Department for Education

Reinforced Autoclaved Aerated Concrete (RAAC)

Estates guidance

December 2022

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Contents

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Summary

This publication provides non-statutory guidance from the Department for Education. This guidance has been produced to help Responsible Bodies from the education system (school and college leaders, staff and governing bodies) understand the process of assessing, investigating and developing a Reinforced Autoclaved Aerated Concrete (RAAC) management and remediation strategy. It also provides guidance on the level of information to be provided by specialists, to ensure a consistent approach to RAAC assessment.

Review date

This guidance will be reviewed before December 2023.

Who is this publication for?

This guidance is for:

- local authorities (for community, voluntary-controlled schools and maintained nurseries)
- academy trusts (for academies and free schools)
- governing bodies (for voluntary-aided schools)
- school/college leaders, staff and governing bodies in further education colleges, maintained schools, academies and free schools or other education settings
- building professionals (e.g., structural engineers) who have been commissioned to provide technical advice to the above clients regarding RAAC.

Definitions

Terms and acronyms used throughout the guidance are defined below.

Bearing - The width or distance that a RAAC element (panel or plank) sits on the support, measured from the edge of the support to edge of the panel.

Bending - The force within a structural system that causes deviation from a straight line to a curve.

Compression - The force within a structural system that pushes down or into an element.

Panel - The term to describe the individual RAAC element. May be referred to as ‘plank’ when considering horizontal elements.

Span - The horizontal (or vertical) distance between supports, typically measured from the centreline of the supports. Clear span is often used to describe the distance between the faces of support.

Shear - The force within a structural system that causes slippage on a plane of failure, typically close to a support.

Introduction

This publication provides non-statutory guidance from the Department for Education (DfE). It has been produced to help estates' teams/site managers understand the process of assessing, investigating and managing the presence of Reinforced Autoclaved Aerated Concrete (RAAC) panels in floors, walls, eaves and roofs (pitched and flat).

This publication replaces previous guidance issued by the DfE entitled 'Reinforced Autoclaved Aerated Concrete: Lightweight Concrete Roofs - A guide for identification and initial action' dated February 2021.

The Local Government Association (LGA) has previously issued advice about Reinforced Autoclaved Aerated Concrete (RAAC) in schools, with the Department for Education (DfE) also issuing an alert drawing attention to the LGA advice.

This guidance note is set out in two sections, supported by two appendices:

Section 1 - Stage Approach Summary, this section briefly summarises the five stages as outlined diagrammatically below.

Section 2 - Detailed guidance on each stage, this section discusses each stage in detail.

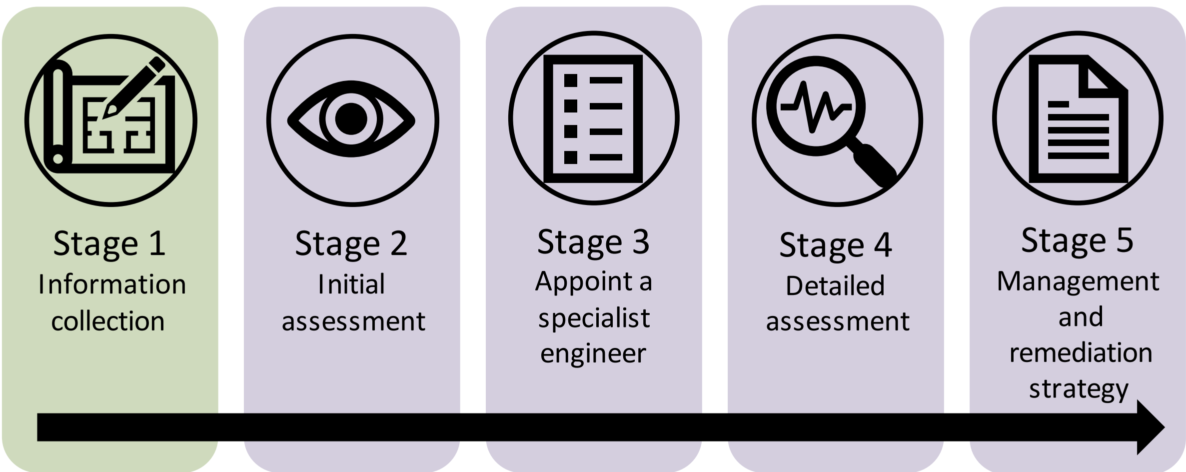

Figure 1: Guidance stages

Flowchart of Guidance Stages

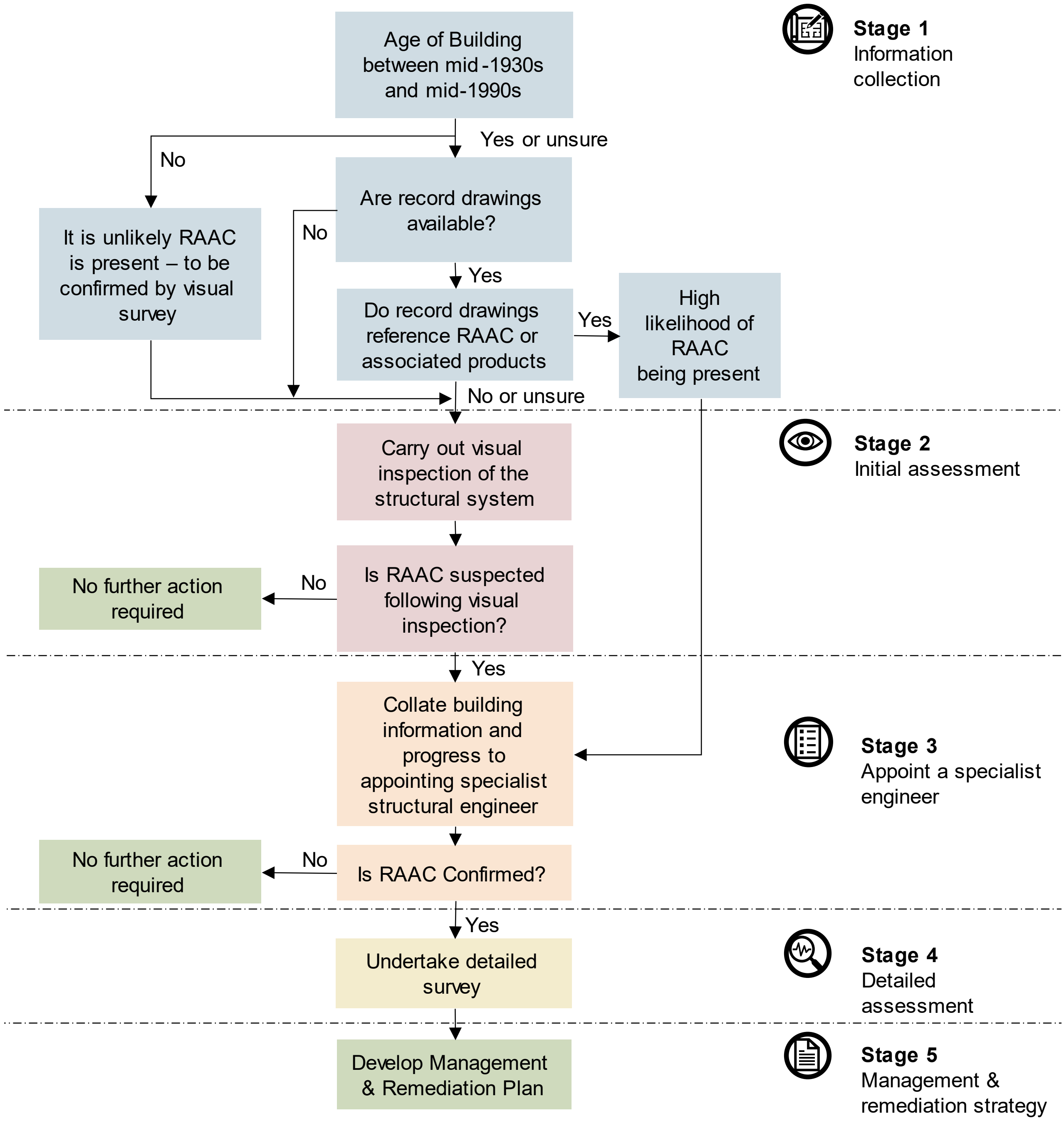

Figure 2: Flowchart of guidance stages

What is Reinforced Autoclaved Aerated Concrete (RAAC)?

Reinforced Autoclaved Aerated Concrete (RAAC) is a lightweight form of concrete. The Standing Committee on Structural Safety (SCOSS) has noted that: ‘Although called “concrete”, (RAAC) is very different from traditional concrete and, because of the way in which it was made, much weaker. The useful life of such (panels) has been estimated to be around 30 years’ (SCOSS Alert, May 2019).

If RAAC is suspected, a specialist Structural Engineer should be appointed. If RAAC is confirmed, the specialist should undertake a detailed assessment and prepare a management and remediation strategy.

Where is RAAC commonly found?

