

Guidebook for

VIRTUAL
TOP/CSC

360
CAPTURE

Pre-release

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INTRODUCTION

The construction industry is increasingly embracing technologies to enhance inspection processes. One such example is the utilisation of 360 Capture. This technology uses 360-degree photos and videos to create a virtual representation of project sites, enabling inspectors to conduct virtual inspections without the need to physically go to the project site.

Doing a 360 Capture of project sites is fast and easy with many off-the-shelf platforms available in the market. Simply attach a 360-degree camera to a helmet or selfie stick and walk the site as per normal. A digital twin of the construction site will then be created in the 360 platform to enable virtual inspections. This entire process can be completed within a day. A 360 capture of the site can help project teams to track site progress, conduct site supervision and improve communication among project parties as well as regulators.

Compared to the tedious compilation of 2D photos, 360 Capture provides faster and better documentation of the site, with more comprehensive site details. This removes the need for inspectors to be physically at the site. However, there are situations where physical site inspections are still required (for example, when there is a need to take precise measurements or to witness live operations). Nevertheless, in such cases, 360 Capture is still useful as a means of hybrid inspections where the majority of the areas are inspected virtually with only focused areas being inspected physically. This is useful as it reduces the resources required for an inspection while still ensuring that all inspection objectives are met.

In summary, the adoption of the 360 Capture platform for site inspections holds the potential to enhance construction industry inspection processes, making inspections safer, more efficient, and more effective.



Picture 1 and 2: Virtual inspections can be done using 360 capture devices to record site findings

INTRODUCTION

360 Capture is accepted as an alternative form of inspection evidence by the Building Construction Authority (BCA) in lieu of physical inspection or as part of a hybrid inspection prior to TOP/CSC issuance. This will be rolled out in phases, starting with building typology with typical and standardised designs.

This Guide has been developed to help industry practitioners in understanding how to use 360 Capture for TOP/CSC inspection purposes.

It is important for Supervising QPs and Project Teams to ensure due diligence and compliance with regulatory standards, even when utilising new technology. In addition, the requirements of the 360 Capture submissions should be met.

The provisions listed in this Guide are not exhaustive and the Project Team should take reasonable steps and exercise due diligence in inspecting the building works pursuant to the BC Act, BC Regulations and SSP Guide. It is the Project Team's responsibility to ensure that all relevant building regulations and standards are complied with.

Terms and Definitions

For the purpose of this Guidebook, the definitions of key items are listed below.

- "Supervising QPs" refers to an individual responsible for overseeing the inspection process for a construction project. This individual typically holds professional qualifications and expertise relevant to the construction industry, such as an architect or engineer.
- "Project Team" refers to the group of individuals involved in the construction project.
- An "Operator" refers to an individual tasked to operate the 360 Capture equipment during 360 Capture.
- A "360 Capture" refers to the process of capturing a 360-degree field of view of the physical environment using specialised cameras.
- A "360 Capture platform" refers to a software solution or online platform that facilitates the capture, processing, and sharing of 360-degree images and videos.
- "Virtual inspection" refers to the process of assessing and evaluating a physical environment remotely, typically using digital technologies and tools.
- "Process for Virtual TOP/CSC Inspection" refers to the procedures, steps and guidelines that must be followed when conducting virtual inspections for the Temporary Occupation Permit (TOP) or Certificate of Statutory Completion (CSC) purposes.
- "Submission of 360 Capture" refers to the process of providing the captured 360-degree images or videos to the BCA for review and evaluation.

Overview of workflow for virtual TOP/CSC inspection

The diagram below summarises the 4 key processes within virtual inspections.

