tel: 01698 464620
GREENGRID
The Natural Choice for Your Roof

SPECIFICATIONS

ENERGY

IMAGE BANK

GreenSpec

Search

HOME
PRODUCTS
MANUFACTURERS
SPECIFICATIONS (available 2007)
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHMENT
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS & INSTALLERS
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & STRATEGIES
RESEARCH & PAPERS
RESOURCES
CPD
HOW WE SELECT PRODUCTS
CONTACT GREENSPEC
REGISTER YOUR PRODUCT

DURABILITY CONTENTS
Timber cladding
Prefabricated structural panels

Durability - Contents

Introduction

These articles, by Peter Mayer of *Building LifePlans*, are based on the premise that for any component the market supplies a range of options with different whole life performance and cost consequences. Whole life costs are influenced by durability – component replacement interval, maintenance activities and frequency as well as costs. Other whole life performance factors which make an impact on cost are addressed as applicable, for example thermal or energy efficiency.
For each component type:

- Common component options are described by the criteria which are expected to determine durability in the UK
- Indicative service lives are listed
- Key design, installation and maintenance criteria to maximise whole life performance are identified
- Pointers are given to further good practice guidance
- Generic whole life costs for the common component choices over a 60 year period are tabulated.

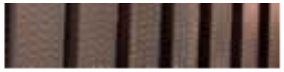
The longer the whole life performance and lower the whole life cost the better a component performs from a sustainability perspective.

Contents

- Timber cladding
- Prefabricated structural panels
- Steel fire protection
- Coated steel cladding
- Single ply membranes

DURABILITY CONTENTS
Timber cladding
Prefabricated structural panels
Steel fire protection
Coated steel cladding
Single ply membranes
High performance roofing
Acoustic separating flooring
Floor decking
Sealants
Offices - natural ventilation
Solar hot water
Rainwater harvesting
Retail lighting
Industrial Doors
Kitchen furniture
Anti-bacterial components

- Key design, installation and maintenance criteria to maximise whole life performance are identified
- Pointers are given to further good practice guidance
- Generic whole life costs for the common component choices over a 60 year period are tabulated.



The longer the whole life performance and lower the whole life cost the better a component performs from a sustainability perspective.

Contents

- Timber cladding
- Prefabricated structural panels
- Steel fire protection
- Coated steel cladding
- Single ply membranes
- High performance built-up roofing
- Acoustic separting flooring
- Floor decking
- Sealants
- Offices - natural ventilation
- Solar hot water
- Rainwater harvesting
- Retail lighting
- Industrial doors
- Kitchen furniture (domestic)
- Anti-bacterial components for healthcare buildings

© National Green Specification 2006

GreenSpec

Search

HOME
PRODUCTS
MANUFACTURERS
SPECIFICATIONS (available 2007)
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHMENT
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS & INSTALLERS
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & STRATEGIES
RESEARCH & PAPERS
RESOURCES
CPD
HOW WE SELECT PRODUCTS
CONTACT GREENSPEC
REGISTER YOUR PRODUCT

DURABILITY CONTENTS
Timber cladding
Prefabricated structural panels

Durability - Offices - natural ventilation

Natural ventilation not only makes financial sense but also offers a sustainable solution to environment management. **Peter Mayer** of *Building LifePlans* examines the whole-life costs.

Introduction

Naturally ventilated offices have 25% – 50% lower annual energy costs than air-conditioned offices. A recent British Council for Offices report on office sustainability undertaken by multidisciplinary consultant Arups, suggests natural ventilation has a payback period of two-and-a-half years.

Getting the right system and strategy for an office requires careful design and management to take into account a multitude of factors. These include:

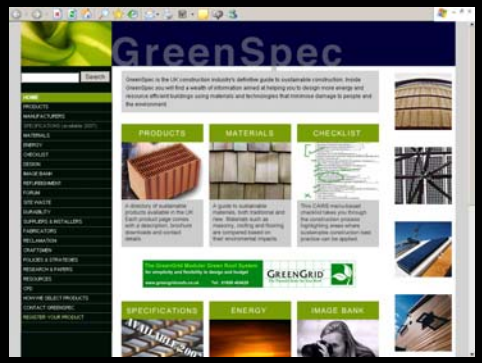
• **External environment** Temperature and rainfall regimes, cloud cover, wind direction and speed.

