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1. Scope

- 1.1 This Specification lays down the technical specification, functional features, performance characteristic, and installation requirements of a close circuit television system and its components. Some test methods and associated equipment are also described for contractor's observation.
- 1.2 This Specification should be read in conjunction with the "General Requirements for Electronic Contract, ESG01" and the Particular Specification. Unless otherwise stated elsewhere in the Particular Specification and/or written instructions of the Engineer, the requirements in this Specification shall apply to all contracts for the supply and installation of closed circuit television systems issued by the Electrical & Mechanical Services Department.
- 1.3 In the event of a conflict between this General Technical Specification with the Particular Specification of the Contract or Order, the Particular Specification of the Contract or Order shall prevail.

2. Description of System

2.1 A closed circuit television (CCTV) system shall be used for picture taking, recording, reproduction, amplification, transmission and distribution of video signals to dedicated receivers or monitors. A CCTV system shall comprise of items for monitoring, transmission and controlling purposes, which shall typically consist of

- picture generation equipment;
- a video signal transmission and distribution network;
- a central observation suite and other auxiliary observation stations, where the video signals are displayed on monitors or projected onto screens;
- other ancillary equipment e.g. mixing, splitting or multiplexing equipment to obtain special display effects on monitors; and
- recording equipment.

2.2 A CCTV system is not limited to equipment sited at one locality or confined to a single centralized control regime but may include the use of remote transmission or decentralized control. Detailed tailoring of individual system included specialized techniques and equipment components are required for a particular system, these shall be referred to the relevant Particular Specification.

3. Related Documents and References

3.1 Statutory Obligations

Materials and equipment shall be built and installed complying with the following:

- (a) Electricity Ordinance, Chapter 406, and other subsidiary legislation made under the Ordinance;
- (b) Telecommunications Ordinance, Chapter 106, and other subsidiary legislation made under the Ordinance;
- (c) Waste Disposal Ordinance, Chapter 354 and other subsidiary legislation made under the Ordinance; and
- (d) Environmental Impact Assessment Ordinance, Chapter 499 and other subsidiary legislation made under the Ordinance.

3.2 References to User/Design/Installation/Testing Specification

The following references are stipulated to guide the contractor on design, installation and other requirements: -

- (a) General Requirements for Electronic Contract, ESG01, issued by Electrical & Mechanical Services Department, the Government of the HKSAR;
- (b) General Requirements for Electronic Purchases, ESG03, issued by Electrical & Mechanical Services Department, the Government of the HKSAR;
- (c) Generic Code of Practice on Television Technical Standards, Communications Authority, the Government of the HKSAR;
- (d) General Specification for Electrical Installation in Government Buildings of the Hong Kong Special Administrative Region, issued by Architectural Services Department, the Government of the HKSAR.

3.3 International Standards / References

Materials and equipment shall be built and installed complying with the general principles of the standards and Codes of Practice laid down by the International Standards Institutions. The following are of particular relevance:

- (a) Recommendation ITU-R BT 470-4 “Television Systems;
- (b) ITU-T Recommendation J.61: Transmission Performance of Television Circuits Designed for Use in International Connections;
- (c) Television Measurement Techniques, I E Weaver, IEE Monograph Series 9;

- (d) International Radio Consultative Committee (CCIR) Standard on T.V. practice;
- (e) IEC 61146 - Video Cameras (PAL/SECAM/NTSC) - Method of Measurement;
- (f) IEC 62305 - Protection against lightning;
- (g) IEC 62262 - International numeric classification (IK ratings) of protection enclosures for electrical equipment against external mechanical impacts;
- (i) IEC 60529 - Degrees of protection provided by enclosures (IP code);
- (j) IEC 60068 - Environmental testing

3.4 Other National or International Standards

Equipment complying with other National or International Standards may be offered. Tenderers shall demonstrate clearly that these standards are equivalent to or better than those standards required by this Specification.

