ZERO CARBON HUB

SERVICES GUIDE

An illustrated guide to building services in new homes

FMB The sign of building quality

NHBC

citb

LABC

HBF HOME BUILDERS FEDERATION

Pollard Thomas Edwards

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Further copies of this guide are available as a PDF download from **www.zerocarbonhub.org**

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Pollard Thomas Edwards (PTE) uses practical experience and research to complement and inform one another. We contribute to best practice and debate through research, report-writing and public speaking. Recent publications have included the Builders' Book, Superdensity, and research into housing density, overheating, ventilation and the performance gap in homes. This publication is the result of another successful collaboration with Zero Carbon Hub and their partners in researching design and installation of domestic building services.

SIG360 Technical Centre is a service that focuses on helping customers deliver energy efficient buildings.

Central to SIG360 is an easily accessible impartial team of technical specialists, who draw on over 55 years of experience and an extensive range of products in providing the most cost effective build, suited to your preferred building style.

ACKNOWLEDGEMENTS

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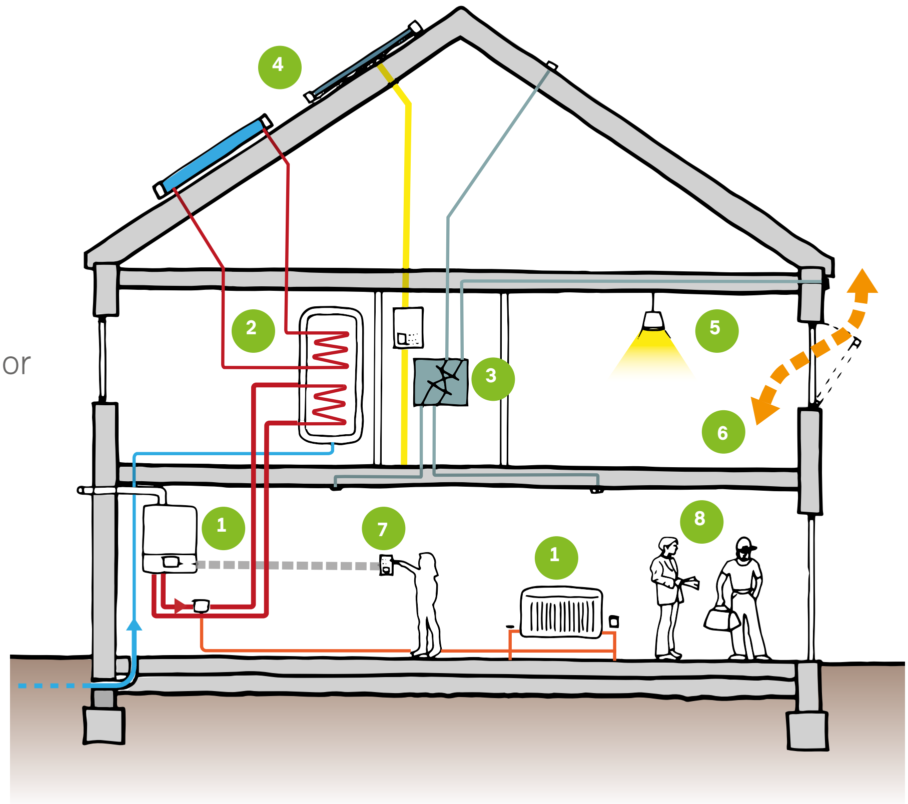


ACRONYMS / GLOSSARY

ADE	Association of Decentralised Energy
AD(F)	Approved Document Part F of the Building Regulations (2010)
AOV	Automated Opening Vent
ASHP	Air Source Heat Pump
BPEC	British Plumbing Employers Council = Trade certification
CHP	Combined Heat and Power
CIBSE	Chartered Institute of Building Services Engineers
DHW	Domestic Hot Water
DBSCG	Domestic Building Services Compliance Guide
DVCG	Domestic Ventilation Compliance Guide
FGHR	Flue Gas Heat Recovery
GSHP	Ground Source Heat Pump
HIU	Heat Interface Unit
HWSC	Hot Water Storage Cylinder
MCS	Microgeneration Certification Scheme
PV	PhotoVoltaic (Solar Panels producing electricity)
RC	Reinforced Concrete
RWP	Rain Water Pipe
Solar Thermal	Solar panels producing Hot Water
System 1	Intermittent Extract Fans and trickle vents
System 2	Passive Stack Ventilation
System 3 MEV	Mechanical Extract Ventilation (Centralised or Decentralised)
System 4 MVHR	Mechanical Ventilation Heat Recovery
TRV	Thermostatic Radiator Valve
UFH	Underfloor Heating

INTRODUCTION

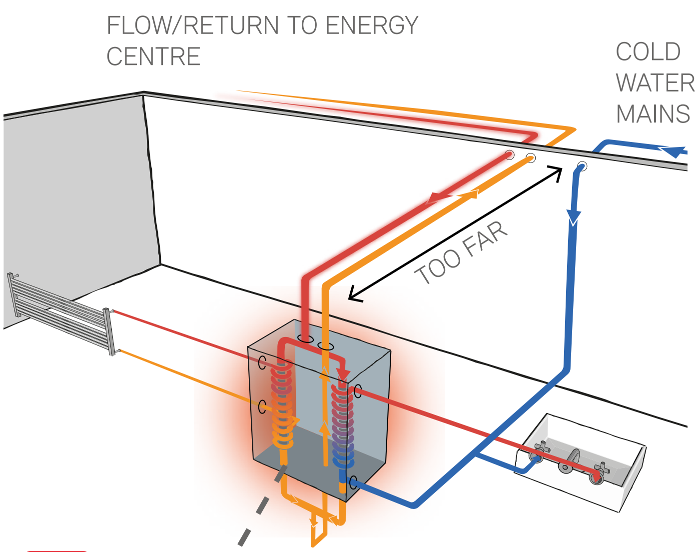
This good practice guide aims to improve the standard of building services in new homes. The information is aimed at SME builders and their advisors, but there will be parts relevant to other building professionals. The scope is limited to focus on the major problems around design and installation of services that affect the comfort, indoor air quality and energy performance of new homes. The guide highlights "problems to avoid" showing common issues that contribute to the gap between intended and actual performance. The "What to do" guidance provides useful solutions and tips for a successful design and installation. This guidance will aid the site and wider project team in the effective delivery of building services that perform as intended.

The majority of the content has been directed to address the top issues that have arisen from a lengthy site review process examining 27 live building sites around the UK. Some sections, such as those dealing with tried and tested solutions like gas condensing boilers, have very little content. Other sections, such as those dealing with newer technologies in ventilation, have more content. This is to be expected as the knowledge and skills to appropriately design, install and commission newer technologies takes time to disseminate. This guide is not exhaustive in its scope, and has not examined some relatively new or rare technologies.

All photos are of current building sites around the UK, and have been taken by the author, the Zero Carbon Hub or their partners in this publication. What to do guidance is compliant with Building Regulations and NHBC / LABC standards. However, this guide is not a legal document and does not form part of a Building Regulations approved specification. It is not a project specific design, so please consult your design team and Building Control Officer for details of compliance in specific projects.

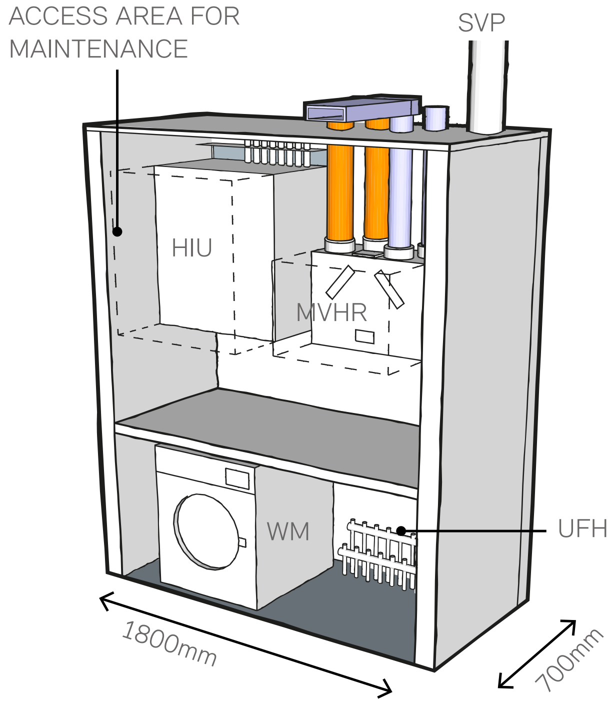
This guide is one of a series of good practice guides that are aimed at addressing the performance gap and improving the design, procurement and construction quality of new homes. All publications in the series are available from the Zero Carbon Hub website.

PROBLEM TO AVOID



HIU NOT INSULATED

WHAT TO DO?



WELL DESIGNED HEATING/VENTILATION CUPBOARD IN AN APARTMENT

SUMMARY – TOP ISSUES LEADING TO POOR PERFORMANCE

Problems	Recommendations
Poor commissioning of services	Check commissioning carried out to correct standards
Services not performing as intended	Check operation of services and heating bills after 6-12 months of occupation
Product substitution for poorer products and services	Ensure performance criteria are checked and agreed specification is met. Use proprietary, guaranteed systems where possible
Heat pumps not performing as predicted	Heat pumps to be installed and commissioned by MCS certified contractor and occupant educated about operation e.g. low operating temperatures
Ventilation fans not commissioned correctly. Domestic Ventilation Compliance Guide not checked	Commission fans with DVCG checklist, testing flow rates for trickle and boost
Services designed and specified to meet SAP requirements and not useful for end user	Design services based on usage and not on SAP points
Lack of insulation of primary pipework and fittings	Insulate all pipework to standards in Domestic Building Services Compliance Guide (DBSCG)
Poor seal to incoming service ducts will lead to air and gas ingress	Seal all incoming services from air and ground gases
Poor installation and commissioning of solar thermal	Solar thermal to be installed by experienced contractor with MCS certification
Fixed lighting that is not energy efficient	Ensure low energy lights are installed instead of halogen downlights
Controls that are too complicated and not accessible	Install simple to use smart controls

RADIATORS

1.0

PROBLEMS TO AVOID

- Penetrations through plasterboard directly behind radiator allow air leakage and heat loss
- Incorrectly sized radiators
- Poor commissioning

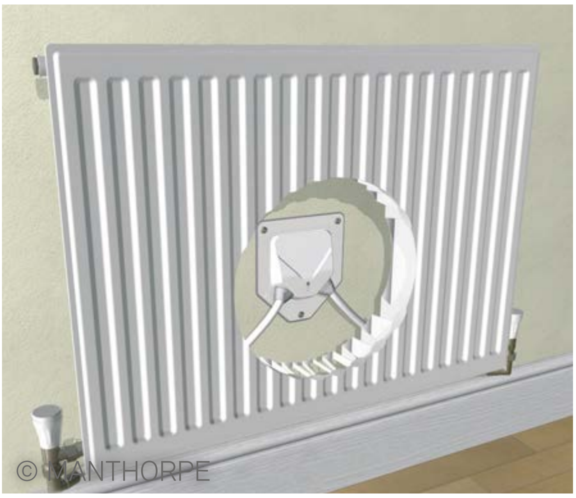
RADIATOR SEAL PROBLEMS – POOR SEAL

AIR LEAKAGE TO OUTSIDE AND UNDERSIZED RADIATOR

WHAT TO DO?