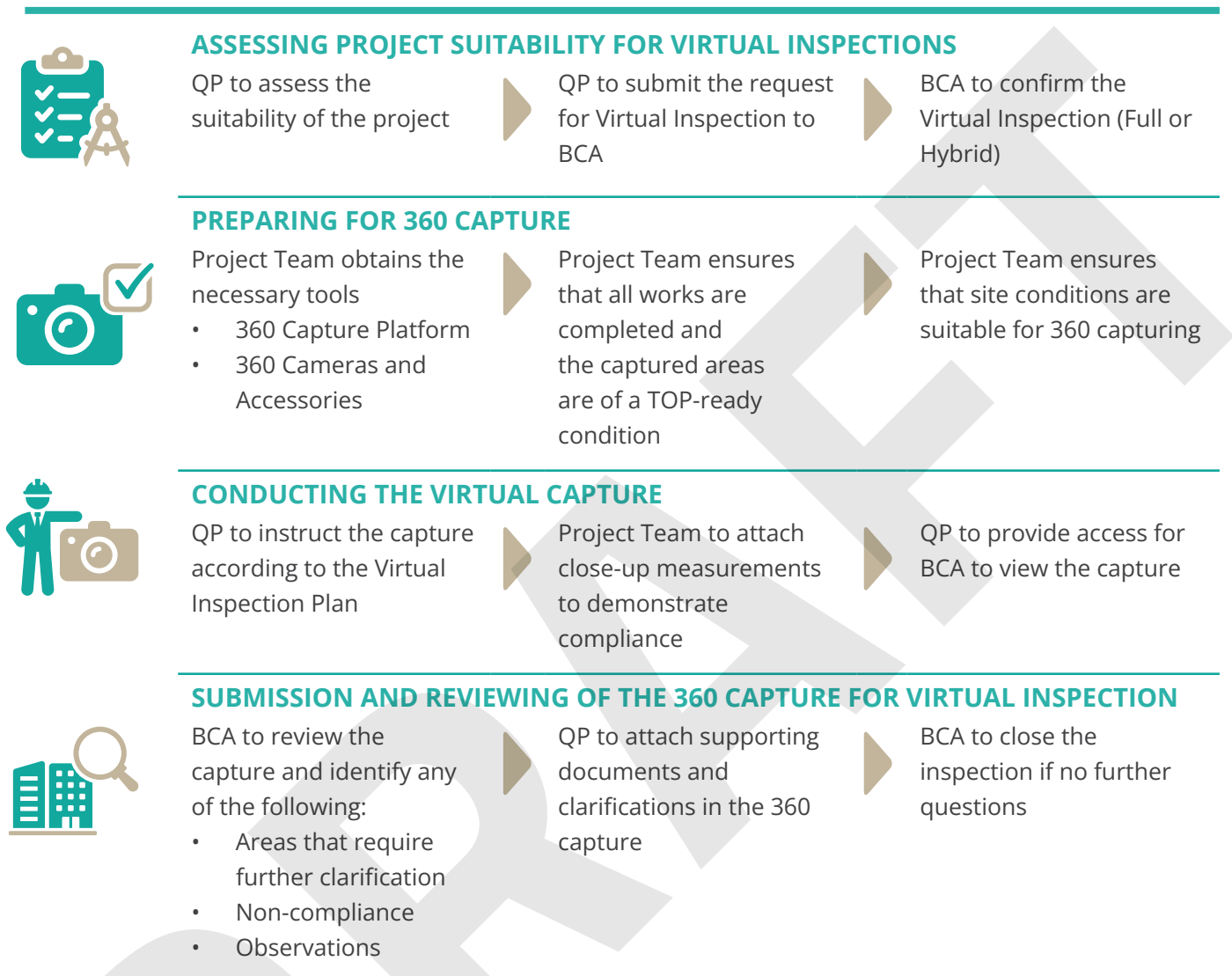


Figure 1: Virtual inspections for TOP/CSC can be divided into 4 key processes which Project Teams must complete for the virtual inspection