4. Definition

4.1 Terminology and Glossary of Terms

- (a) “Aliasing” - This is the special phenomenon within the CCD camera due to discrete sampling of the focused image, giving rise to false frequency components of the coded video signal.
- (b) “Aspect ratio” - This is the ratio of width to height of a television picture.
- (c) “Contrast ratio” - This is the ratio of maximum luminance level of a white area in the picture to the luminance level of a subjective black
- (d) “Electronic shutter” – This is an arrangement for camera to change its sensitivity by electronically controlling its exposure time.
- (e) “Gamma” - This term refers to non-linear input/output transfer characteristics in television systems. The non-linearity may be intrinsic e.g. the gamma of a picture. Or it may be a special design feature, e.g. the gamma correction circuit of a video camera.
- (f) “HD” or “High Definition” – This term means the resolution of 1920 x 1080 pixels.
- (f) “Interlace” – This means the arrangement of positioning of the scan lines of alternate fields so that the even field lines are vertically spaced between the odd field lines.
- (g) “Lens” - An optical device for projecting an image of a desired scene onto the photosensitive surface of the imaging device.
- (h) “Pan” - A horizontal movement of a video camera.
- (i) “Pixel - This is the smallest sample of an image, which may be a discrete sample produced by a solid state imaging device or a digitized sample.
- (j) “Progressive scan” – This means a way of displaying of all the lines of each frame are drawn in sequence.
- (k) “Return loss” – This means the reflection damping of the input termination
- (l) “Sensitivity” – This is the illumination necessary for an imaging device to produce a defined composite video signal amplitude with a defined signal to noise ratio.
- (m) “Shading” - This is an imperfection generated by a video camera, mostly in the pickup devices. It creates unevenness in the horizontal or vertical direction in responding to a uniform illumination on the photoelectric sensor.
- (n) “Terminated input” – This means the input with a termination of 75 Ω .

- (o) “Tilt” - A vertical movement of a video camera.
- (p) “Video” - Video refers to the phenomenon or, in engineering use, the signals, objects associated with visual images e.g. video camera, video signal, etc.
- (q) “Video signal” - A signal resulting from the transformation of an optical image into an electric signal.
- (r) “Video camera” - An electronic device or equipment that transforms luminous properties of an object or scene to be televised into a video signal of a particular format.
- (s) “Video monitor” - A piece of electronic visual display that converts a video signal into a visual image.
- (t) “Video switcher” or “Video switch” - An electronic equipment that accepts a number of video signal inputs, channels these, either under an automatic time sequence or directed by an operator command, into a defined number(s) of output(s).
- (u) “Video multiplexer”- A video equipment that accepts multiple video signals and processes all the signals for transmission in a single medium for recording and playback of multiple signals.
- (v) “Video recorder” - An electronic equipment capable of recording video and audio signals generated from the camera inputs or other video equipment on a medium for storage and reproduction. The recording formats are classified into various standards according to the type of video recorder to be used.
- (w) “Zone 1” - This is a central circular picture area with a diameter of 0.8 times the picture height.
- (x) “Zone 2” - This is the area defined by a circle equal to the picture width.
- (y) “Zone 3” - This is the picture area outside Zone 1 and Zone 2.
- (z) “4K” – This term means a resolution of 3840 x 2160 pixels.

4.2 Abbreviations

- (a) “AGC” means Automatic Gain Control
- (b) “BS” means British Standards
- (c) “CCD” means “charge coupled device”
- (d) “CCIR” means the International Radio Consultative Committee, Comité consultatif international pour la radio or Consultative Committee on

International Radio

- (e) “CMOS” means “complementary metal-oxide-semiconductor”
- (f) “DA” means Distribution Amplifier
- (g) “EBU” means the European Broadcasting Union
- (h) “EIA” means the Electronic Industries Alliance
- (i) “fps” means Frames Per Second
- (j) “GI” means Galvanised Iron
- (k) “H.264” means the ITU-T H.264 standard
- (l) “H.265” means the ITU-T H.265 standard
- (m) “IEC” means International Electrotechnical Commission
- (n) “IET” means Institution of Engineering and Technology
- (o) “IP” means Internet Protocol
- (p) “ITU” means International Telecommunication Union
- (q) “MPEG” means Moving Picture Experts Group
- (r) “OFCA” means Office of the Communications Authority
- (s) “PAL” means Phase Alternating Lines system or PAL signal format
- (t) “p-to-p” means “peak to peak”
- (u) “rms” means “root mean square”
- (v) “SATA” means Serial AT Attachment
- (w) “SMPTE” means the Society of Motion Picture and Television Engineers
- (x) “SSID” means Service Set Identifier
- (y) “sync” means “synchronisation” or “synchronisation pulse”
- (z) “USB” means Universal Serial Bus
- (aa) “WPA” means Wi-Fi Protected Access
- (ab) “w.r.t.” means “with respect to”