- Bring pipe work down to the centre of the radiator to limit the pipe work penetrations through the plasterboard
- Use a proprietary radiator pipe seal to form an air tight seal around both the plasterboard penetration and pipe exit points
- Ensure radiators are correctly sized with appropriate controls (TRVs or Room stat)
- Ensure radiators are correctly commissioned, balanced and system is fully charged

RADIATOR SEAL

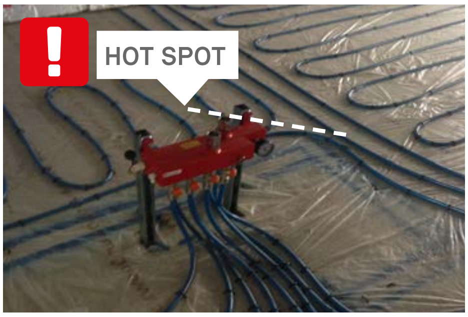


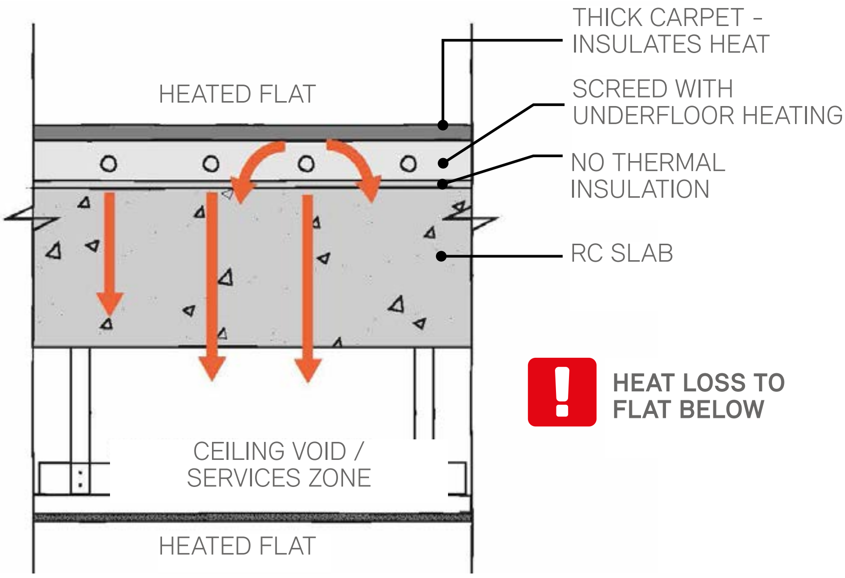
RADIATOR SEAL SOLUTIONS – INSTALLED SEAL

UNDERFLOOR HEATING (UFH)

PROBLEMS TO AVOID

- Underfloor heating not insulated sufficiently
- Carpet installed over underfloor reduces heat flow to room
- Poor design and product substitution leading to 'Hot Spots'

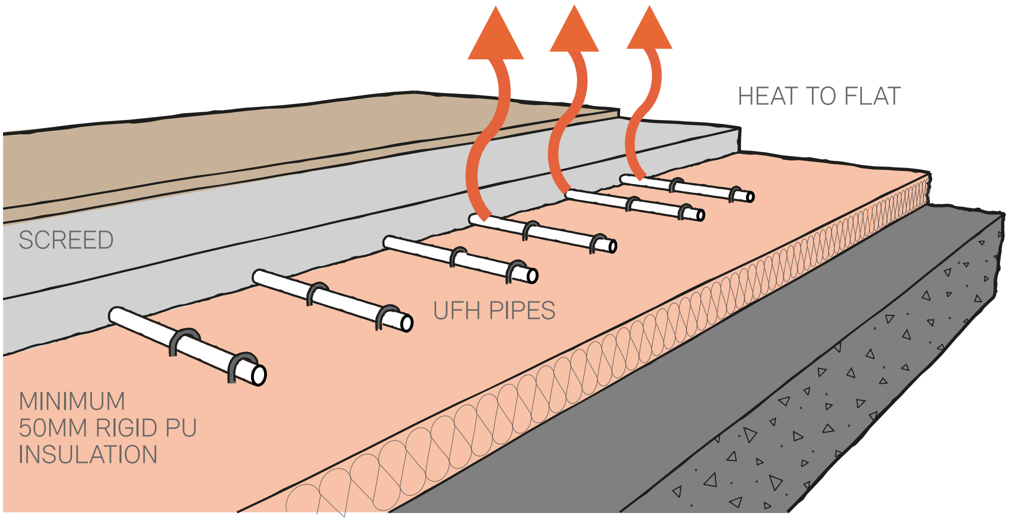




LACK OF INSULATION IN TYPICAL SEPARATING FLOOR BETWEEN FLATS

WHAT TO DO?

- Install minimum 50mm rigid insulation underneath heating loops
- Consider tile or vinyl or timber instead of carpet over UFH
- Use a fully certified system and pressure test UFH loops
- Specify and install proprietary system
- Install pipe spacing around room to avoid hot spots
- Use plastic sheet to keep insulation dry during screeding



GROUND SOURCE HEAT PUMP (GSHP) 1.2

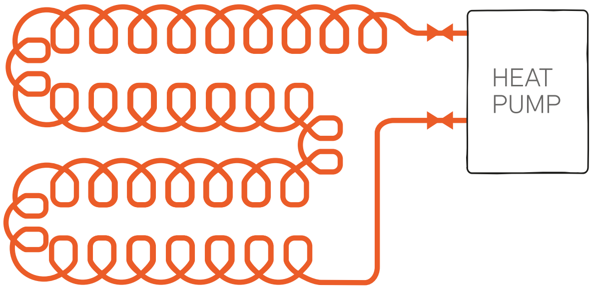
PROBLEMS TO AVOID

- Inaccurate or incorrect flow rates for radiators or underfloor circuits
- Poor insulation on pipework
- Complicated controls set at high temperatures above 45°c
- Heat loop not filled completely, with trapped air in system reducing performance
- Long pipe runs for the ground array resulting in high pump energy demands

AIR IN SYSTEM

PUMP FULL SPEED

LONG PIPE LENGTHS = HIGH PUMP ENERGY FOR GROUND ARRAY



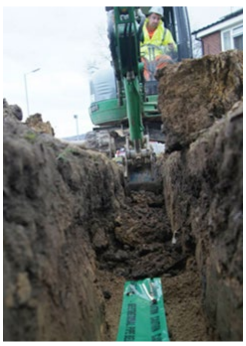
GROUND SOURCE ARRAY

WHAT TO DO?

- Keep heating flow temperature as low as possible with low set points for large heat emitters like underfloor heating
- Fully insulate all pipework
- Make the control strategy simple for the user and suited to their usage patterns
- Employ reverse return techniques in the ground array hydraulic design
- Accurate calculation of thermal conductivity of the soil allows good design of ground array

SHORT PIPE RUNS = LOW PUMP ENERGY FOR GROUND ARRAY BUT SAME HEAT RESERVOIR

MANIFOLDS LOCATED IN ACCESS CHAMBERS WITH ISOLATING / FLOW CONTROL VALVES


PROPER ARRAY WARNING IN GSHP TRENCH


CORRECT GSHP TRENCH FOR LOOP & BACKFILL


NEAT GSHP INSTALLATION IN EXTERNAL CABINET

IMAGES COURTESY OF © HPA

AIR SOURCE HEAT PUMP (ASHP) 1.3

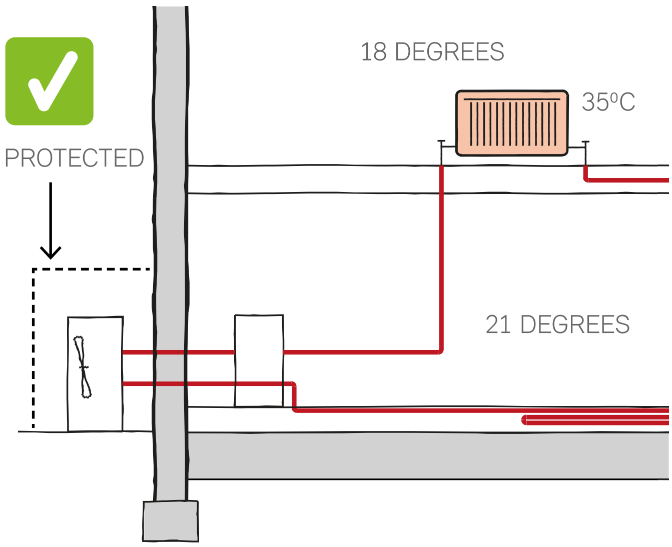
PROBLEMS TO AVOID

- Setting the output at average conditions (e.g. 7ºC ambient) rather than design conditions (typically < 0ºC)
- Setting the output at the wrong maximum flow temperature of 35°c flow instead of more realistic 55°c
- Lack of space for ventilation and access to outdoor ASHP unit, so it is vulnerable to abuse and power outage
- Installing large radiators instead of underfloor heating can lead to a perception of low air temperature, as radiators do not feel hot
- Poor commissioning leads to high energy bills as immersion heater is used

POOR INSTALLATION

WHAT TO DO?

- Allowing spare capacity over and above design conditions to allow for periodic defrosting of the outdoor coil
- Keep heating flow temperature as low as possible
- Ensure AHSP fan unit is in a protected area with appropriate space around unit for air supply and access
- Locate unit away from windows and isolate vibration if fixed to a building
- Make the control strategy simple for the user and suited to their usage patterns
- Install low temperature heat emitters, underfloor heating is preferred
- Ensure any installer is registered with MCS (Microgeneration Certification Scheme) by asking for their certificate number and check online.



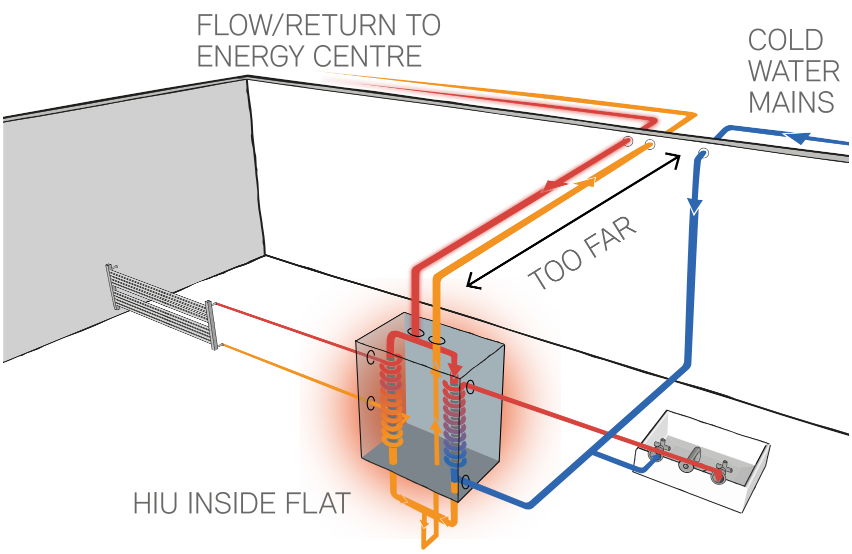
DISTRICT HEATING

1.4

PROBLEMS TO AVOID

- Poorly insulated pipework and HIU
- Boiler flue creates co-ordination and planning issue
- Undersized HIUs means under heating and inefficient operation

UN-INSULATED
HEAT INTERFACE UNIT (HIU)



- HIU too far from flat entrance
- Incorrect size of HIU
- Poorly insulated pipes and HIU
- Flow and return too hot 80-60ºC

WHAT TO DO?