PART 1

ASSESSING PROJECT SUITABILITY FOR VIRTUAL INSPECTION

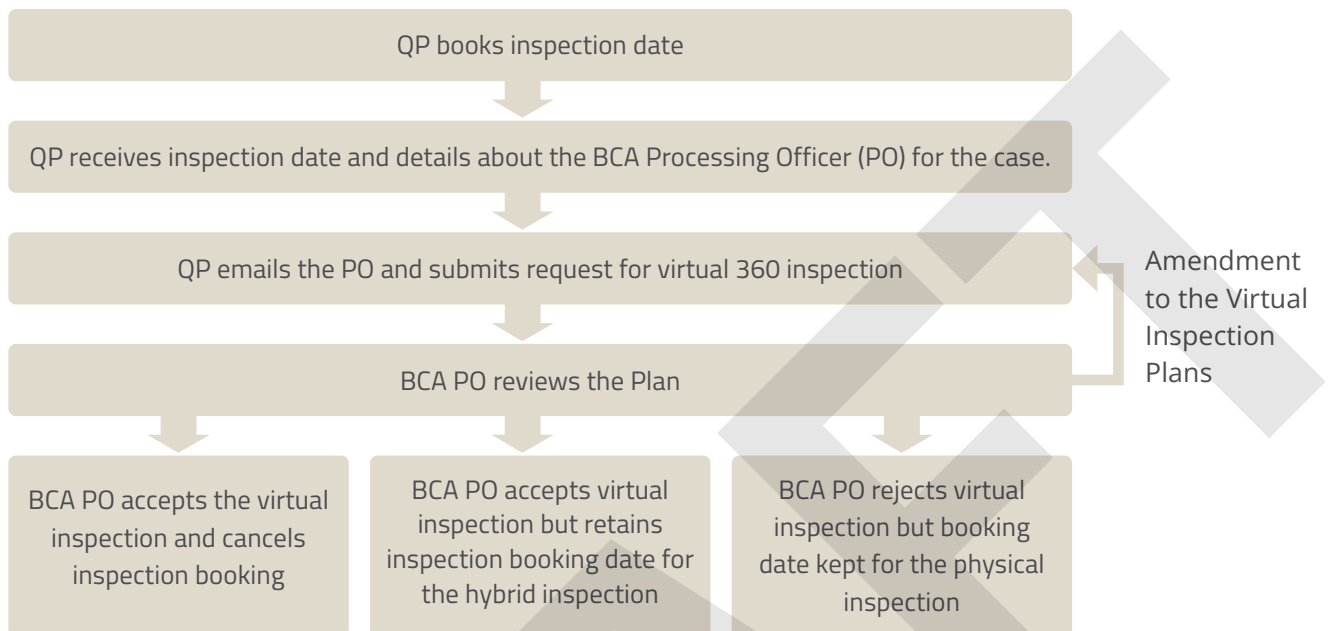
In preparation of the virtual inspection, the Supervising QP will determine the project's suitability and then submit a request to the Building and Construction Authority (BCA), to confirm that the inspection can be carried out virtually (either as a full virtual or as a hybrid).

1 TYPE OF PROJECTS ACCEPTED

- 1.1 The use of 360 Capture is accepted for either a full virtual inspection or a hybrid inspection. Supervising QP should assess the project before expressing their intention for virtual inspections.
- 1.2 The type of projects accepted for Full Virtual Inspections are:
 - Newly erected landed houses by a Developer (*as in landed development built for sales instead of own stay*);
 - Newly erected industrial building with typical floor plans;
 - Newly erected HDB residential blocks in partial TOP phases. (*Note: This refers to HDB blocks under the 2nd partial phase and beyond only. The 1st & last residential blocks and all mixed used spaces would still be required to be inspected with a physical site inspection*).
- 1.3 In Hybrid Inspection, the Project Team can record 360 Capture for the whole project but only selected areas that are typical in the project will be accepted for the virtual inspection. This will be supplemented by physical inspections by BCA for the remaining areas. The type of projects applicable for Hybrid Inspection are:
 - Residential buildings in private condominium projects that are of typical design,
 - Hotels room floors in commercial projects that are of typical design,
 - Office spaces in commercial projects that are of typical design,
 - Institutional projects, for example, schools and nursing homes, that are of typical design,
 - A&A works in localised areas. (*Note: QP to arrange discussion with the BCA Officer on their case on the areas that can be conducted via virtual inspections for larger A&A works*).
- 1.4 For project types not in the list, BCA will review the use of 360 Capture on a case-by-case basis. The Project Team can assess the suitability and set up a discussion to propose the areas for virtual inspection to BCA, prior to the virtual inspection application.