RAAC was used in schools, colleges and other building construction from the 1950s until the mid-1990s. It may therefore be found in any school and college building (educational and ancillary) that was either built or modified in this time period.

Where unsure of the date of construction and/or modification of buildings, it is advised to assess all buildings thought to be constructed between the mid-1930s and mid-1990s.

RAAC ‘panels’ were precast offsite and used for flat and pitched roofs, eaves, floors and walls within building construction.

Refer to Appendix 2 for further images of RAAC panels.

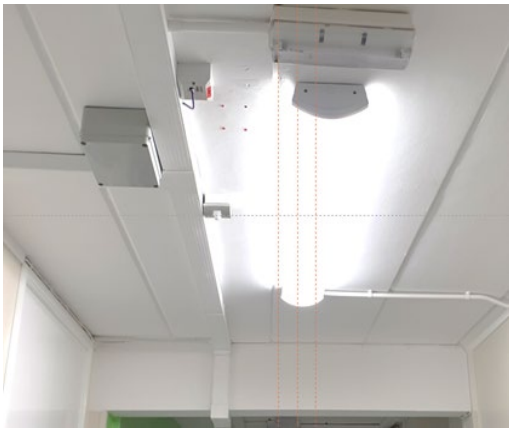

Figure 3: Images of RAAC panels

RAAC panels can span between isolated beam supports (steel or concrete) or onto masonry walls (brickwork or blockwork).

Typically, panels are hidden behind finishes (suspended ceilings or plasterboard) and therefore may be difficult to identify without minor intrusive works. Ceiling panels may need to be removed to inspect a roof or access may be required into loft voids.

RAAC panels are usually (but not always) 450mm to 600mm wide and 2.4m to 3m long, although panels were available up to 6m in length. They typically have a slight chamfer to each edge. The colour varies from white to pale grey. In a roof, the easiest way to identify RAAC panels is to look at the underside.

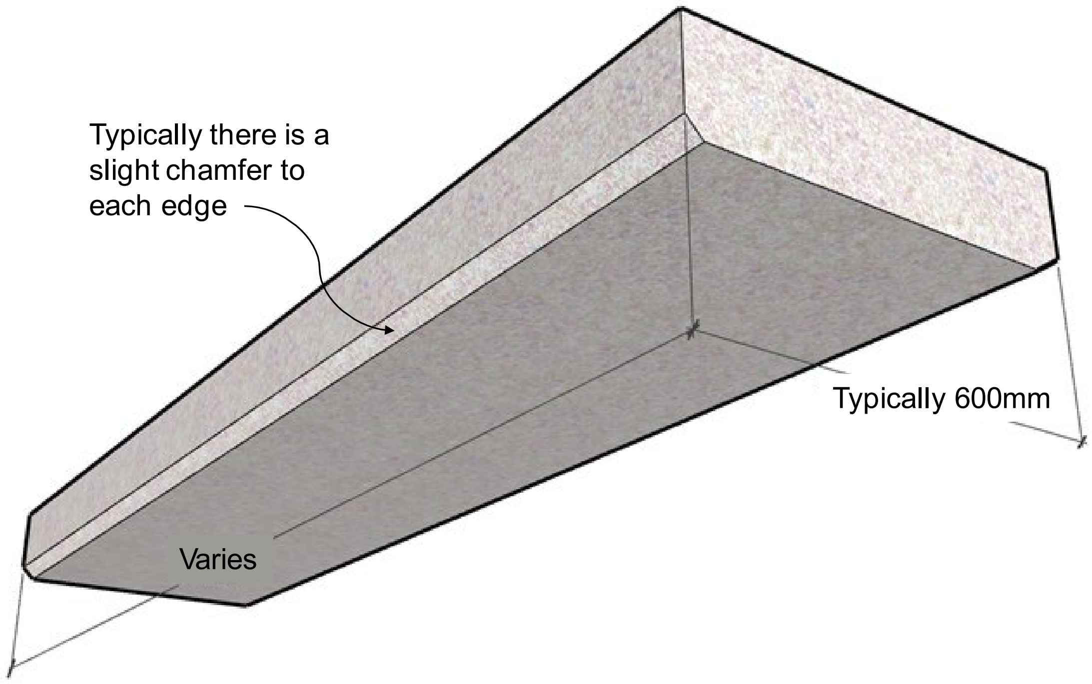

Figure 4: Typical RAAC panel geometry

A number of building owners have already taken steps to identify RAAC. For those that have not, this guidance explains how a Responsible Body (e.g., local authority, academy trust, diocese, or governing body) can carry out an initial check to determine whether further advice/action is necessary.

Note: You may need to engage an appropriately qualified person to help carry out this initial check. If in any doubt, seek qualified help from a chartered surveyor, structural engineer, architect, or other construction professional.

Why is RAAC a potential risk?

In the 1990s, several bodies recognised structural deficiencies apparent in RAAC panels installed up until the mid-1990s. It was recognised that the in-service performance was poor with cracking, excessive displacements and durability all being raised as concerns.

In the mid-1990s, the Building Research Establishment (BRE) undertook a number of inspections of school roofs, reporting the findings within BRE Information Paper IP10/96. The paper highlighted the concerns outlined above. The concerns were also raised within the 1997 Standing Committee on Structural Safety (SCOSS) report. The report recommended that school owners should identify and inspect RAAC panel construction to determine deterioration and put in place management strategies.

In December 2018, the Department for Education (DfE) and the Local Government Association (LGA) made building owners aware of a recent building component failure in a property constructed using RAAC. In May 2019, SCOSS raised an alert to emphasise the potential risks from such construction and highlighted the failure of a RAAC panel roof construction within an operational school. This collapse was sudden.

RAAC has the following embedded systemic problems:

- Panels have low compressive strength, being around 10-20% of traditional concrete, meaning the shear and bending strength is reduced. This strength is further impacted by water saturation.
- It is very porous and highly permeable. This means that the steel reinforcement within the panels is less well protected against corrosion ‘rusting’ than steel reinforcement in traditional concrete.
- The reinforcement within RAAC panels is less well bonded to the surrounding concrete. The dominant connection is via secondary reinforcement (transverse reinforcement).
- It is aerated (looks ‘bubbly’) and contains no ‘coarse’ aggregate, therefore it is less dense than traditional concrete; being around a third of the weight.
- RAAC has reduced ’stiffness’ characteristics resulting in high displacements, deflections and sagging.
- The bearing of planks is often insufficient, by comparison to modern standards, which presents a significant risk.
- There was limited quality control during manufacture and installation meaning there is a high degree of variability between panels.

It is recognised that RAAC panels have material and construction deficiencies making them less robust than traditional concrete. This increases the risk of structural failure, which can be gradual or sudden with no warning.

Sudden failure of RAAC panels in roofs, eaves, floors, walls and cladding systems would be dangerous, and the consequences could be serious.

Section 1 - Stage Approach Summary

This section sets out the five stages of the process of assessing, investigating and developing a RAAC management and remediation strategy.

The suggested ownership of each task is provided within this section.

It is recommended that a consistent owner of the process is identified early on and maintained throughout to ensure continued estate knowledge.

A flowchart of this process can be found on page 10.

Stage 1: Information Collection

Stage 1 should be undertaken by a person or team familiar with the day-to-day running of the school and with some knowledge of the buildings. See page 17 for detailed guidance.

Stage should include:

- familiarisation with the existing guidance on RAAC (i.e., publications by DfE, BRE, CROSS)
- collation of existing building record information
- identification of property age and details of modifications
- reading of Condition Data Collection (CDC) report
- raising awareness of RAAC within the building to wider site and education team
- development of initial RAAC risk profile.

Stage 2: Initial Assessment

Stage 2 may be undertaken by someone who has responsibility for building or estate management as well as the day-to-day running of the school. Depending on experience, advice may be required from a building professional. See page 21 for detailed guidance.

Stage should include:

- a visual inspection to identify presence of RAAC
- a log of interventions and adaptions associated with RAAC
- identification of applied loading (weight applied) conditions to RAAC
- identification of deterioration to RAAC
- identification of high-risk spaces which contain RAAC

Stage 3: Appoint a Specialist Engineer

Once RAAC has been suspected or identified, a specialist Structural Engineering Consultant should be appointed to undertake a detailed assessment. To ensure consistency, the consultant should adopt a unified scope. See page 28 for detailed guidance.

Stage should include:

- establishing a scope of works
- requesting evidence of credentials and relevant experience of specialist Structural Engineer
- appointing a specialist Structural Engineer.

Stage 4: Detailed Assessment

Stage 4 should be undertaken by the consultant structural engineer. See page 30 for detailed guidance.

Stage should include:

- validation of the information collated in previous stages
- detailed visual appraisal
- intrusive investigation (where appropriate)
- development of the management and remediation strategy dataset.

Stage 5: Management and Remediation Strategy

Stage 5 collates the information from Stage 4 and presents how RAAC should be managed on site. This is focused on the long-term strategy for remediation which is based on the risk profile. This will be developed by school staff with input from the consultant structural engineer. See page 35 for detailed guidance.