- Insulate pipework to high standards to prevent heat loss and overheating in common parts
- Plan in flue at early design stage
- Manufacturers to provide a fully insulated system
- Locate HIU close to the entrance of the dwelling to reduce pipe runs and heat loss
- Install correct size and specification of HIU and ensure it is fully insulated
- On larger systems specify multiple boilers to achieve modulation
- Refer to CIBSE Heat networks code of practice for the UK, CP1

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FULLY INSULATED HIU

ADEQUATE INSULATION AROUND
PIPES IN CORRIDORS AND FLATS

COMBINED HEAT AND POWER (CHP) 1.5

PROBLEMS TO AVOID

- Lack of accurate metering – this will make it harder to see how efficient the plant is operating, and where energy is being distributed
- Poor initial commissioning, and no seasonal commissioning
- High operating temperatures reduces plant efficiency and increases cost of operation
- Poor pump and flow control means systems are “always on” regardless of heat required, meaning increased heat loss

OVERSIZED CHP

WHAT TO DO?

- Design and install simple, short layout of pipework with fully continuous insulation
- Design for 70°C flow and 40°C return temperature
- Insert performance criteria into specification
- Commissioning with third party and review in use after one year
- Refer to CIBSE and ADE Guidance for design, installation and maintenance
- CHP size to be specified as small as possible with ability to modulate to 40%
- Ensure that electrical base load is continuous with private wire network where possible

CORRECTLY SIZED AND WELL MAINTAINED CHP

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GAS BOILERS

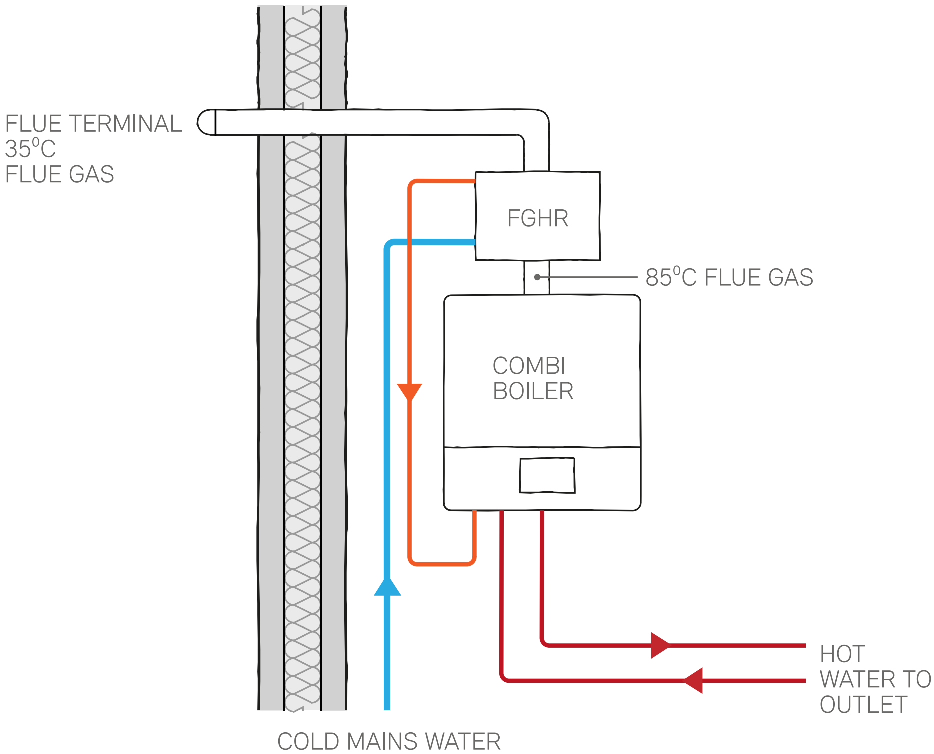
1.6

PROBLEMS TO AVOID

- Oversized boiler - meaning it will not condense and efficiency will be reduced
- High return temperatures meaning efficiency reductions

WHAT TO DO?

- Correctly size boiler for best efficiency in use
- Check boiler is compatible with controls such as weather compensation and delayed start thermostat
- Consider flue gas heat recovery (FGHR) on combi boilers to further increase hot water efficiency
- Ensure boiler can modulate low enough to be compatible with low flow outlets
- FGHR can increase efficiency by using waste heat from flue gas to raise temperature of incoming cold water



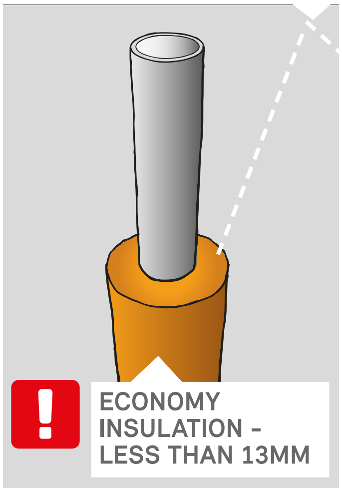
PIPEWORK

2.0

PROBLEMS TO AVOID

- Uninsulated domestic hot water pipes - leading to heat loss and potential overheating

UNDER-INSULATED PIPES
NOT SEALED OVER VALVES



WHAT TO DO?

- Insulate all pipework, fittings and valves
- Rule of thumb – min. 25mm thick insulation around pipes
- Install pipes with space for 25mm of lagging around diameter to conform to BS 5422
- Use correct stand off brackets
- Do not cover up or dryline before pipework is insulated
- Insulate cold water pipes against heat gain

RAINWATER HARVESTING

2.1

PROBLEMS TO AVOID

- Foul drain or wastewater connections run into surface water drainage resulting in contamination of stored rainwater
- Illegal connection to mains back up supply
- Rainwater fed to appliances such as washbasins in contravention of the Water Regulations
- Electrical Work contravenes the IET (IEE) Wiring Regulations (BS 7671)

NON COMPLIANT ELECTRICAL INSTALLATION

CROSS CONNECTION TO FOUL DRAIN

RWP TO YARD GULLEY

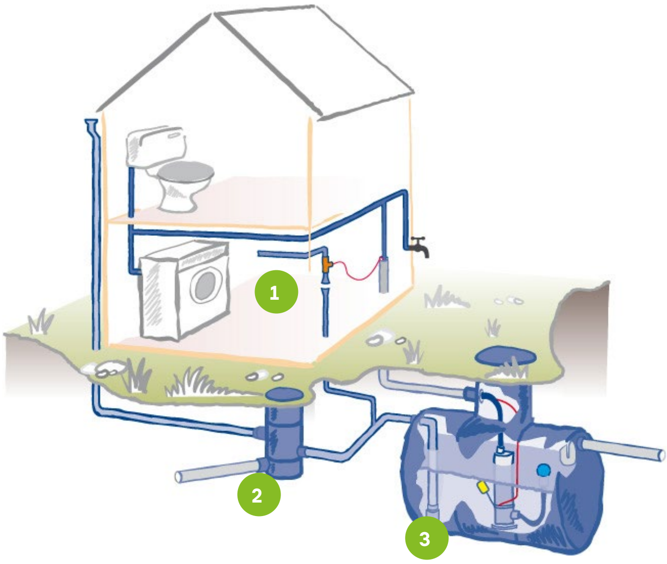
RAINWATER PIPE (RWP)

FILTER IMPOSSIBLE TO MAINTAIN (WELDED)

RW SUPPLY WITH CONNECTION TO MAINS

WHAT TO DO?

- Check that site drawings show all foul water drains and surface water drains run separately. Check that ground workers follow site drawings at all times
- Ensure all rainwater pipework connects directly to surface water drain (no back inlet gullies)
- If collecting rainwater from paved areas, then make sure it is treated before storage
- Connection to mains must be made via a type AA or type AB air gap compliant with Water Regulations. Use proprietary rainwater harvesting systems which will have the air gap built in or will provide the relevant parts and instructions to ensure correct installation
- Pipework carrying rainwater to be marked as such. Ensure that both first fix and second fix plumbers understand which appliances can and cannot be fed by rainwater
- Label appliances and taps appropriately
- Ensure filter can be accessed easily after other works completed (including landscaping)
- Check that electrical connections are IP66 or IP67 rated as required by BS 7671



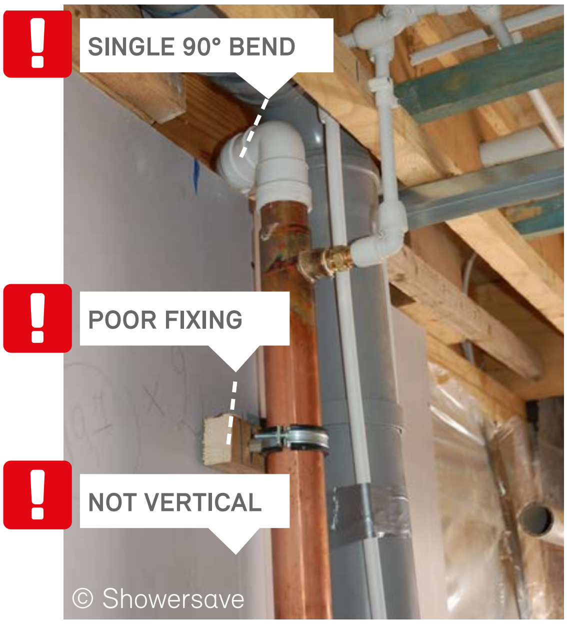
1. Compliant air gap connection with mains water
2. Accessible filter
3. Correctly sized water storage

WASTE WATER HEAT RECOVERY (WWHR)

2.2

PROBLEMS TO AVOID

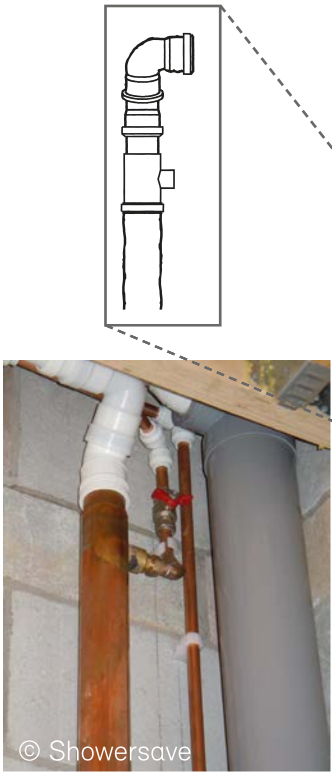
- Waste Water Heat Recovery pipe not installed vertically
- WWHR installed with unsuitable incoming mains water pressure
- Single 90º bend not in accordance with the manufacturers recommendations

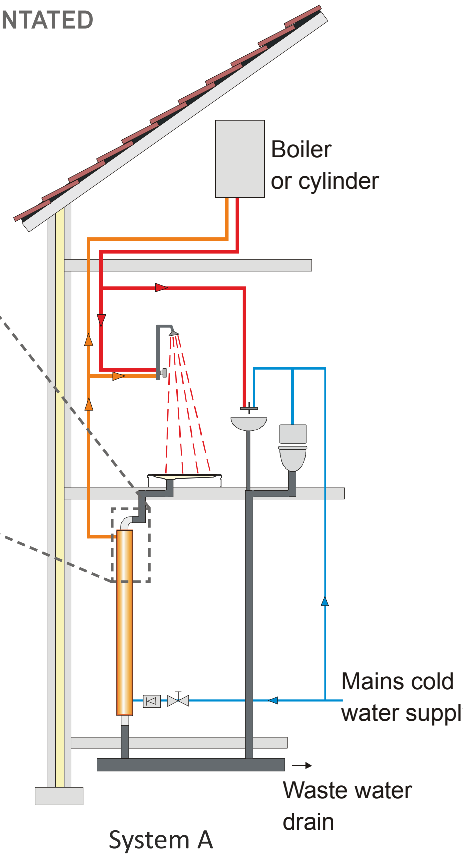


WHAT TO DO?