2 REQUEST FOR VIRTUAL TOP/CSC INSPECTION

2.1 The process to request for virtual TOP/CSC inspection is as follow:



- The Supervising QP will book an inspection in the BCA system when works are completed and ready for inspection. The completed and signed BCA-CSC-TOPCSCDQP (QP Declaration Form) and the completed and signed BCA-CSC-CSPBW (Certificate of Supervision) must be submitted upon booking for BCA's inspection.
- If the Supervising QP finds the request eligible and intends to adopt virtual inspection for their TOP/CSC, they will need to complete the online form "Virtual Inspection Plan" (<https://go.gov.sg/viplan>). In the form, the QP will select the floor to propose for virtual inspection. Please note that with regards to the selection of floors, the QP must consider the following:
 - a) A minimum of 3 typical floors (~1 for every 10 floors) are to be selected in each building for the virtual inspection.
 - b) Selected floors should be spread out within that building.
 - c) A scan of any roof with maintenance access in the building must be included.
 - d) All other additional non-typical floors must be included whenever applicable. (eg. common area, external areas)
- The Supervising QP is to send a PDF copy of the Virtual Inspection Plan to the BCA PO in charge of their case no later than **7 working days** prior to the booked inspection date.
- The BCA PO must respond to the Supervising QP's email within **3 working days** after reviewing the plan and confirm the following:
 - a) Acceptance of the virtual TOP/CSC inspection or,
 - b) Acceptance of the virtual TOP/CSC inspection but with additional areas to capture or a need for a Hybrid Inspection,
 - c) Rejection of the virtual inspection and a physical site inspection to proceed on the booked date.

PART 2

PREPARING FOR 360 CAPTURE

Prior to the 360 Capture, the project team is required to prepare the site by completing all outstanding works and conducting proper housekeeping to ensure the site is ready for the capture process. All necessary hardware and software to enable the 360 Capture must also be obtained. The QP must also ensure all project teams and operators understand their tasks for the virtual captures.

3 360 CAPTURE PLATFORM AND EQUIPMENT

3.1 The minimum performance requirements to ensure that the 360 Captures are acceptable for TOP/CSC inspection purposes are as follows:

Equipment: 360 Camera	
S/N	Description
01	Utilise a high-quality 360 camera compatible with Android and iOS devices.
02	Ensure the camera supports at least 6K resolution, is suitable for low-light conditions, and is equipped with dual 1-inch CMOS sensors.
03	Battery capacity must be able to support at least 60-90 minutes of continuous video capture.
04	Employ a camera featuring 6-axis stabilisation and a proprietary image stabilisation algorithm for smooth videos.
Equipment: 360 Capture Platform	
S/N	Description
01	Ensure that the platform allows users to capture 360 capture using most 360 cameras
02	The platform must be able to capture by continuous capture, by spot captures or by mixed captures. <ul style="list-style-type: none"> For large areas, continuous capture must be used. For smaller areas such as a room or a toilet unit, spot capture is allowed. However the operator must ensure the spot capture is able to clearly capture all four sides of the room, the floor and ceiling. Mixed capture refers to the utilisation of both types of capturing methods.
03	The platform must be able to tie every photo and capture onto an uploaded building plan.
04	The platform should allow for comments and additional photo evidence to be attached onto the 360 Capture.
05	External parties (e.g. BCA inspectors) must be able to access the 360 Capture.
06	For the purpose of TOP/CSC inspection, BCA inspectors must be able to tag comments on the 360 Capture.
07	QPs must be able to attach evidence of compliance (e.g. photo, video etc) to show the rectification of BCA comments
08	Users must be able to generate a report on all the comments to facilitate proper documentation.