• **Office building issues** Thermal mass, shape, height, layout of partitions etc, internal wall reflectance, usage patterns, internal energy input, ventilation rate required. and required ventilation rates.

• **Window issues** Area, orientation, glazing system, window and shading.

Design guidance may be based on BS 5925, *Code of Practice for Natural Ventilation*. There is also a wealth of information on natural ventilation strategies, detailing and energy efficiency from organisations such as CIBSE and BRE.

Large deep plan offices or where external traffic noise levels are unacceptably high or where security is a risk may preclude the use of opening windows. Stack ventilation may be an alternative in these



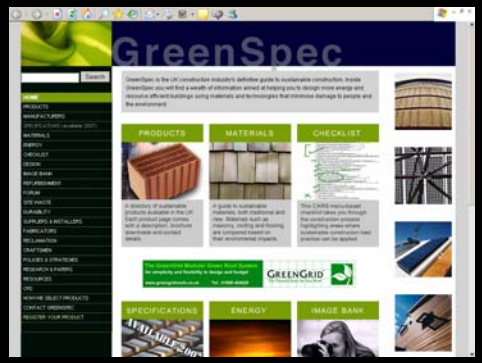
Finishes:

National Green Specification

www.greenspec.co.uk

- Consider High Performance Micro-porous finish to all faces
- Full build up to all faces especially face in contact with masonry
- Coat before installing or reinstalling
- Forest Stewardship Council (FSC) certified wood and ply

© NGS 2004-7 Air Movement In Buildings



Trickle vents

National Green Specification

www.greenspec.co.uk

- Usually associated with windows and roof windows, can be in doors too.
- Must be within reach to ensure they can be used easily and controllable
- Not permanently open and out of reach
- Windows without them have great potential to loose considerable energy when left ajar.
- And could be less secure in this state

Cat Flaps

- 20,000 mm2 or more, hole in the wall
- Air leakage excessively high
- Destroy all efforts to make an airtight building if flapping in wind
- Consider:
- cat collar electronic key releases otherwise held-closed flap to control leakage
- lobby with two flaps, cat occupies space blocking air flow, but would cats use them?

Bin Chutes

- In Australia they have a chute over the kitchen sink
- straight to the bins fixed to the wall outside
- Okay in a warm climate assuming there is smell seal
- BedZED planned to have them but too complicated and abandoned

Soil, Waste and Vent pipes

- Small amounts of Air from bathrooms and kitchens is drawn into waste pipes
- Air admittance valves draw air into Soils stacks with no vent to roof level
- Sewer gas is prevented from leaking back into the room

Hot or cold air hand dryers

- Move air around and add heat
- They squander electricity made at 25% efficiency
- They fail to dry your hands unless you have all day and no queues behind you
- Avoid specifying them if you can
- Don’t position over radiators (convectors) avoid rust
- Dyson’s Blade uses unheated blade of 400 mph air to blast water from hands
- Much better energy efficiency
- Will be on the market soon

Test Yourself Part 5

- How much heat is lost through air leakage?
- At what stage should air testing be carried out?
- How is a house air tested?
- What happens when architects interfere with manufacturer's standard details?

How did you do? Part 5

- 50%
- External envelope substantialy complete, no finishes
- Seal up opening, connect fan suck out air and smoke wand identify leaks
- Often acoustic, fire and airtightness performance integrity compromised

Air Movement in Buildings: 5 of 9 Sub-topics in 10 separate files

- Principles of Element Design
- Climate Change
- Wind
- Wind Tunnel Testing
- Wind Turbines
- Natural Ventilation
- Moisture Vapour & Condensation
- Thermal Insulation
- Breathing Construction
- Airtightness
- Wind & Airtightness Testing
- Building Elements
- Passive Ventilation
- Active Ventilation
- Stack Effect
- Atrium
- Solar Orientation & Solar Gain
- Conservatories
- Thermal mass
- Conduction, Convection, Radiation
- Solar Shading
- Thermal mass, Passive and active cooling
- Fluid dynamics
- Mechanical Ventilation
- Air-Conditioning
- Questions and Answers