Stage should include:

- ownership/organogram of responsible persons for the management of RAAC
- overview of RAAC locations and condition
- remediation proposals
- management proposals
- communication strategy
- risk assessment.

Section 2 - Detailed guidance on each stage

This section provides detailed information about each of the five stages of the process of assessing, investigating and developing a RAAC management and remediation strategy.

Stage 1 - Information Collection

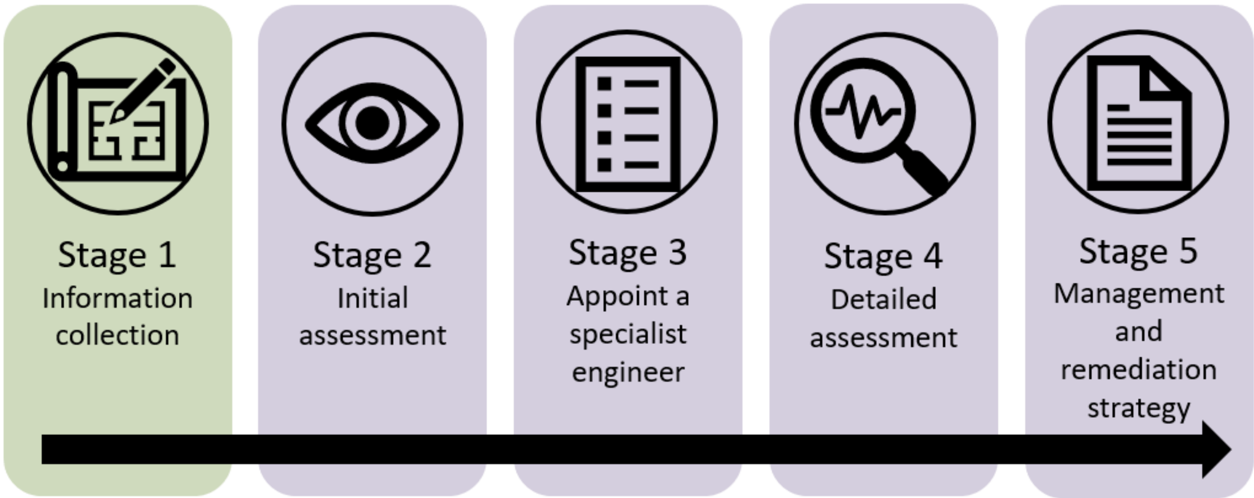

Figure 5: Stage 1 Information Collection

Stage 1 should be undertaken by a person or team familiar with the day-to-day running of the school and with some knowledge of the buildings.

Stage 1 is necessary to ensure that those doing future stages have the most accurate information for their assessment. This will reduce costs when appointing external suppliers.

The information gathered will be used to identify the potential risk of RAAC in existing buildings. It should draw upon the knowledge of the onsite technical or estates team.

The building identification will rely on access to existing records for the buildings within the estate. However, it is recognised that the level of record information will vary and therefore not all information will be available.

Review existing RAAC guidance

The onsite technical or estates team should familiarise themselves with existing guidance on RAAC. The following resources are available:

- Reinforced autoclaved aerated concrete (RAAC) panels: Investigation and Assessment – The Institution of Structural Engineers - March 2022
- SCOSS Alert: Failure of reinforced autoclaved aerated concrete (RAAC) planks - May 2019

- Reinforced autoclaved aerated concrete panels: review of behaviour, and developments in assessment and design – BRE 445, 2002
- IP10/96 – Reinforced autoclaved aerated concrete panels designed before 1980 – BRE, 1996

Collate information on existing building records

The onsite technical or estates team should collate all relevant existing building information within the estate. This should include the following:

- when different parts of the school were built; this may include correspondence, drawn information (outlined below), local authority planning or building control references
- drawn information; this should include historic building plans, sections and elevations together with any detailed construction drawings showing the structural framing
- record photographs; construction photographs, aerial photographs, historic maps – these may be used to help determine construction dates
- specifications or reports; this may include building specifications, condition, or investigation reports
- Condition Data Collection (CDC) report(s)
- dates and information of any alterations, extensions or interventions within the existing building that may have caused either the addition of RAAC panels, or an adaptation to RAAC panels
- building services systems and revisions; any adaptions that may have altered loading, fixings into roof or floor systems or altered internal environments within a space (humidity, temperature etc)
- re-roofing works; confirmation of any works that may have been undertaken and the reasons why e.g., ponding or leaking.

Where existing building information mentions RAAC, the following should be confirmed:

- the type of RAAC e.g., Siporex, Durox, Celcon, Thermalite, Hebel and Ytong;
- the size and shape of RAAC panels - the overall dimension, thickness and width; and
- records of previous investigation work, if any.

Where no building information exists, anecdotal information should be recorded to provide insight into the development of the estate.

Note: The asbestos register must be consulted.

Understand the property age

The property age is critical when determining the risk profile and potential for RAAC. Using the knowledge of the onsite technical or estates team, an initial risk assessment should be carried out to identify the age of construction of all buildings on site as well as the age of any modifications, including modifications to buildings constructed before 1930, and determine whether they present a risk.

RAAC panels constructed between 1955 and 1990 are considered to be at the highest risk. Given some buildings constructed in the 1930s and 1940s can have similar characteristics to those built in the 1950s, care should be taken to ensure a building's age has been identified correctly. Where unsure of the date of construction and/or modification of buildings, it is advised to assess all buildings thought to be constructed or modified between the mid-1930s and mid-1990s. If in doubt, further advice should be sought. There is also the possibility that modifications and refurbishment of pre-1950s buildings have used RAAC, again further advice should be sought, if in doubt.

The age of construction and modification of buildings should be identified within the building plans or aerial photographs. An example is shown below. This should include all buildings on the site and include modifications and minor ancillary buildings.

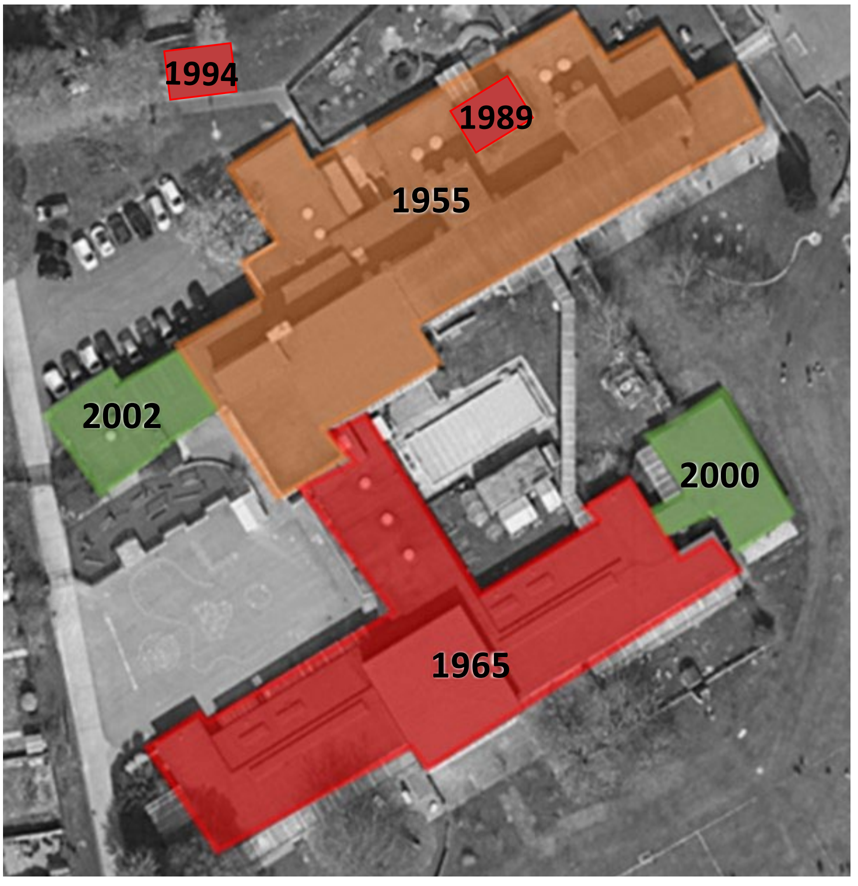

Figure 6: Example diagram showing property ages on aerial photograph

Raise awareness

If any buildings are identified as being at risk of containing RAAC, the property lead should raise awareness with all members of staff.

It is important that the potential risks are communicated to all members of staff and the affected areas are appropriately managed and monitored. Refer to Stage 5 for further details.

Develop an initial RAAC risk profile

An initial risk assessment should be undertaken. It should consider:

- the occupancy risk: how many and how often do people access the space. How vulnerable are the users or what the risk to the operation of the facility may be e.g., the impact should a boiler room be disrupted
- the service risk: are the panels in areas that present a risk of accelerated degradation e.g., under leaking or previously leaking roof structures, in high humidity spaces such as plant, kitchen, pool or changing rooms, areas of increased or historic loading, areas subjected to vibrations etc.