- 3.2 As different 360 Capture platforms may perform differently to achieve the same requirements, please seek your solution provider's best practices and user guides. If there are any requirements that the solution provider may not be able to meet, the QP should highlight these concerns to BCA prior to the 360 Capture.

4 SITE PREPARATION

- 4.1 Like in a physical inspection, the project team must ensure that all works are completed and cleaned up in a TOP-ready condition. Incomplete works seen in the capture will be rejected. In addition, the capture should be done under optimum conditions to ensure high quality captures and imagery.
- 4.2 Please also ensure good housekeeping is done at the inspection location, especially if the operator is using a handheld device and may be less aware of their surroundings. The safety of all workers, including the operator, must be prioritised.

Dim or poorly lit spaces

Employ a supplementary light source to achieve optimal indoor low-light area image quality. This additional illumination can be provided by an LED light or spotlight mounted alongside the 360 cameras on a monopod or hard hat.

For very dark spaces, utilise "High Exposure" mode. Stand or hold the camera still or mount it on a tripod while capturing when in this mode.

5 OPERATOR PREPARATION

- 5.1 The project team must equip the operator with the relevant tools required for the virtual inspection process, such as the 360 camera and measuring tape for close-up measurements.

PART 3

CONDUCTING THE VIRTUAL CAPTURE

The Project Team shall ensure that preparations are made in accordance with the Virtual Inspection Plan before conducting a virtual inspection. During the virtual inspection, the Supervising QP must also provide additional close-up measurements to demonstrate compliance to the codes. Once completed, the Supervising QP will submit the capture to BCA for the virtual inspection.

6 REQUIREMENTS FOR 360 CAPTURE

- 6.1 For both full and hybrid Virtual Inspection, the QP must capture the areas as listed in the Virtual Inspection Plan using 360 Capture tools. This will include all external areas as drawn in the approved Building Plan. The 360 scans must be done no later than 3 months from the capture submission date.
- 6.2 The Supervising QP shall also ensure that:
- All works to be captured in the virtual inspection process must not deviate from the approved plans and;
 - All areas under the virtual inspection process must be fully completed.
- 6.3 Additional supporting evidence is required to be documented to show compliance with the Code when conducting the 360 Capture in accordance with the Virtual Inspection Plan:
- The Supervising QP to attach adequate close-up measurements in the 360 Capture platform for the following key clauses to show compliance in the project.

Section 1A		
For Factory & Hotel		
S/N	Description	Clause
01	Typical storey to show the completion of common area (lift lobby to roof), manoeuvring spaces at doors @ lift lobby	AC 4.4.6.1
02	Changes in levels at common area	AC 4.5.2 / AC 4.5.5
03	Common areas (MSCP/basement carpark, sky terrace garden, gym, swimming pool & etc.) to show completion	AC 4.4.6.1

AC = Accessibility Code 2019

Section 1B		
A minimum of 3 typical floors (~1 for every 10 floors) to be scanned for typical residential block. The Supervising QPs must state the proposed level to audit in the Virtual Inspection Plan		
S/N	Description	Clause
01	Safety from falling @ common corridor	AD H.3.2.1 / AD H.3.4.1 / AD H.3.4.3
02	Safety from falling @ window glass barrier within residential units	AD H.3.2.1
03	Entrances @ residential units	AC 7.2.2
04	Retrofitting bathrooms @ residential units	AC 7.3.3 / AC 7.3.5 / AC 5.6.6.1

AC = Accessibility Code 2019

AD = Approved Document

*Note: Depending on the project, BCA may request for additional evidence of compliances for other clauses if necessary. QP can also attach additional photos to demonstrate compliance with other clauses.