- Refer to manufacturer's installation manual to check the site incoming mains water pressure is suitable for the WWHR unit
- Install the WWHR pipe vertically within 1° vertical to ensure maximum performance
- Ensure the top connectors are correctly orientated to achieve maximum distribution of the waste water circulating down the inside face of the inner pipe
- Ensure the WWHR unit is plumbed in accordance with the system (either A, B or C) as defined in the dwelling SAP calculation. In most cases this will be System A (see diagram)
- If installing two systems then second must be system B
- Fit in-line isolation valves and independently secure the fresh water feed pipes

CORRECTLY ORIENTATED TOP CONNECTOR



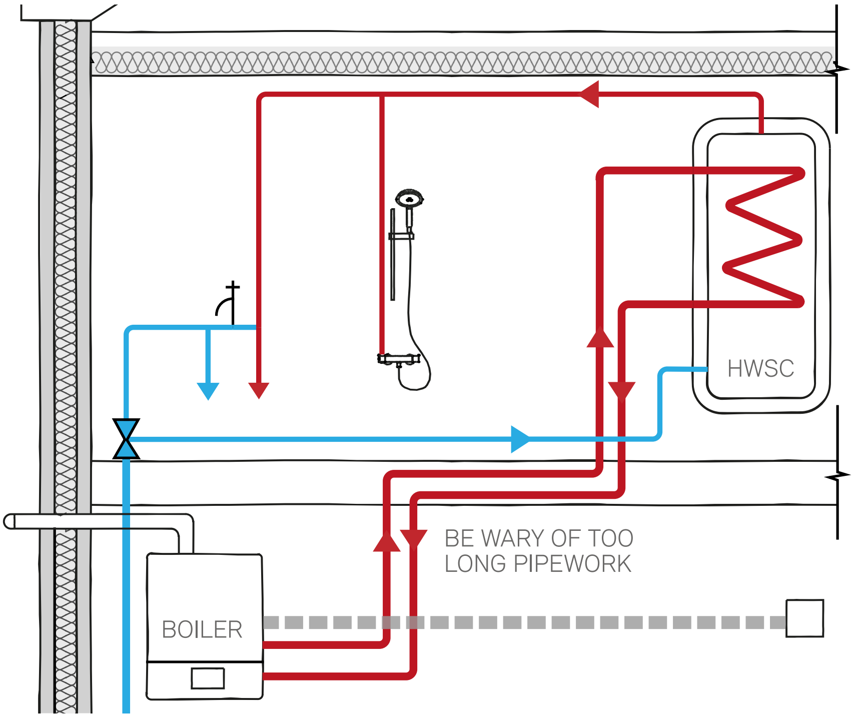


UNVENTED HOT WATER CYLINDER

2.3

PROBLEMS TO AVOID

- Hot Water Storage Cylinder not installed correctly with lack of access for controls and maintenance
- Cylinder not commissioned correctly or labelled for future maintenance
- Wasted water and heat caused by long pipework runs and dead legs



WHAT TO DO?

- Complete benchmark checklist to commission services as in DBSCG
- Consider installing better performing, better insulated cylinders
- Ensure sufficient access and labelling of valves and controls for future maintenance
- Install cylinder 200mm away from one side of cupboard to ensure accessibility for future maintenance
- For low temperature heat sources e.g heat pumps, ensure coil and cylinder is adequately sized to manufacturer's recommendation

UNVENTED CYLINDER INSULATED AND LABELLED

SOLAR THERMAL

2.4

PROBLEMS TO AVOID

- Poor installation and commissioning of solar thermal leading to inefficient usage and reduced savings

POOR PIPE SUPPORT DISRUPTS INSULATION IN ROOF

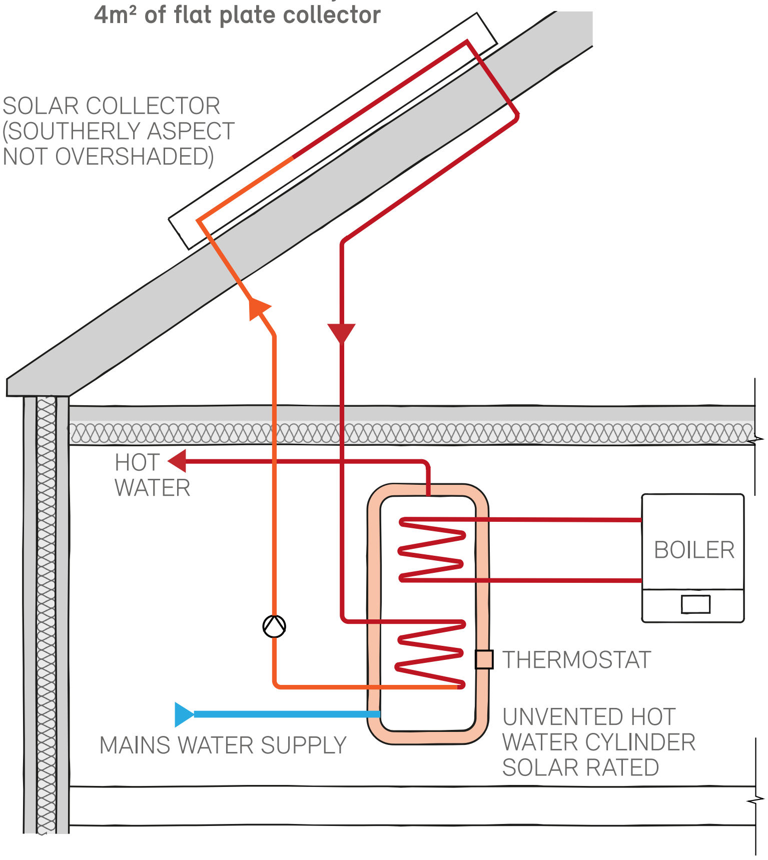
PARTIALLY INSULATED SOLAR PIPEWORK AND INACCESSIBLE CONTROLS

WHAT TO DO?

- Install pre-insulated flexible solar thermal pipework
- Ensure solar thermal is connected to bottom of cylinder
- Check controls are working correctly, and ask occupier or site manager to demonstrate
- Ensure installers are experienced at installing solar thermal and have MCS certification
- Check Glycol mix as part of installation and maintenance

PRE INSULATED SOLAR PIPEWORK

RULE OF THUMB:
$1m^2$ solar thermal panel per 50 litres of water cylinder
3 bed house = 200l cylinder = $4m^2$ of flat plate collector

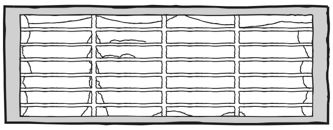


VENTILATION - GRILLES

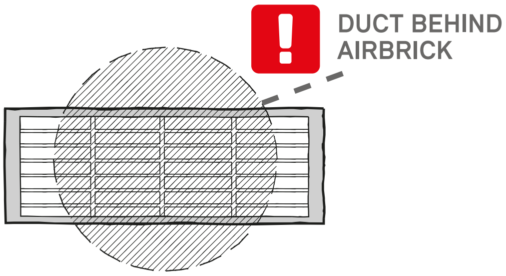
3.0

PROBLEMS TO AVOID

- Undersized ventilation grilles, not cleaned out properly



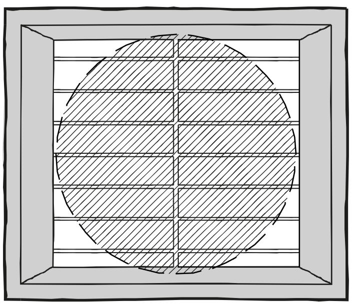
GRILLE OPENING BLOCKED WITH MORTAR



CLAY AIR BRICK DOES NOT HAVE ENOUGH FREE AREA

WHAT TO DO?

- Ensure terminal has large enough free area
- This normally requires double grille of 2 airbricks, although some airbricks can achieve free area with 1 brick
- MVHR will normally require a double air brick to reduce pressure drop and inefficiency of fan

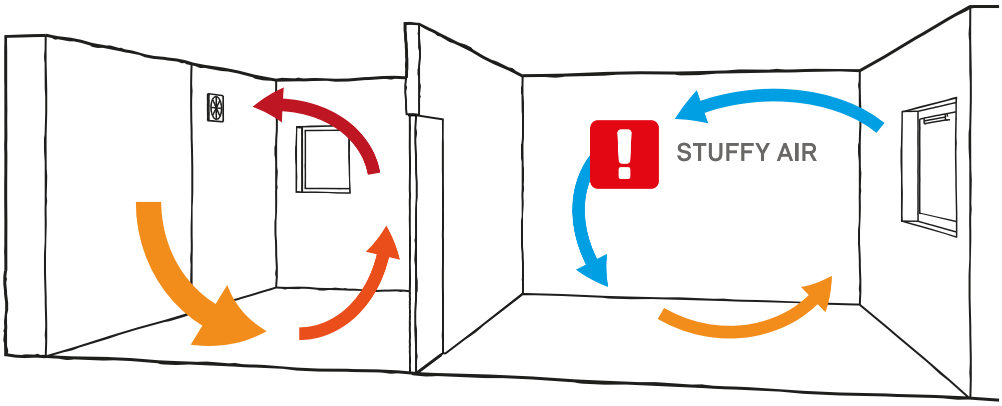


GRILLE DISCHARGE OPENING = CORRECT FREE AREA

VENTILATION - DOOR UNDERCUTS 3.1

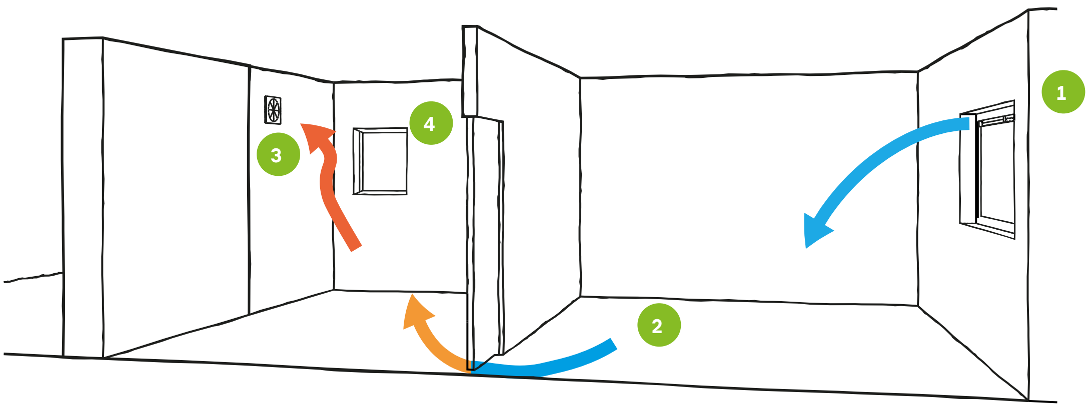
PROBLEMS TO AVOID

- No door undercut will prevent transfer of air between rooms with rooms becoming stuffy



WHAT TO DO?