Stage 2 - Initial Assessment Guidance

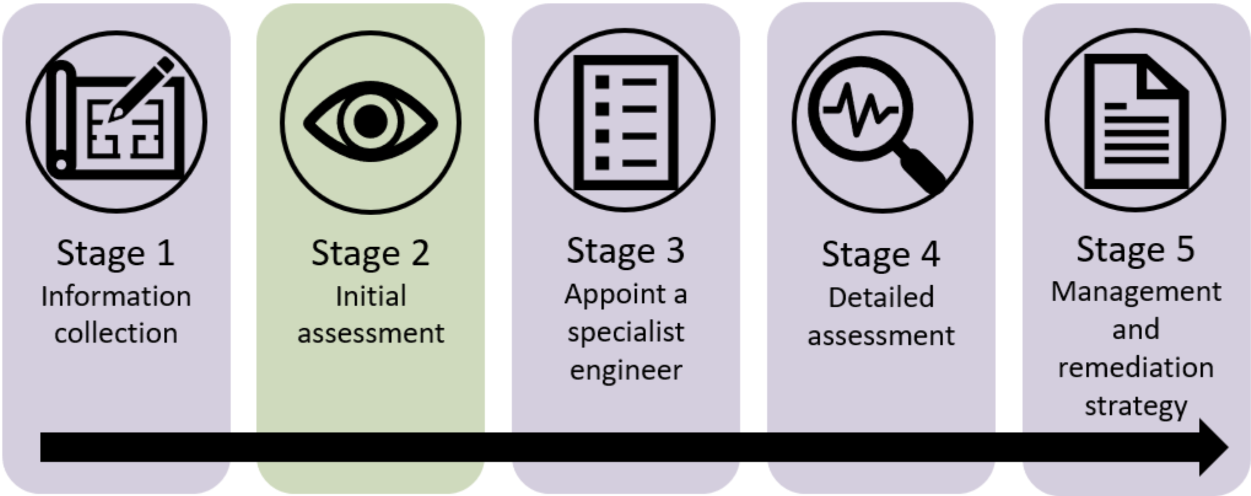

Figure 7: Stage 2 Initial Assessment

Stage 2 may be undertaken by someone who has responsibility for building or estate management as well as day-to-day running of the school. Depending on experience, advice may be required from a building professional.

If, based on the information gathered in Stage 1, there is the possibility of RAAC being present, a visual inspection should be carried out on site by the technical or estates team. This initial assessment should be used to confirm the presence of RAAC, the existing structural form, risk factors that may inform the risk profile and any observed defects. There are the following key steps to Stage 2:

- plan the inspection
- carry out the inspection
- record key structural details based on inspection findings
- record known historic interventions
- identify applied loading
- identify deterioration of RAAC panels
- identify high risk spaces

While many of these steps could be carried out by a qualified structural engineer (see Stage 3 for procurement guidance) it is recommended that as much information as possible is gathered and recorded prior to their appointment.

Planning the inspection

A plan should be made to ensure the inspection can be carried out safely. This may include visiting the areas for inspection to identify any access and safety issues, understand the extent of work involved, undertake a risk assessment, and plan the work. The height of the area for inspection is an important safety consideration.

During the planning you should consider the following questions:

1. Is the area for inspection so high that access equipment will be needed to see the surface clearly? If yes, engage an appropriately qualified person to access the area.
2. Can the area for inspection be seen clearly and accessed easily? If yes, take photographs to compare with this guidance or email to a qualified professional for an expert opinion.
3. Is the area for inspection less than 3m above the floor and covered with a suspended ceiling? If yes, it may be possible to access the area by following the guidance in the 'Safe use of ladders and stepladders' by the Health and Safety Executive (HSE), removing a ceiling panel and viewing the underside of the roof or floor.
4. What type of suspended ceiling is present? Use the 'Best Practice Guide – Maintenance and Access into Suspended Ceilings' from the Finishes & Interiors Sector (FIS) to identify the type of ceiling panel used; some can be accessed easily, while others require specialist input.

Where a roof and/or upper floor is hidden by a suspended ceiling, you will need to gain access to the ceiling void or remove at least part of the suspended ceiling.

Before attempting this, you should consult the school's asbestos register to make certain that the ceiling void does not contain asbestos material.

Asbestos

Take particular care when inspecting a roof or ceiling void due to the possible presence of asbestos-containing materials. Before breaking through plasterboard into a ceiling void, consult the asbestos register or arrange an asbestos survey if this has not been conducted previously.

Even if an asbestos register is available, suspended ceiling tiles may not have been lifted during the survey, and subsequent works in the ceiling void may not have been well managed, leading to the possibility of asbestos debris within the void.

RAAC panels may have been coated with Artex. In this case, the panel should only be broken into by an asbestos professional under controlled conditions (see note on Artex, below).

Further information about managing asbestos is available online from the Health and Safety Executive (HSE): Managing my asbestos - A step by step guide to the duty to manage asbestos.

Artex (also refer to the **asbestos** note above)

Where there is an Artex coating it is harder to determine the presence of RAAC. A structural engineer specialising in RAAC could undertake this either visually, based on the age of the building (and structural form elsewhere and within the area) and looking for reflective cracking at panel locations OR intrusively from above by using a small drill hole (circa 30-50mm) to determine whether RAAC is present. Note: This should be undertaken carefully as RAAC panels are likely to present little resistance to drilling.

Any drilling should be preceded by cover-meter scanning to avoid reinforcement where possible and care should be taken where panels may be considered unstable. (Cover-meter scanning enables the position, depth and size of reinforcement bars buried in concrete to be estimated.) Large core drilling is not recommended given the potential to strike reinforcement or cause instability.

Any drilling from above will need thorough reinstatement of the waterproofing (where applicable) to prevent water ingress that could lead to plank instability.

If you do not have sufficient experience to inspect the area safely, you should engage an appropriate structural engineer specialising in RAAC to carry out the inspection. You (or the structural engineer) should undertake a thorough risk assessment to plan how to carry out the inspection safely.

Carrying out the inspection

To carry out a visual inspection you may need to take some photographs and expand them to get a close-up view of the surface to compare with the photographs in this guidance.

If you can see a concrete surface and can safely reach it, tap it with a hammer to identify whether it is normal heavyweight concrete or lightweight RAAC. Normal concrete sounds solid and hard when tapped, while RAAC feels much softer. If the panels do not have a coating, try to push a small screwdriver or nail into the material. A screwdriver will not penetrate normal concrete but will make a small hole in RAAC. **If there is a coating, do not make a hole – the coating may contain asbestos.**

Do not go up onto a roof, particularly if there is no safe means of access, such as a staircase, or there are no guardrails around the roof perimeter.

Where a roof or floor is concealed by a suspended ceiling and the panels are relatively light and can be lifted up and moved to one side to expose the ceiling void, follow the Best Practice Guide – Maintenance and Access into Suspended Ceilings' from the

Finishes & Interiors Sector (FIS). Use a torch to view the underside of the roof and take photographs. Do not touch or disturb any of the materials in the ceiling void.

No risk is identified

If you are confident that your roof, eaves, upper floors and/or walls are of the common forms of non-RAAC construction outlined in Appendix 1 of this guidance, no further action is required.

Risk is identified

If you think your roof, eaves, upper floors and/or walls may be constructed of RAAC panels, or you are not sure what the form of construction is, you should arrange an inspection/assessment by a structural engineer specialising in RAAC. That is the responsibility of the Responsible Body.

If there are plans for an asbestos survey, this can be a good opportunity to check for RAAC panels at the same time. It would also be worth ensuring that any routine condition survey specifically covers RAAC.

If RAAC is suspected or identified (using Appendix 2 as necessary), the following should be recorded (wherever possible):

- the span direction of panels
- the number of panels within the space
- the approximate width of panels
- the type of supporting structure e.g., steel frame, concrete frame, masonry walls etc and evidence of bearing width
- any evidence of ‘cut’ or ‘damaged’ panels
- any evidence of water ingress

While this information could be carried out by a structural engineer, with a thorough risk assessment in place to ensure safe and sufficient access, the onsite technical or estates team may be able to gather this information, saving time and cost.

If the presence of RAAC panels is confirmed, remedial work may be required. Your structural engineer will be able to advise on the level of risk, and scope and costs of any necessary work, based on their survey and assessment.