7 360 CAPTURE PROCESS

- 7.1 The Supervising QP shall ensure the use of appropriate equipment and adopt best practices for 360 Capture (see 3.1).
- 7.2 Please refer to your solution provider's user guides on how to operate their system regarding Capture techniques, best practices, and guidelines.
- 7.3 When conducting the Capture, the project team must ensure that clear communication of instructions has been given to the operator.
- 7.4 The Capture must follow the requirements set out in the approved Virtual Inspection Plan. Some of the best practices are as follows:

Photo/Video Capturing	
01	Leverage the solution platform AI to automatically map every image captured twice per second to floor plans during passive video capture (approximately 120 images per minute).
02	Maintain camera stability by utilising accessories such as an extension arm, monopod, or hard hat mount (more than 20 cm above head) to facilitate smooth walkthroughs and image captures.
03	Position the camera in the centre of the path or space, maintaining a minimum distance of 2 metres from walls.
04	Capture each area within a 5–10 metre radius.
05	Remain at key areas for 2–3 seconds to allow the camera to capture sufficient images.
06	Maintain a normal walking speed; avoid running or jumping as the camera will continue scanning while walking.
07	When transitioning between very bright and very dark spaces, slow down to allow the camera to adjust. Alternatively, initiate a new capture session when switching between bright and dark environments.
08	Avoid capturing in rain as raindrops can obstruct the camera lens.
09	To protect the 360 cameras from overheating, especially during hot summer days, cease capturing, power off the camera, and allow it to cool down. Choose cooler times for capturing, such as early mornings or late afternoons.

8 END OF THE VIRTUAL INSPECTION SESSION

- 8.1 After the end of each capture, the project team shall perform a self-check as follows:
- a) Verify that the captured locations are accurately mapped onto the digital plan.
 - b) Ensure additional photos of the close-up measurements are provided to show compliance to the Approved Document and Accessibility Code.
 - c) Review and ensure that the virtual capture of the project is in order.

PART 4

SUBMISSION AND REVIEWING OF THE 360 CAPTURE FOR VIRTUAL INSPECTION

The 360 Capture is to be submitted to BCA upon completion. The BCA PO will assess the captured footage to identify areas that require clarification, instances of non-compliance, or observations. The Supervising QP will be required to provide clarification and attach supporting documents. Once all clarifications are deemed satisfactory, the BCA PO will close the inspection process.

9 SUBMITTING THE 360 CAPTURE TO BCA

- 9.1 Once the capture is satisfactory for the Project Team, the Supervising QP must complete the "Virtual Inspection Instruction Form" (<https://go.gov.sg/viinstruction>).
- The Supervising QP must provide key instructions to enable the BCA PO to log in to their system to audit and give comments on the virtual inspection.
 - The Supervising QP must email a PDF copy of the Virtual Inspection Instruction Form to the BCA PO and alert him/her to review the site captures.
 - The BCA TOP Processing Officer (PO) will review the 360-capture and issue comments on the Virtual Site Inspection to the Supervising QP for follow-ups **within 3 working days** from the submission of the Virtual Inspection Instruction Form.

10 REVIEW OF THE 360 CAPTURE BY BCA

- 10.1 The BCA TOP PO will review the submitted Capture and provide comments based on the items observed. The following type of comments will be tagged in the Capture for the QP to follow up.

Type of comments	Remarks
Non-compliance	Items that are not in compliance with the Approved Document and the Accessibility Code
Observations	Any other issues that are identified from the virtual site inspection
Clarifications required	When the area in the Capture is blurry, underexposed or not easy for any user to see, the provision of a photo measurement to clarify will be required

- 10.2 An official reply for the inspection will be sent based on the comments in the 360 Capture but the project team can proceed to perform the necessary rectifications.
- 10.3 In response to BCA TOP PO’s comments, if the QP will be using the 360 platform to respond to the comments, the QP must provide the response with the following standardised tags.