- Trim all doors to achieve a clear gap of 10mm: at least 25mm without finishes fitted



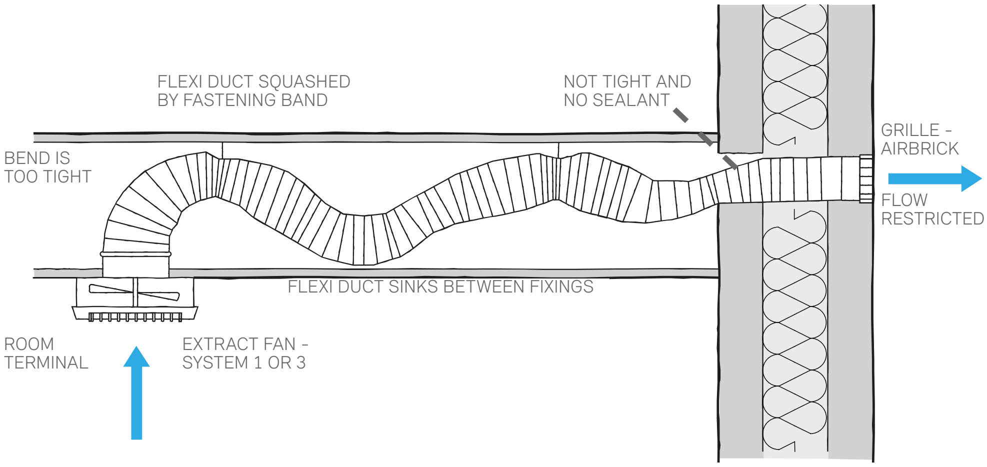
1. Background ventilation = trickle vents correct size
2. Transfer = Door undercut at 10mm
3. Extract fan, duct and grille correct size
4. No trickle vents in wetrooms

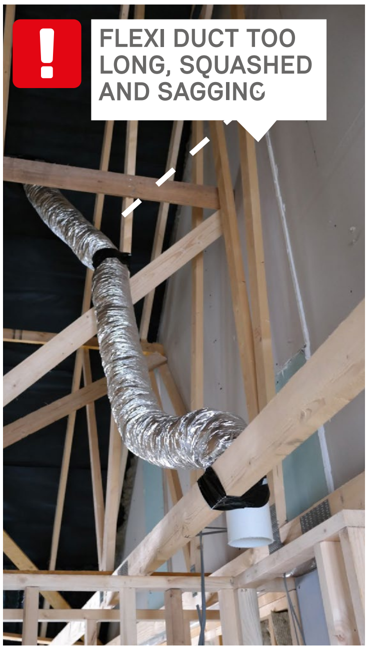
VENTILATION - FLEXI DUCT USE

3.2

PROBLEMS TO AVOID

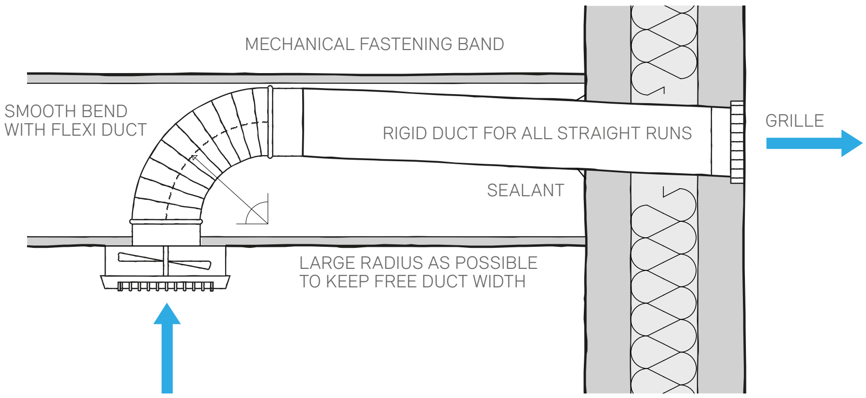
- Flexi duct use more than 300mm reduces airflow
- Squashed, saggy flexi duct restricts flow area and causes a noisy, inefficient fan





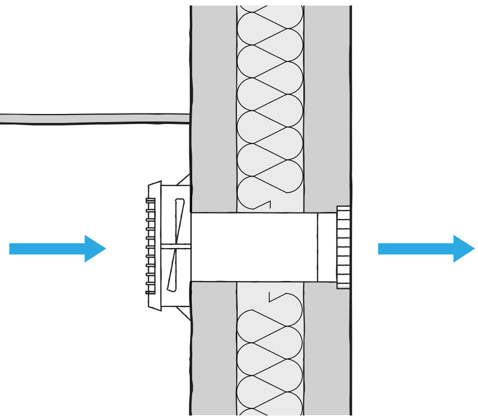
WHAT TO DO?

- Ensure all ducting is rigid apart from the last 300mm approaching duct, or approaching terminal
- Keep duct work short and straight as possible
- Ensure joints are sealed
- Position fan to minimise length of ductwork - through the wall where possible
- Install condensate traps on vertical sections of duct work
- Cavity insulation to remain continuous round duct
- Specify and install ductwork that can be cleaned



CEILING MOUNTED EXTRACT

CAVITY INSULATION TO REMAIN CONTINUOUS ROUND DUCT

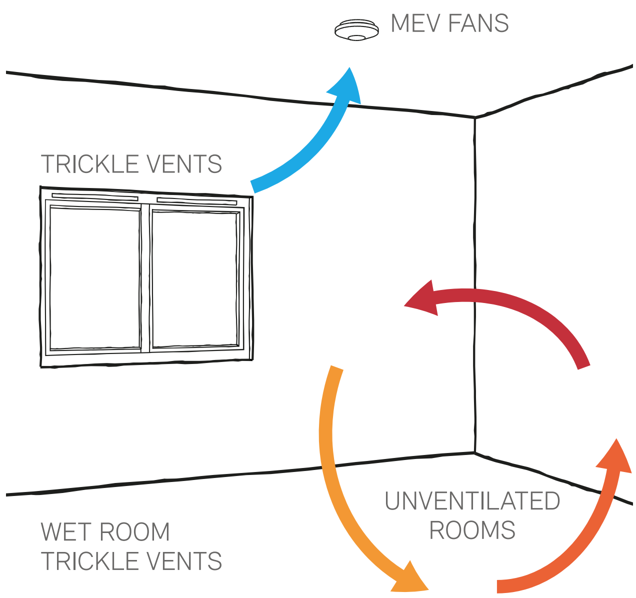


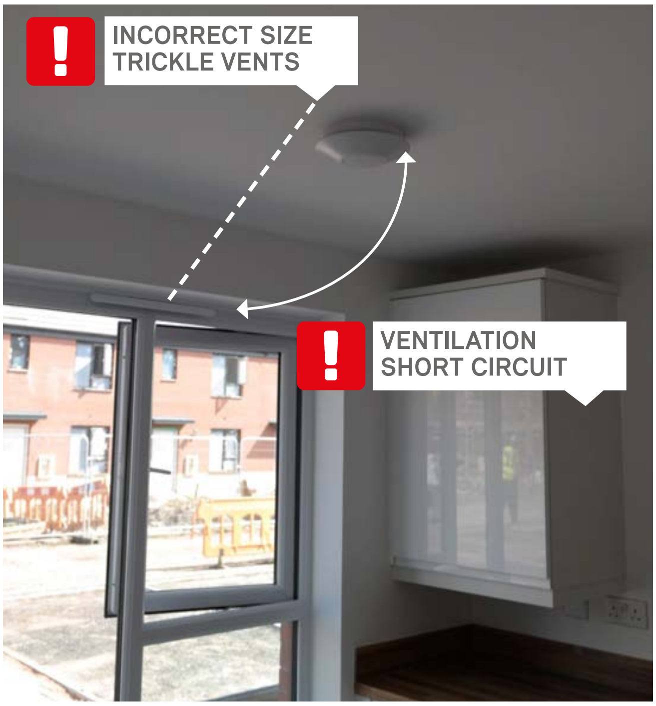
WALL MOUNTED EXTRACT

VENTILATION - TRICKLE VENTS 3.3

PROBLEMS TO AVOID

- Ventilation short circuit

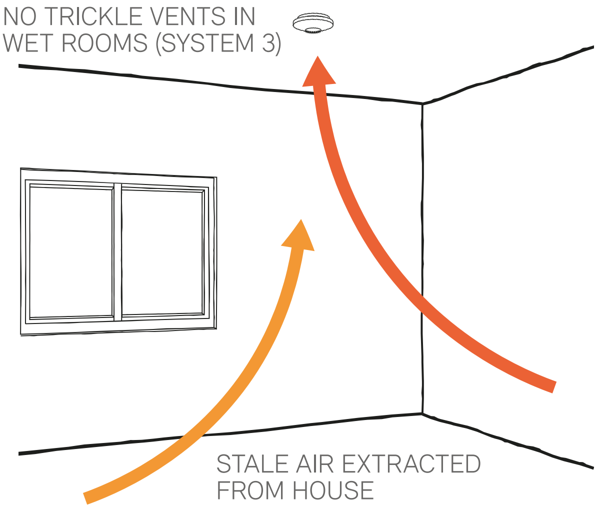




WHAT TO DO?