The information should be recorded on plan drawings, such as fire plans. See the example below:

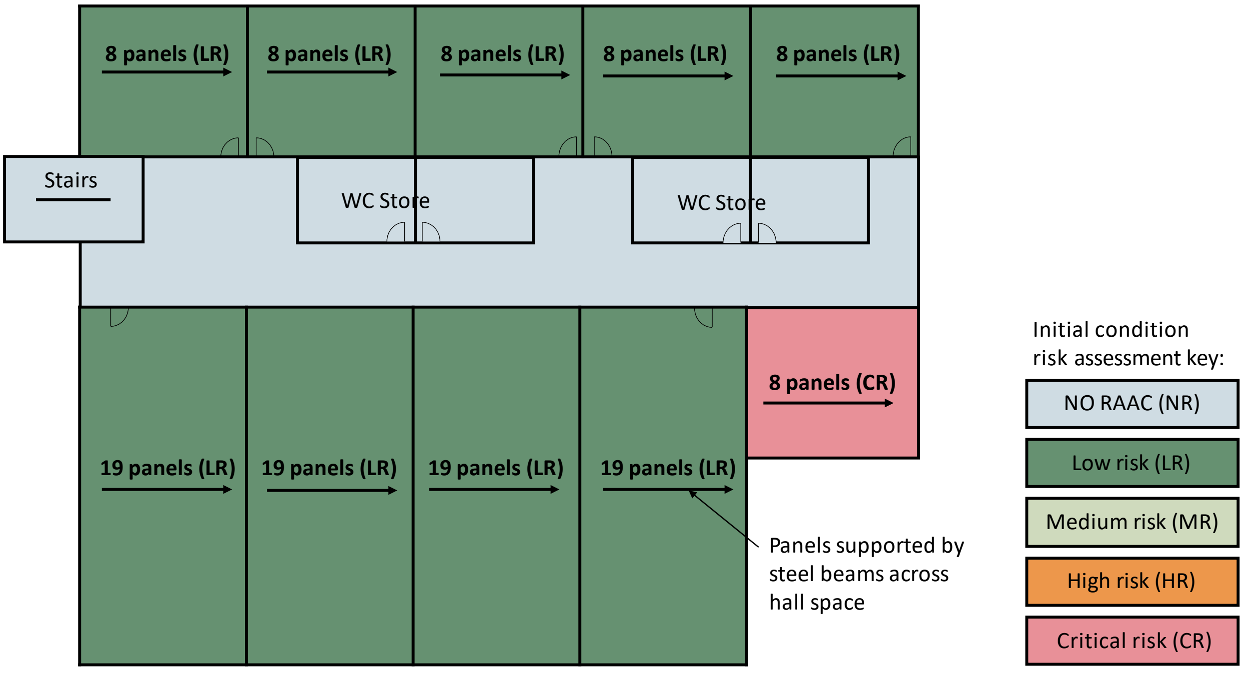

Figure 8: Diagram showing RAAC panel span direction (arrows), number of RAAC panels (number) and initial condition risk assessment (colour)

Log interventions and adaptions associated with RAAC

It is important that any adaptions to RAAC panels are identified. Adaptions, either from the original construction or through later works, should be identified and noted within the RAAC management strategy as these may affect the integrity of the panels. (The RAAC management strategy is covered in detail in Stage 5, it is a live document recording the location and condition of RAAC within the estate, as well as remedial actions that have been undertaken or planned.)

This may include:

- cut panels: panels that have been cut as part of the original installation or as part of new work e.g., for heating, cooling, plumbing or electrical services
- new services installations: evidence of new heating, cooling, plumbing or electrical services. This may include new fixings, ceilings or new holes
- new finishes: evidence that a new roof or floor finishes have been installed above the affected area
- remedial works: evidence that remedial works have been installed. This may include new steelwork or timber joists or remedial propping.

Examples of logging interventions are shown overleaf:

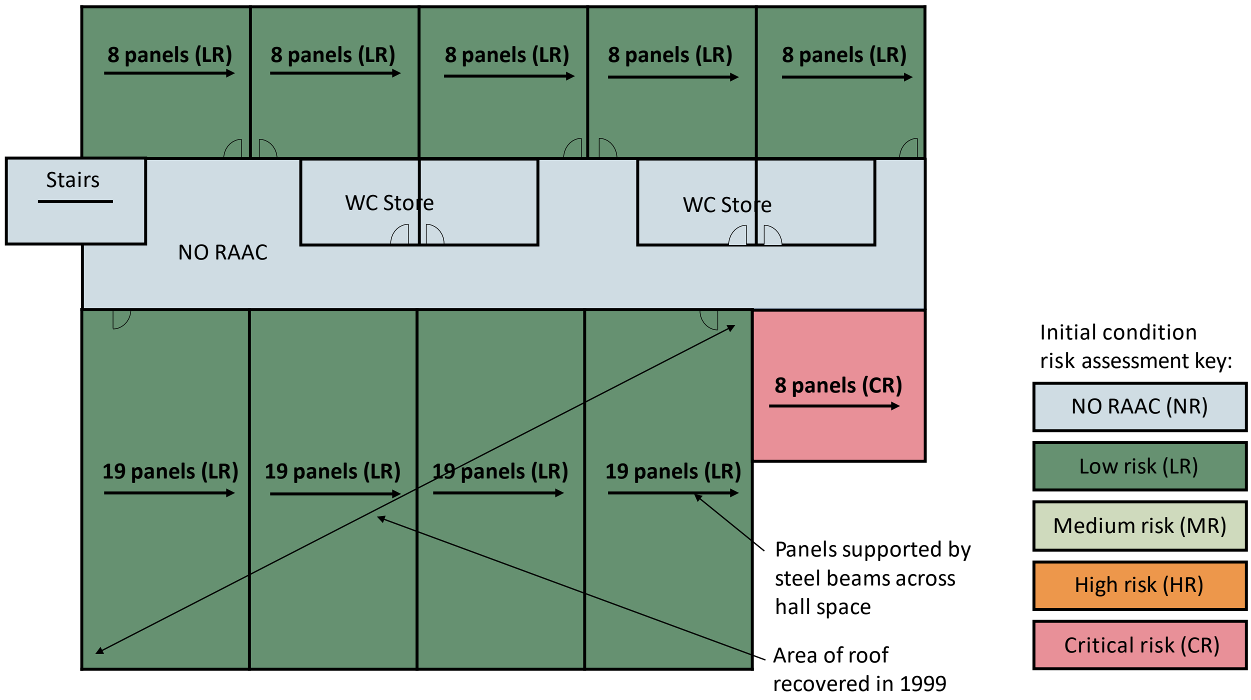

Figure 9: Annotated on plans interventions and/or adaptions

Identify applied loading conditions to RAAC

The 'loading regime' or 'weights applied to the panels' should be commented on for future reference; this could be from building services, water tanks, access walkways etc. At this stage, this does not need to include a detailed assessment, but a commentary.

For example:

- if RAAC panels are on the floor, do they support typical classrooms or specialist classrooms (e.g., design and technology or science rooms)?
- if the RAAC panels are in the roof, do they support only the ceilings and building services (heating, ventilation and electrical services) or do the panels support substantial building services' loads, such as mechanical equipment or water tanks etc?
- are the RAAC panels located in an area subject to adverse weather condition loading (e.g., drifting snow on roofs)?

Identify deterioration of RAAC

Visible deterioration of RAAC panels should be noted at this stage for future assessment. Concerns to note are as follows:

- significant and regular visible cracking to the soffit, particularly at supports
- cracking or spalling (falling material) around reinforcement
- visible displacements - this may be identifiable through ponding at roof level or panels appearing to sag

- water ingress or staining from water ingress.

Example plan shown below:

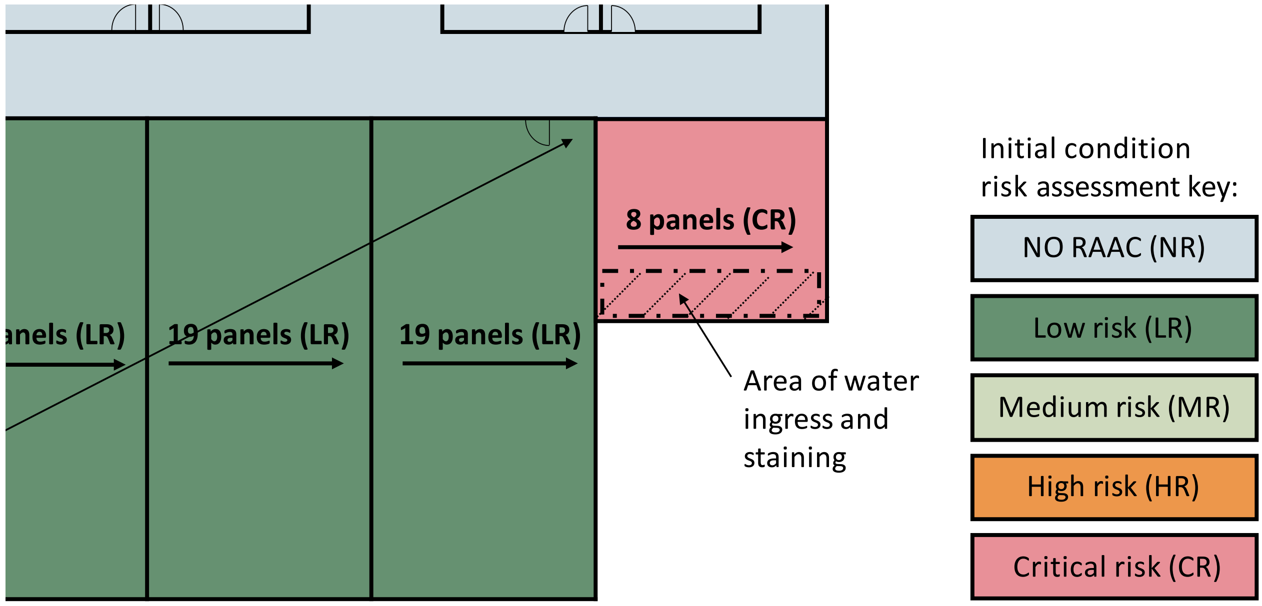

Figure 10: Annotated on plans areas of water ingress or similar

Identify high-risk spaces which contain RAAC

An initial risk assessment should be prepared by the Responsible Body to identify any areas where RAAC is present and is perceived to be in poor condition.