BCA comments	QP/Project Team’s reply
Non-Compliance	Rectified (Photo evidence of rectification to be attached)
Observation	Rectified (Photo evidence of rectification to be attached)
Clarification required	Clarification attached. (Photo evidence in response to required clarification to be attached)

11 DOCUMENTATION OF VIRTUAL INSPECTION

- 11.1 The QP must generate a site inspection closure report which should contain:
 - All BCA comments on the Non-compliances and Observation items
 - All accepted rectifications to these items
- 11.2 The closure report must be submitted along with all the other TOP/CSC documents before the TOP/CSC certification can be issued.

FREQUENTLY ASKED QUESTIONS (FAQ)

- 14.1 What kind of projects are currently eligible for full virtual inspection?**
Projects such as newly-erected landed houses by a Developer, industrial buildings with typical floor plans, and HDB residential blocks in partial TOP phases are accepted at the current stage.
- 14.2 What types of projects are suitable for hybrid virtual inspections?**
Residential buildings in private condominium and HDB projects, hotel room floors, office spaces in commercial projects, and A&A works in localised areas are suitable for hybrid virtual inspections.
- 14.3 What are the situations in which physical inspections will still be required?**
Currently, physical inspections will be necessary for a non-typical layout or when the virtual inspection submission has been found to not meet the minimum required standards.
- 14.4 What is the process for requesting for a virtual inspection?**
The supervising QP needs to book an inspection through the Portal and complete the Virtual Inspection Plan for submission to the BCA Processing Officer for review. Refer to flowchart in Section 3 of this Guide for full details.
- 14.5 What is the submission process after a virtual inspection?**
The supervising QP completes the Virtual Inspection Instruction Form for submission to the BCA Processing Officer for review when ready.
- 14.6 How fast can a 360 Capture of the virtual site be completed?**
Depending on the system used, most capture processes can be completed within a day.
- 14.7 Are there any regulatory considerations when using virtual inspections through the 360 Capture platform?**
The platform is designed to complement and not replace the existing regulatory requirements. The Project Team must still adhere to all local building regulations and Code of Standards.
- 14.8 Can the 360 Capture platform integrate with existing site inspection workflow, or does it require a complete overhaul of current processes?**
The platform is designed to streamline and integrate with existing site inspection workflows, ensuring a smooth transition without the need for a complete overhaul of established processes.
- 14.9 Will the 360 Capture platform completely replace traditional physical site inspections in the future?**
360 Capture inspections will complement and provide a flexible and efficient alternative current processes.

14.10 What is the cost structure associated with the adoption of the 360 Capture platform, and are there different pricing plans available?

Users can seek advice from solution providers to choose a plan that aligns with their specific needs, providing cost-effectiveness and scalability. BCA strongly recommends that project teams maximise the benefits of 360 Capture by using it for progress monitoring or internal checks and reporting, not just for regulatory inspection clearances.

14.11 Will there be any training provided for using the 360 Capture platform?

The Guide lays out the general instructions and requirements for 360 Capture. The 360 Capture solution providers will be able to provide additional technical details and training.

14.12 What are the key requirements for the 360 Capture equipment?

Utilise a high-quality 360 camera with at least 6K resolution, suitable for low-light conditions, and equipped with dual 1-inch CMOS sensors. Refer the table in Section 4 of this Guide for full details.

14.13 Can the 360 Capture platform be customised to accommodate specific industry or project requirements for site inspections?

Yes, the 360 Capture platform is designed to be flexible and customisable to meet specific industry or project needs. The users should seek advice from the solution providers if additional cost is required.

14.14 How secure is the data captured through the 360 Capture platform?

Each 360 Capture platform should have their own safeguards to ensure data is secured.

14.15 Is there a limit to the number of users who can access the 360 Capture platform for site inspections?

This will be different from system to system. Most platforms can accommodate multiple users to capture, comment and review the captures.



Feedback

This Guide will be updated progressively from the First Edition published on April 2024. We welcome your comments about this Guide to help us continue to develop and improve it. Please provide your inputs at <https://go.gov.sg/vifeedback> or scan the QR code on the right.