- Check window schedule and window order for trickle vents
- Tape up trickle vents during construction to protect from dust
- Explain use of trickle vents to occupants – keep open to ensure adequate ventilation

NOTE: Refer to part F for sizes depending on dwelling size, windows and airtightness



RULE OF THUMB FOR TRICKLE VENTS:

System 1 = large trickle vents: areas from AD(F),

System 2 = trickle vents to provide background air for passive stack

System 3 MEV = 2,500mm^2 for each room except wet rooms

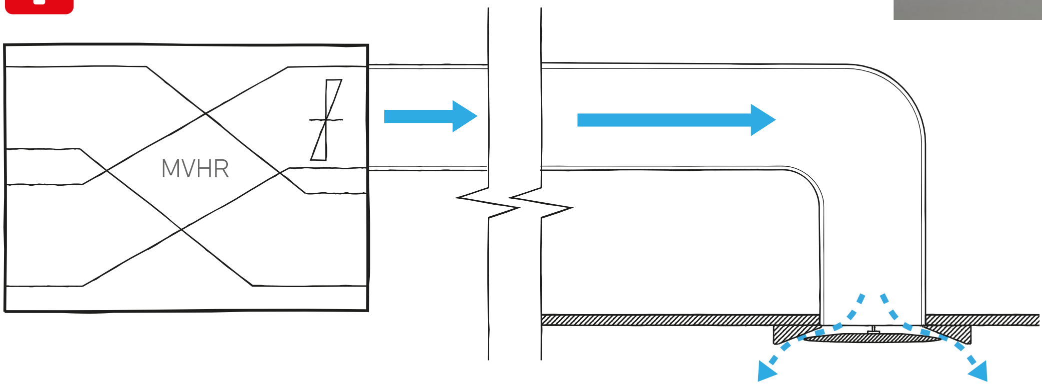
System 4 = no trickle vents

PROBLEMS TO AVOID

- Terminals not fixed in position with locking nuts, so easily altered
- System not balanced, so too much or not enough free area at terminal

TERMINALS TOO TIGHT
NOT ENOUGH FREE AREA

NOISY MVHR



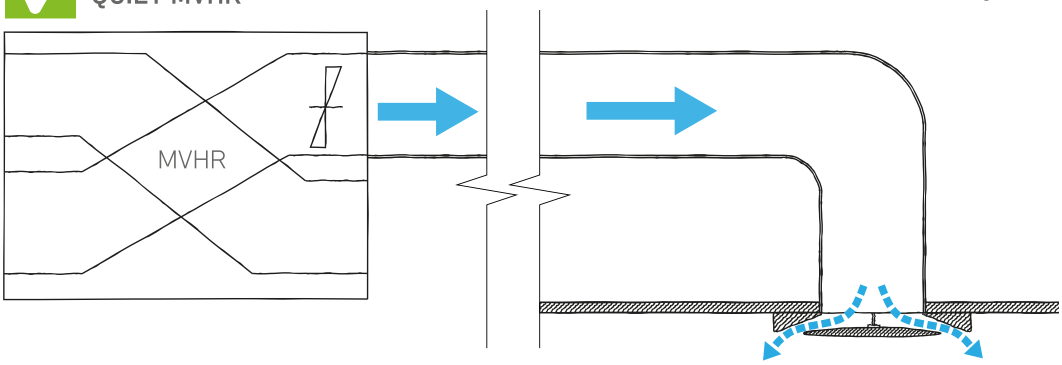
WHAT TO DO?

- Ensure enough free area at terminals - approximately a finger width gap dependant on ductwork and fan
- Fix terminals with locking nut after commissioning to prevent alteration

ALTERNATIVE VENTILATION TERMNAL
WITH FIXED FREE AREA

© RENSON

EFFICIENT /
QUIET MVHR



CORRECT
FREE AREA AT
TERMINAL

VENTILATION - MVHR

3.5

PROBLEMS TO AVOID

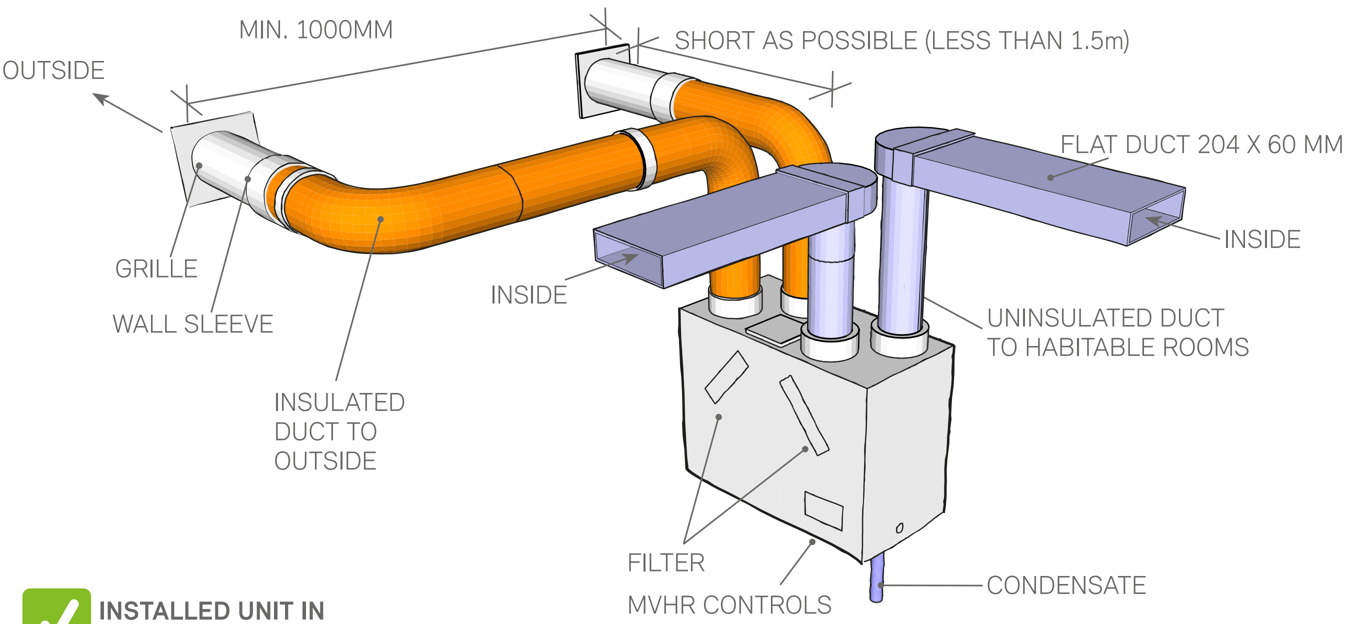
- Intake/Exhaust ducts not insulated
- Unit installed in loft creates problems of heat loss and access

HEAT LOSS IN LOFT

MVHR IN LOFT – UNINSULATED DUCT

WHAT TO DO?

- Use proprietary insultation ductwork for all ducts connected to outside
- Install MVHR inside heated, easily accessible space
- Install unit within 1.5 metre of outside wall for efficient operation



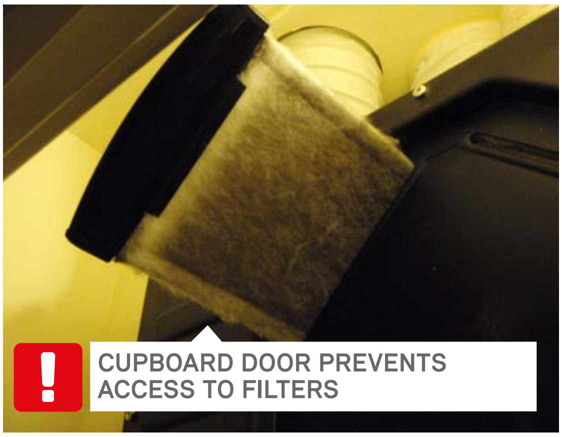
INSTALLED UNIT IN WARM SPACE

VENTILATION - MEV/MVHR

3.6

PROBLEMS TO AVOID

- Poor installation of ductwork, with multiple bends preventing air flow and creating noise
- Difficult access for maintenance
- Complicated information given to home owner



WHAT TO DO?

- Ensure access for cleaning and maintenance of unit, especially filters
- Ensure flexible connection is not crushed or kinked at the connection to the terminal
- Connect the ducting to the unit with minimal bends and positively fix with proprietary clips or collars
- Ensure ducts are not twisted around each other.
- Cut MDF template in ceiling with holes for duct penetration with a tidy, sealed finish
- Install MVHR/MEV units with mounting bracket on masonry walls or use suitable pattress for stud walls such as 18mm ply to reduce noise vibration
- Provide clear and simple information about the filters and maintenance to the home owner

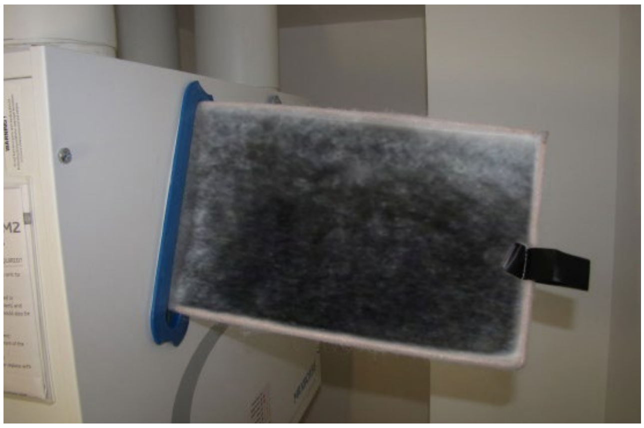
VENTILATION - OPERATION AND MAINTENANCE

PROBLEMS TO AVOID

- Home occupier handover not sufficient
- Dirty filters, ducts and heat exchanger will restrict air flow, leading to poor indoor air quality, condensation and mould
- Fans not commissioned

DIRTY DUCTS

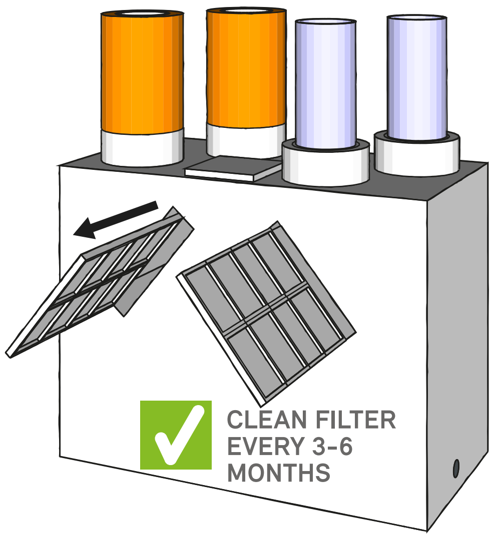
DIRTY FILTERS WILL SIGNIFICANTLY WORSEN INDOOR AIR QUALITY AND FAN EFFICIENCY



DIRTY EXTRACT FAN NOT MAINTAINED

WHAT TO DO?