In areas where panels have been cut, have limited support or have been subjected to water ingress, immediate action is recommended which may include exclusion zones and/or temporary propping. Immediate advice should be sought from a specialist.

Review and update condition surveys

Condition surveys should be updated to capture the presence and condition of RAAC panels.

The work during this stage will not be detailed but should inform latter stages of the investigation and review.

Stage 3 - Appoint a Specialist Engineer

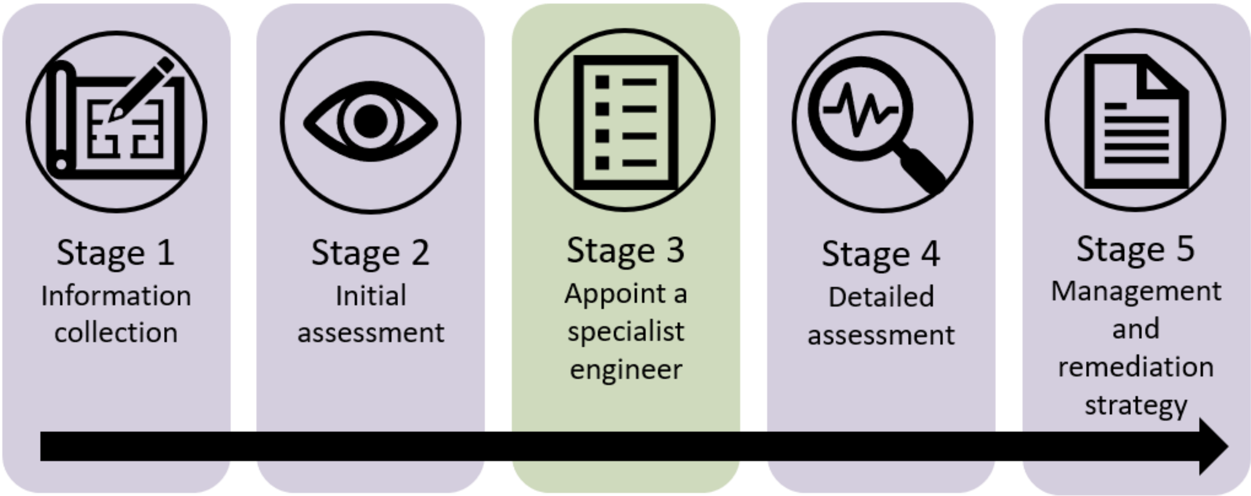

Figure 11: Stage 3 Appoint a Specialist Engineer

Having identified that a premises may contain RAAC and collected relevant historical records, assistance should now be sought from a specialist structural engineer with experience of RAAC. They will be able to provide further information on the proposed remediation and management works that should be carried out.

This section provides advice on how specialist structural engineering services should be procured to ensure individuals with the correct skills and experience are employed.

A non-exhaustive list of RAAC specialists is provided within the Institution of Structural Engineers (IStructE) Website: Reinforced Autoclaved Aerated Concrete planks - The Institution of Structural Engineers (istructe.org)

Scope of works

The following list sets out the summary scope of works that should be considered when tendering for specialist Structural Engineering advice (with more detailed advice provided in Stages 4 and 5).

The specialist should be able to:

- verify and validate existing record information
- identify and confirm the presence of RAAC panel systems
- confirm the span, width, and thickness within each space, alongside the number of RAAC panels. This should also include any assessment of high-risk factors, such as water ingress or adapted panels
- assess and provide evidence of bearing width(s)
- identify the type of support and condition i.e., the structural framing system
- comment on the loading regime applied to panels
- schedule and manage investigation works

- identify defects and at-risk areas
- support the production of a management strategy, developing a risk-based approach to the implementation of remediation and medium-long term monitoring
- produce remedial works proposals, drawings and specifications, where appropriate
- produce RAAC panel general arrangement plans to capture the above including individual panel referencing system.

Requesting credentials of specialist structural engineer

To ensure that the Structural Engineer has the appropriate qualifications, their credentials should be requested and include:

- Chartered Membership of the Institution of Structural Engineers (CEng MIStructE), and/or
- Chartered Membership of the Institution of Civil Engineers (CEng MICE).

Ideally the Engineer should feature on the IStructE RAAC register

Requesting experience of specialist structural engineer

Evidence of experience of the following should be provided:

- surveying, assessment and design/specification of remediation works to existing buildings
- visual inspection works and desk-study works
- physical inspection works, either specification and management or physical works
- management and post-completion evaluation of remedial works construction.

Evidence of RAAC experience is essential.

Stage 4 - Detailed Assessment Guidance

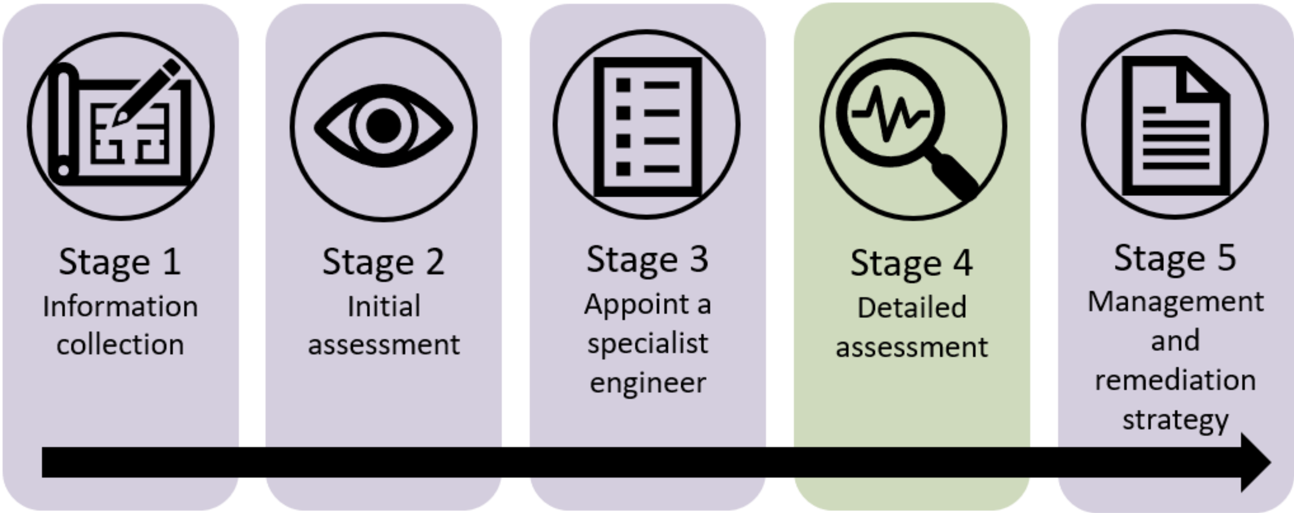

Figure 12: Stage 4 Detailed Assessment

Stage 4 should be carried out by the specialist structural engineer, based on the scope of works below (which may be included within the tender for the services). The investigation work undertaken by the engineer should reference the guidance published by the Institution of Structural Engineers in March 2022: Reinforced Autoclaved Aerated Concrete (RAAC) panels: Investigation and assessment - The Institution of Structural Engineers (istructe.org).

A RAAC survey template for the detailed assessment is provided on gov.uk to ensure a consistent approach to the level of information provided in the RAAC assessment by the specialist structural engineer.

The detailed assessment should include the following processes:

Validation of the information collated in previous stages

The specialist structural engineer should validate the existing information collated through Stages 1 and 2.

Detailed visual appraisal

The specialist structural engineer should undertake a detailed visual inspection of all the areas containing RAAC. This should culminate in a series of general arrangement building floor plans that include the following information:

- individual references for each room or space and the number of panels
- the span and panel size and shape
- the bearing form (width, condition) and risks associated
- the condition risk for each space in low, medium, high or critical metrics
- verification of loading conditions

- verification of adaptions; historic or recent and an assessment of implications
- visible degradation of panels, including displacements, cracking, spalling of concrete, staining etc
- assessment of panel displacements with appropriate interpretation of the risks of excessive displacement (refer to IStructE guidance: Reinforced Autoclaved Aerated Concrete (RAAC) panels: Investigation and assessment – March 2022).