- All systems to be commissioned on completion using air flow hood to measure normal and boost flow rate (BSRIA BG/2013)
- Provide completed commissioning sheets provided to the site manager and Building Control
- Write a simple Home User Guide to explain maintenance of ventilation (hard copy including images, online)
- Label the ventilation units to demonstrate maintenance
- Filters should be replaced every year
- Other maintenance (cleaning ductwork) will be carried out by a suitably qualified person



CLEAN FILTER EVERY 3-6 MONTHS

TESTING TO BE DONE WITH AIR FLOW HOOD

DVCG CHECKLIST

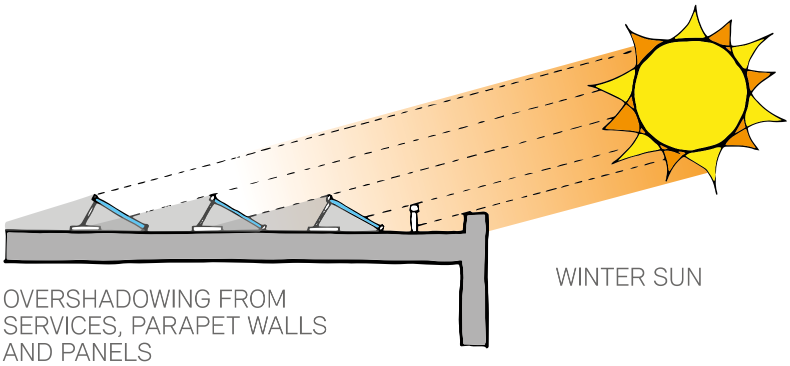
CLEAN DUCTWORK EVERY 5 YEARS

PHOTOVOLTAIC PANELS (PV)

4.0

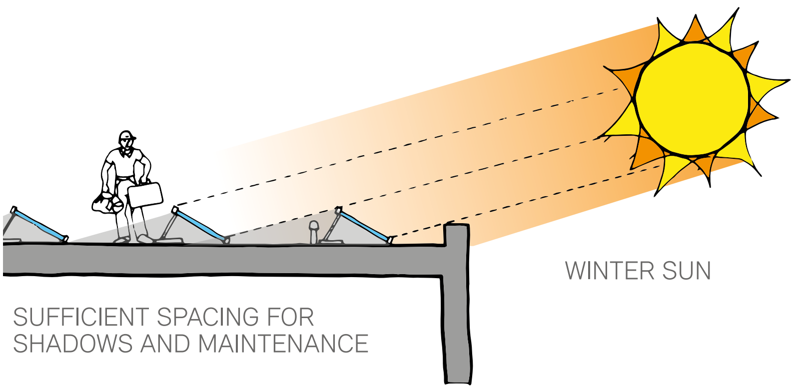
PROBLEMS TO AVOID

- PVs installed on north facing roofs, shaded roofs, or shading each other
- Product substitution for a worse performing PV panel
- Incorrect size of inverter



WHAT TO DO?

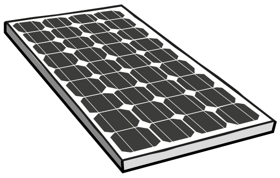
- Design and install PV to limit over-shading
- For flat roofs, 30° degree tilt will be most efficient, but 15° angle will cause less overshading and allow more panels
- Check PV panels match the performance in the specification and SAP
- Specify PV inverter that is optimised for the array
- Install energy feedback displays to enable occupants to optimise use of renewable energy



PHOTOVOLTAIC PANELS (PV) 4.1

PROBLEMS TO AVOID

- Specifying small amounts of PV to get SAP pass



1 PANEL = TYPICALLY 250, 265 OR 285 Wp

! 1 or 2 PV panels - will not produce significant energy and is too small for standard inverter

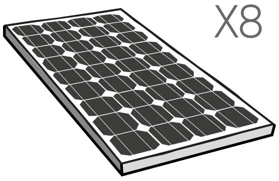
WHAT TO DO?

- Specify at least 2 kWp (8 panels) for significant renewable energy contribution
- Revisit the SAP to improve fabric performance instead of specifying 1 or 2 panels

RULE OF THUMB FOR MINIMUM PANELS:

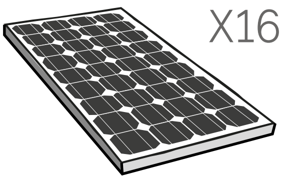
1 BED = 4-6 PANELS
2 BED = 6-8 PANELS
3 BED = 8-10 PANELS
4+ BED = 12+ PANELS

X8



8 PANELS = 2 kWp

X16



16 PANELS = 4 kWp

FIXED LIGHTING

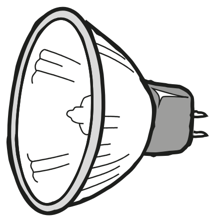
5.0

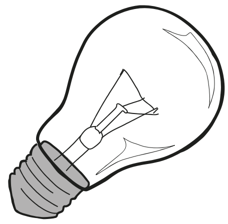
PROBLEMS TO AVOID

- Halogen, Tungsten filament or other standard lights installed
- 100% energy efficient lights specified in SAP, but standard downlights get installed

1 AD(L) building regs now require at least 75% low energy light bulbs
2 All traditional filament have been banned

NOT LOW ENERGY





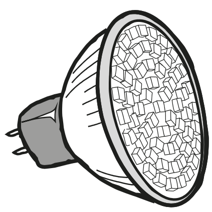
HALOGEN LIGHT BULBS (SPOTLIGHTS)

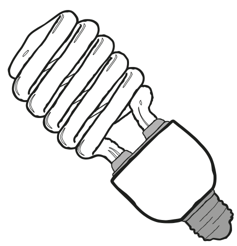
TRADITIONAL FILAMENT - INCANDESCENT (GLS)

WHAT TO DO?

- Fit CFL (compact fluorescent lights) and LEDs – to greater than 400 lamp lumens
- Aim for 100% low energy lights, but realise this will mean LED downlights
- Consider smart controls such as PIR or daylight sensors

LOW ENERGY LIGHTS





LED - LIGHT EMMITTING DIODE

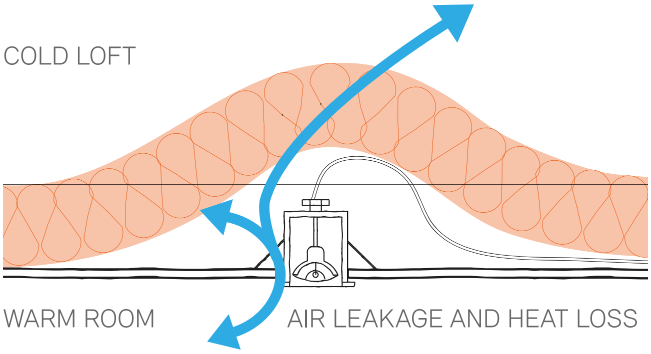
CFL - COMPACT FLOURESCENT LAMPS

DOWNLIGHTS

5.1

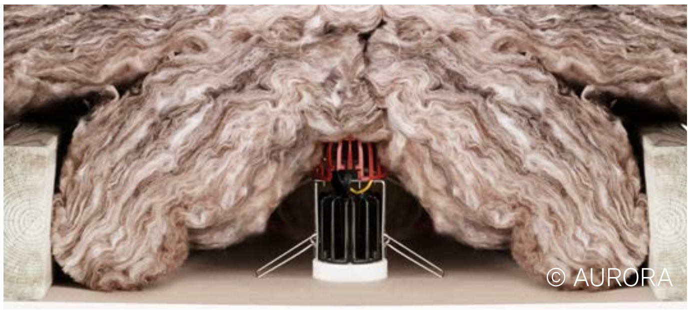
PROBLEMS TO AVOID

- Downlights not fire rated, not airtight, not low energy



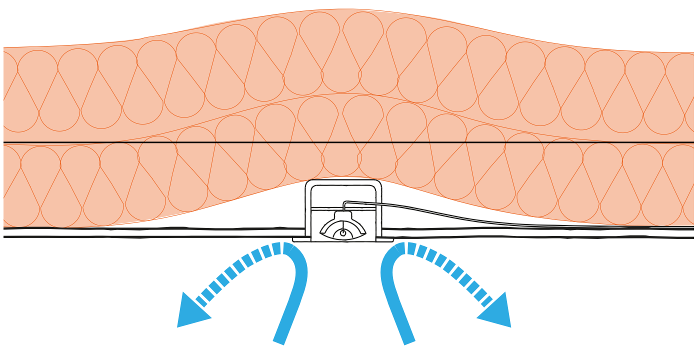
WHAT TO DO?

- Specify fire rated down-lights with sealed, airtight box
- Ensure airtightness – ply box or back box seal or sacrificial service zone with airtightness layer behind
- Install low energy lights – LED downlights



AIRTIGHT SEAL

INSULATION CAP



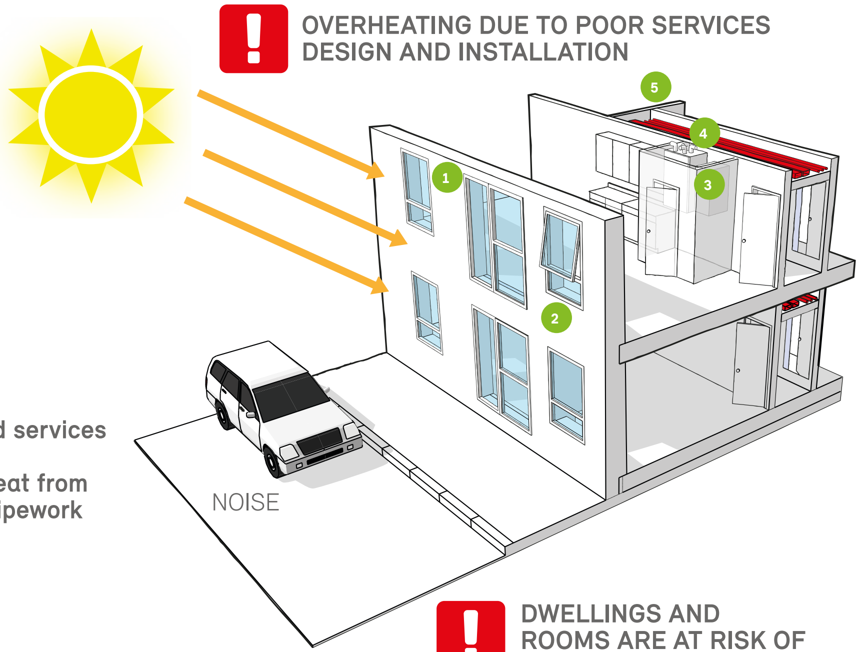
AIRTIGHT CAP OVER DOWNLIGHTS

OVERHEATING

6.0

PROBLEMS TO AVOID

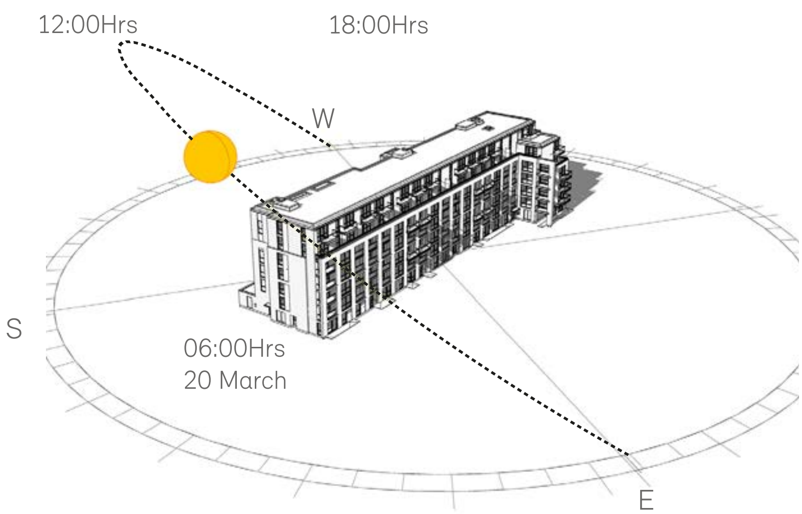
- Excess heat in homes resulting in high internal temperatures
- Bedrooms reaching temperatures above 26ºC at night (CIBSE TM52)
- Living rooms with temperatures above CIBSE TM52 standards



1. No shading or High G value window
2. Restricted windows single aspect
3. Ventilation unit not sufficient for purge ventilation
4. Un-insulated services
5. Unwanted heat from communal pipework

WHAT TO DO?

- Ensure the designer considers overheating and uses appropriate dynamic simulation software to analyse dwellings at risk
- Environmental modelling should use future climate data and consider urban heat island
- Reduce internal heat gains with efficient lighting and appliances
- Design and install communal heating to minimise heat loss from pipework to HIU eg. 70/40 flow return
- Where dwellings are at risk of overheating, consider passive design measures in 6.1
- Ventilate all risers and stairwells with temperature controlled AOVs
- MVHR to have automatic summer bypass and boost to at least three time standard rate

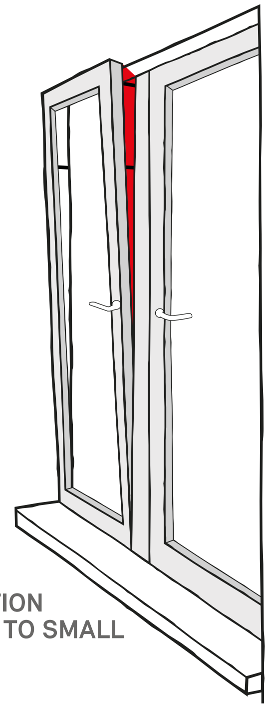


ENVIRONMENTAL MODELLING OF SOLAR GAIN AND OVERHEATING

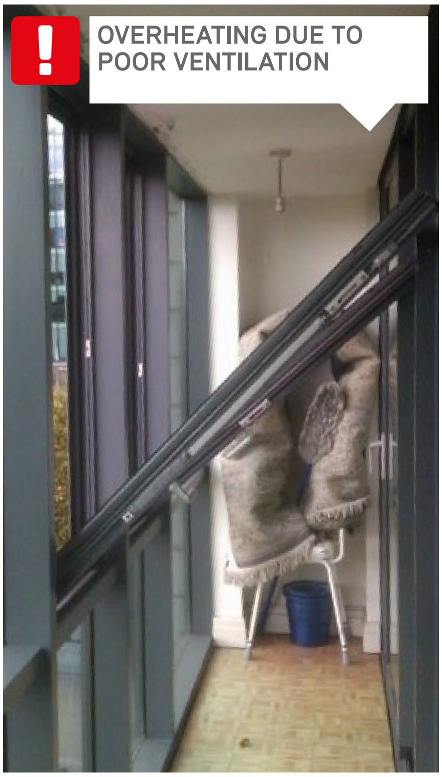
OVERHEATING 6.1

PROBLEMS TO AVOID

- Poor purge ventilation, with windows not opening fully
- Single aspect flats are especially at risk, with no opportunity for cross ventilation
- Restrictors limit the opening lights



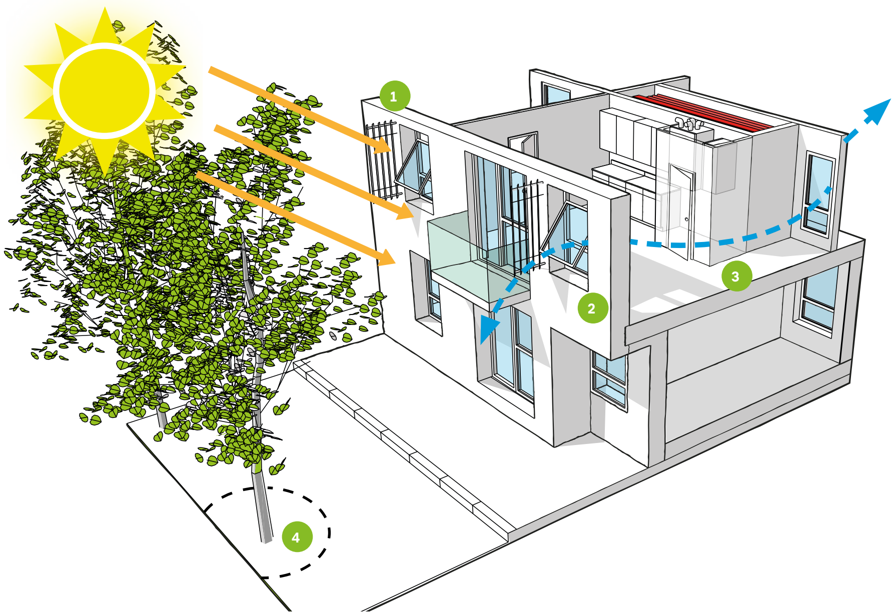
VENTILATION OPENING TO SMALL



OVERHEATING DUE TO POOR VENTILATION

WHAT TO DO?

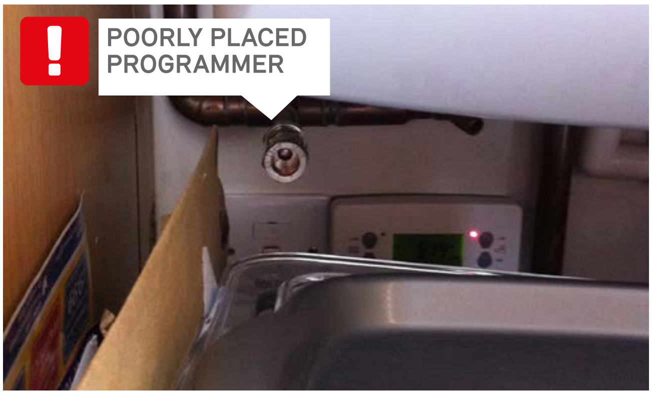
1. Reduce solar gain by:
   - External blinds, louvres or shutters
   - Overhanging eaves, balconies and window reveals
   - Low G value of glazing G < 0.4
   - Internal blinds within double glazed unit
2. Windows should be fully openable, and allow safe, secure purge ventilation in all cases
3. Internally exposed thermal mass such as concrete, plaster, tiles or brick can help regulate temperatures when combined with secure night time ventilation
4. Planting should be well irrigated and positioned in order to shade windows from summer sun



PROBLEMS TO AVOID

- Hidden and difficult to access controls
- Heat interface unit (HIU) cannot be easily read or used

POORLY PLACED PROGRAMMER



CONFUSING CONTROLS

© IAN MAWDITT

COMPLICATED AND SMALL CONTROLS

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WHAT TO DO?

- Install simple to use controls
- Place programmer in obvious, accessible place
- Install easy to read meters in accessible place
- Install smart controls and meters

© OWL

REAL TIME DISPLAY UNIT

SIMPLE BOILER CONTROLS

CONTROLS - VENTILATION AND ELECTRICS

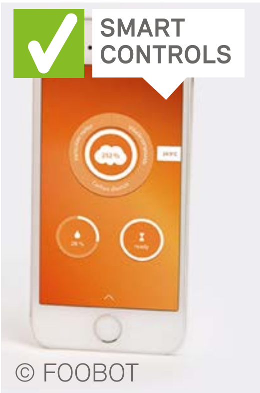
7.1

PROBLEMS TO AVOID

- Fan controls not labelled
- Controls not obvious and unmarked
- Appliances left on standby with excessive power consumption in un-occupied homes
- Controls with no feedback that ventilation is operating

WHAT TO DO?

- Label controls and switches for easy use and maintenance
- Install whole house shut down unit to prevent wasted electric use by occupier
- Consider automatic demand control with CO_2 and humidity sensors



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DESIGN/ PROCUREMENT STAGE CHECK 8.0

? WHAT TO CHECK?

- Fully co-ordinate drawings – with specialist subcontractor design for services
- Put key specification notes on drawings
- Ensure SAP calculation matches design drawings, specification and site installation
- Match airtightness strategy with ventilation strategy – "build tight, ventilate right"
- Simple M & E design will help installation, use and maintenance
- Be wary of complicated new technology and ask for experienced installers
- Use performance based specifications, numerical targets and ask manufacturer and contractor for input into design
- Specify "as built" monitoring of performance using measurable targets
- Ensure commissioning check and handover is part of M & E service
- Ensure enough space for access and maintenance of services
- Specify suppliers and installers that are adequately experienced and qualified:
  - MCS certified - any renewable technology
  - BPEC - ventilation, renewables, plumbing, electrics
  - GAS SAFE - gas appliances/boilers
- Ensure performance targets are met by any product substitution and check with design team and SAP Assessor before agreeing to substitution
- Refer to other guidance and checklists from BSRIA, CIBSE and RIBA plan of work

CONSTRUCTION STAGE CHECK 8.1

? WHAT TO CHECK?

- Seal all penetrations in the floor slab for SVPs and all incoming services: water main, electrical riser, gas pipe
- Seal penetrations in the external wall for lights, BT, doorbell, garage power, boiler flue, any other services and holes in structure
- Install condensate drain for boilers and ventilation units and seal airtight
- First fix heating controls including programmers, room thermostats, weather compensators etc.
- Insulate all hot water pipework that will become concealed
- Install radiator pipe outlets with air seal
- Install Waste Water Heat Recovery (WWHR) to manufacturer's instructions
- Install Solar Thermal to manufacturer's instructions with pre-insulated pipework
- Check downlights have been installed with correct detail to maintain insulation thickness and airtightness
- Fully seal all gaps behind kitchen units, wet rooms, wardrobes and boiler flues
- Check pipework and ductwork has been insulated
- Check ductwork is installed with minimum bends and minimum flexi duct
- Check boiler, cylinder and controls are in line with the design, location, specification and SAP. Speak with Design Team if not
- Take photos as a record of completed work at different stages

COMMISSIONING / HAND OVER

8.2

? WHAT TO CHECK?

- Check air test has been completed in line with regulations
- Complete Domestic Ventilation Compliance Guide installation checklist
- Ventilation specialist to complete commissioning of ventilation units and flow rate measurement
- Check all electrical certificates and ask Electrician to explain if necessary
- Check renewable technology has been installed as per the design, model and location
- Check renewable technology been installed and commissioned by MCS certified contractor
- Check renewable technology has safe and easy access for maintenance
- Complete Homes User Guide, accessible for all in different formats including online and hard copy with diagrams/ images
- Label services for future maintenance
- Give occupant a home welcome visit and return 6 weeks afterwards to check operation
- Encourage occupants to try out operating systems and controls
- Come back 6 -12 months later to check services in operation and energy bills as expected
- Carry out post occupancy evaluation using customer surveys and environmental monitoring in years 1-3

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