Note: It may not be possible to determine the precise bearing width and therefore the supporting structure width should be assessed. Where this may result in bearing widths less than 75mm this should be considered as 'sub-standard'.

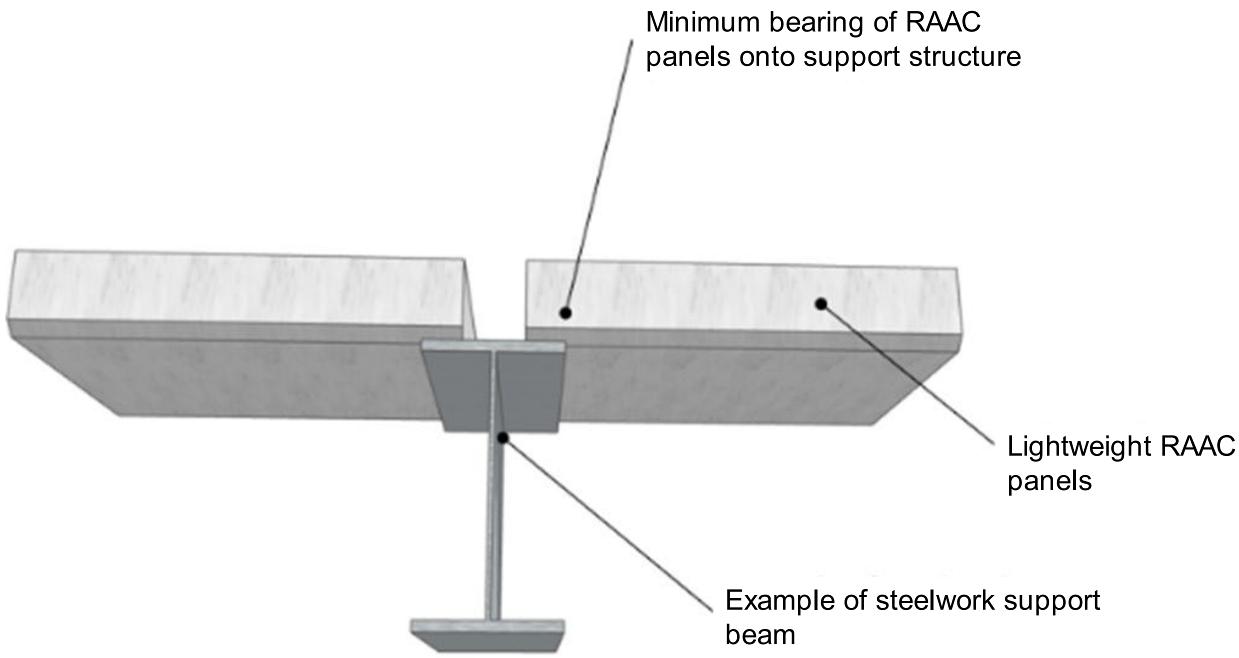

Figure 13: Bearing width diagram

Intrusive investigation, where appropriate

The specification of intrusive investigation works for RAAC panels should be carefully considered.

Non-destructive testing techniques, such as cover meters, can provide some insight into reinforcement location. However, more expensive radar techniques may not yield reliable test results due to equipment tolerances. If used, the specialist structural engineer should ensure that the equipment tolerances will be suitable to support any conclusions.

Destructive investigation techniques, such as core sampling, may be dangerous if panels are already unstable. Such techniques are not recommended.

Intrusive or physical surveys should serve two purposes:

1. To identify current defects and risk factors
2. To see if defects are progressive by undertaking comparisons of defects over time.

The following techniques are suggested to inform the remediation and management strategy:

- visual inspection using photographic records to allow future comparison
- measurement of displacements against known reference points to allow future comparison
- determination of panel thickness by measuring existing holes or small gauge drill holes
- determine bearing width through minor openings
- determine reinforcement through physical exposure
- recording of water penetration etc
- tap testing of panels to identify loose material.

Due to the differences between RAAC and traditional concrete panels, the following tests are not considered appropriate:

- concrete material tests
- core sampling
- carbonation testing
- x-ray/radar testing for reinforcement locations.

Development of Management and Remediation Strategy Dataset

The specialist structural engineer should collate the condition dataset and present this within the management and remediation strategy. Panels or spaces should be identified as low, medium, high or critical condition risk as categorised below.

Important - when using the below criteria, the specialist structural engineer must also advise on any localised areas where immediate action should be taken due to concerns about the integrity of panels in the very short term. This will require spaces to be taken out of use or exclusion zones to be created. If the Responsible Body is unable to address these independently and requires advisory support on short- and long-term remedial needs (including temporary accommodation), it should email Complex.PROJECTS@education.gov.uk

Risk Category Code	Risk Category	Risk Description
CR	Critical	Requires monitoring on a regular basis (monthly or more frequently depending on panel condition, to be confirmed by the specialist structural engineer) OR following any changes in condition (i.e., water leaks, snowfall, significant spalling etc). Urgent remedial action to be carried out within 3-6 months. This may include additional structural support to be provided as soon as practicable.
HR	High Risk	Requires further investigation and/or regular monitoring on a 6-month basis (or more frequently depending on panel condition, to be confirmed by the specialist structural engineer) OR following any changes in condition (i.e., water leaks, snowfall, significant spalling etc). Remedial works should be carried out within 1 year.
MR	Medium Risk	Requires monitoring on a regular basis e.g., annually (frequency to be suggested by engineer).

LR	Low Risk	Requires monitoring on a regular basis e.g., every 2 to 5 years depending on condition (frequency to be suggested by engineer). (Note: it is expected that very few cases will fit into this category).

Ideally each panel should be assessed to identify the condition risk and appropriate remedial or monitoring response. The following provides a non-exhaustive set of examples:

Example situation	Assessed Risk
Panels identified as having a potential bearing of less than 50mm, supported on 100mm wide beam section	**Critical**
Panels have significant water-staining and cracking at bearing	**Critical**
Panels supported on 200mm wide beam section, yet no intrusive survey has identified bearing width. No water penetration is noted however, there is significant cracking at supports	**Critical**
Panels supported on 200mm wide beam section, yet no intrusive survey has identified bearing width. No water penetration is noted. Visible cracking and displacements, with measured displacement at L/125	**High Risk**
Panels supported on 200mm wide beam section, yet no intrusive survey has identified bearing width. No water penetration is noted. Minor cracking noted	**Medium Risk**

Stage 5 - Management and Remediation Strategy Guidance

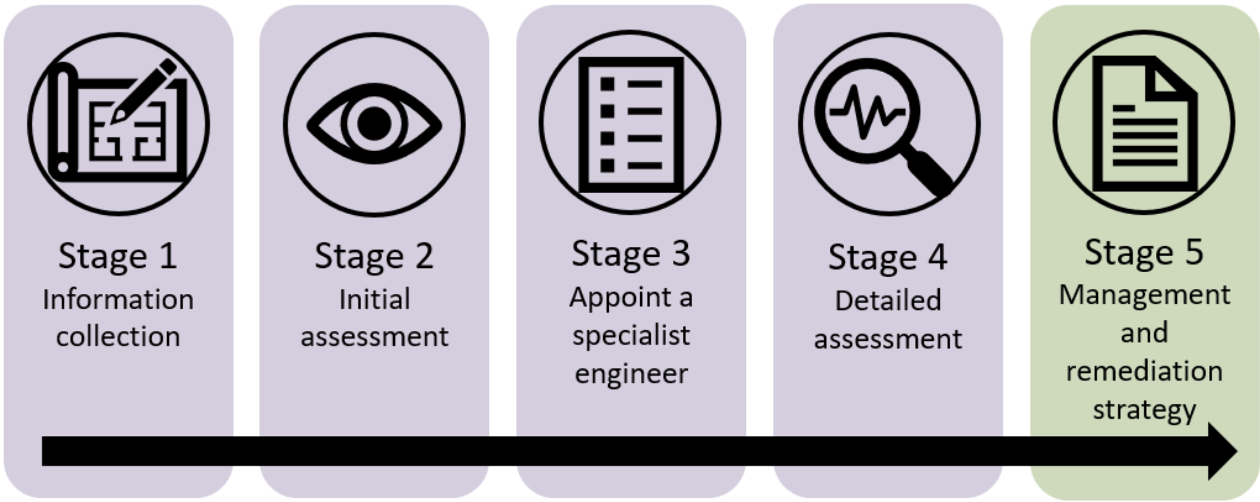

Figure 14: Stage 5 Management and Remediation Strategy

Stage 5 will be developed by school staff (or where applicable, onsite technical/estates staff) with input from the consultant structural engineer and/or Risk Management Specialist. A management and remediation strategy should form part of the site Health and Safety File and should remain as a 'live' document maintained by a responsible person within the education estate. It should maintain records of the location and condition of RAAC within the estate, as well as remedial actions that have been undertaken or planned.

The strategy should include the following:

Ownership/Organogram of responsible persons for the management of RAAC

An organogram of the onsite technical or estate teams should be created. This should include the responsible person identified to manage RAAC.

Their responsibilities should include:

- maintaining the RAAC management and remediation strategy documentation
- raising awareness of RAAC within the estate amongst staff
- procuring support for surveys and remedial works.

Overview of RAAC locations and condition

The management and remediation strategy should be updated annually and include the following information:

- form of structure
- the location of RAAC panels

- the condition of RAAC panels in each location, including reference photographs from surveys
- up to date records of activities that may impact on RAAC condition, such as new building services installations, re-roofing etc
- details of remedial works or temporary supports installed.

The overview should provide a summary of the RAAC panel condition at the time of writing. This should be maintained and updated as remediation works are implemented or the RAAC panel condition changes.

Strategies for remediation

The approach to remediation, including timeframes, should be developed by the structural engineer and estates staff to reflect the condition of the panels and the spaces that are affected. In some cases, immediate actions may be required that would include creating exclusion zones or taking spaces out of use. Once any immediate measures have been implemented, an appraisal should be carried out by both the structural engineer and estates staff to decide on the most suitable remediation strategy.

The remedial strategies may range from retention in place with secondary support to full replacement of the building elements.

The IStructE guidance provides the following proposals for remediation, which may be considered:

- enhanced end bearing to mitigate against known deficiencies or unknown or unproven end bearing conditions. This should include the addition of secondary beams or props close to the support structure to increase the width of the supports
- positive remedial supports to actively take the loading from the panels. This should include the addition of new timber or lightweight steel structures to support the panels directly
- passive fail safe supports to mitigate catastrophic failure of the panels if a panel was to fail, such as a secondary structure designed to support the panels
- removal of individual panels and replacement with an alternative lightweight solution (provided remaining panels remain undamaged)
- entire replacement.

Traditional repair techniques used for concrete, such as repair mortars, are unlikely to be suitable for RAAC panels. Plans for remedial works should be described within the management and remediation strategy. This should include a description of the immediate and long-term works planned.

The remediation strategy should include:

- a description of the proposed remedial works, for example, physical interventions to stabilise or remove RAAC panels
- a description of associated works, for example, replacement of building services or ceilings locally, requirements for re-roofing etc
- method statements for implementation, for example, requirements for working practices within the education environment, any out-of-hours working
- temporary works proposals.

Management strategy

A management strategy may be applicable for medium to low condition risk RAAC panels.

RAAC panels have typically reached the end of their serviceable life. It is expected that panels presenting a low or medium risk will progress to be high risk over time.

The management strategy should consider the current condition of the RAAC panels and include:

- monitoring plans for RAAC panels and inspection regime
- risk assessment details
- areas for future remediation
- the assumption on degradation of RAAC panels that have informed the plans – this should be assessed and informed by the specialist structural engineer based on site conditions
- details of maintenance requirements to ensure RAAC panels remain dry etc, for example, clearing of gutters, drainage
- details of proposed inspection regime following events, for example, heavy snowfall or rain.

The management strategy should also include plans for reducing the risks associated with RAAC panels.

These should include plans for limiting:

- applied operational loads, for example, no-walk zones on RAAC roofs, snow removal regime, removal of ponding water
- applied fixed loads, for example, restricting new loads or removal of existing building services equipment
- durability risks, for example, reducing humidity in plant or kitchen spaces, re-roofing.

Risk assessment

A detailed risk assessment should be undertaken as part of the management and remediation strategy.

This should consider the occupancy risk and service risk as defined within Stage 1. This should be expanded to include the results from the detailed assessment stage.

Communication strategy

A clear communication strategy should be agreed within the onsite team. This should consider how the challenges of RAAC panels are communicated internally and externally.

An awareness campaign should be implemented so that all staff members are aware of the challenges with RAAC. This should provide reassurance that measures are being undertaken, but also help involve staff members in the monitoring. Staff members should be encouraged to notify the responsible person if conditions change, for example, if leaks are detected.

Signs should be placed where horizontal RAAC panels are found to raise awareness and prevent unintended loading being applied.

External communication should be carefully considered and agreed with the onsite team.

Appendix 1: Examples of Non-RAAC Roof Forms

Victorian/Edwardian roofs

Victorian or Edwardian buildings are typically built of red brick (though London Stock also prevalent), have decorative features such as lintels and chimneys, and tiled roofs which are high-pitched or vaulted. Typical roofs will be formed using timber or steel trusses. These may be visible but might also be hidden behind modern suspended ceiling tiles.

Figure 15: Example of a Victorian/Edwardian school roof

Modern timber roof

Modern roofs may have closely spaced timber trusses which can be accessed through a loft hatch. These usually have a flat plasterboard ceiling and a pitched tiled roof.

Figure 16: Examples of a modern timber roof

Timber roof

These are flat roofs supported by closely spaced horizontal timber joists at regular intervals. The underside will often have been covered with plasterboard, while there may be a plywood or strawboard (woodwool) deck over the top.

Small joists (laths) are sometimes used to form a suspended ceiling below the actual roof, so you should confirm the presence of a plywood decking by accessing the roof void.

Figure 17: Example of a timber joisted roof with timber decking

Metal Decking

These roofs have a shiny or painted wavy metal deck, which is usually supported on steelwork. The metal deck may be perforated. In schools these will often be hidden behind a suspended ceiling. The top side of the roof will sometimes have been infilled with concrete or insulation and covered in a waterproof layer.

Figure 18: Example of a metal deck roof

In situ Concrete

An in situ concrete roof is one where the concrete was poured on site. They are usually flat, and the underside of the concrete is likely to have been plastered and painted. It may also be covered by a suspended ceiling. These roofs have a very solid feel with rebound when tapped with a hammer; provided there is not corrosion, and the concrete surface is being tapped (i.e., not plastered surfaces).

Figure 19: Examples of an in situ concrete roof

Solid Precast Concrete Roofs

These roofs are made of concrete panels spanning between beams or onto walls. The width of the panels varies from around 250mm to 2m. As with in situ concrete roofs, they may have been plastered and painted, but could also be hidden behind a suspended ceiling. The concrete has a dense surface texture and a very solid feel with rebound when tapped with a hammer.

Figure 20: Examples of a solid precast concrete roof

Concrete beam and block roofs

These roofs are made of concrete beams, typically 440mm apart (the length of a concrete block), spanning between walls or onto supporting beams. The space between the beams will be filled with concrete blocks. The blocks may be aerated or 'bubbly' but will not be made of RAAC. These roofs are easy to identify by looking for blocks between beams unless they have been directly plastered or hidden behind a suspended ceiling, in which case an area of plaster or ceiling may need to be removed.

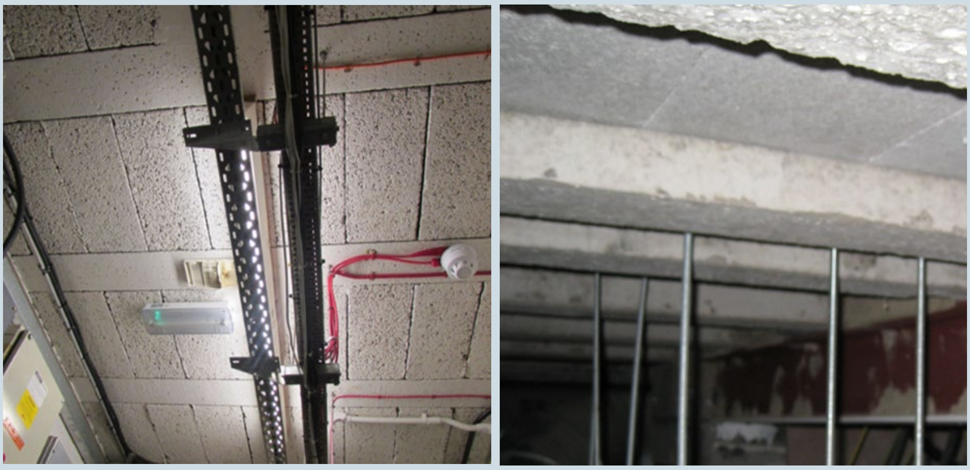

Figure 21: Examples of concrete beam and block roofs

Beam and Pot Roofs

Beam and pot floors comprise hollow clay 'pots' supported by a series of concrete ribs which may be exposed or covered by a thin clay tile. The system is lightweight and typically identifiable by the clay pot extrusion marks (marking a regular linear pattern).

Figure 22: Examples of Beam and Pot Roofs

Appendix 2: RAAC Panel Installation Examples

Figure 23: RAAC roof panels in sports hall

Figure 24: RAAC roof panels

Figure 25: RAAC roof panels

Figure 26: RAAC roof panels accessed through suspended ceiling

Figure 27: RAAC ceiling system with supports to services and suspended ceiling

Figure 28: Example of adapted plank at services penetration

Figure 29: Exterior view of horizontal RAAC wall panels

Figure 30: Exterior view of vertical RAAC wall panels

Figure 31: Interior view of vertical RAAC wall panels

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