5. System Requirements

- 5.1 The system offered shall provide clear video pictures for the purpose of monitoring and surveillance. All equipment shall be of a high manufacturing open standard, reliable, easy to operate, interface and maintain. The layout of the video monitors and operator panel shall take into account ergonomic requirements so as not to put undue strain on the operators.
- 5.2 Final positioning of cameras shall be guided by the field of view in conformance with the operational requirements. Other factors, e.g. illumination level shall also be taken into consideration. If cameras are installed in public areas e.g. halls, walkways, concourse, etc. security against vandalism shall also be taken into account. The cameras, together with their housing, when installed shall be easily removed from the mounting for maintenance and repairing purposes. If there is a water reservoir in the housing, this reservoir shall be readily reached by operating personnel for water filling purposes. For cameras that are mounted at a high level, the tenderers shall suggest the method of access and the method of disassembly of the camera from the housing for maintenance purposes and shall comply with the safety requirement and ordinance.
- 5.3 The colour analog video signal referred to in this Specification shall generally conform to the 625/50 PAL-I signal format stipulated under ITU-R BT 470-4. However, minor variations which do not affect the system display, switching or processing stability may be acceptable and the tenderer is required to state clearly all such variations when submitting his tender. Essential characteristics of the baseband video signal are:-
- (i) 625 lines per frame;
 - (ii) 25 Hz frame rate; 50 Hz field rate; 2 to 1 interlace;
 - (iii) The colour sub-carrier frequency shall be 4.43361875 MHz;
 - (iv) The active line in the composite video signal shall not be less than 51 μ s.

The colour digital video signal referred to in this Specification shall generally conform to the ITU-T H.264 / MPEG-4 Advanced Video Coding (AVC) and/or ITU-T H.265 / MPEG-H Part 2 High Efficiency Video Coding (HEVC) video compression standard and the video resolution requirement shall be stipulated in the Particular Specification.

- 5.4 For all possible signal transmission paths designed into the system between an analog camera output point and a monitor input point, the system shall perform within the limits of the following:-
- (i) Frequency Response – The video signal frequency response shall be 50 Hz to 5 MHz +/- 3dB, measured w.r.t. a signal component of 100 kHz.
 - (ii) Waveform Distortion – The K rating of a “2T pulse and bar” test waveform shall not be worse than

- pulse to bar ratio 4%
 - 2T pulse response 5%
 - 2T bar response 4%
-
- (iii) Signal-to-noise ratio – The signal to noise ratio shall be better than 56 dB weighted in accordance with ITU-T Recommendation J.61.
 - (iv) Luminance non-linearity – The luminance non-linearity shall be less than 5%.
 - (v) Crosstalk – The total unwanted video signal contributed by all other signal paths shall be at least 49 dB below the wanted signal.
 - (vi) Hum – The hum level contributed to the video monitor shall be 49 dB below the wanted video signal.
 - (vii) Differential gain – The error shall be less than 5%.
 - (viii) Differential phase – The error shall be less than 5°.
 - (ix) Chrominance and Luminance delay inequality – The delay error shall be less than 40 ns.
 - (x) Chrominance and Luminance gain inequality – The gain error shall be less than 5%.
 - (xi) Insertion gain – The insertion gain of the transmission system shall be (0 ± 1) dB on the nominal 1 V_{pp} input signal.
 - (xii) Return loss – The return loss in the inputs and outputs shall be ≥ 20 dB from 0,1 MHz to 5 MHz.

Where video is transmitted on various types of data network, e.g. Video over IP, the performance requirement shall be stipulated in the Particular Specification.

5.5 Power supply points at mains voltage of 220V, single phase, 50 Hz shall be provided by others in the main control location, slave control location, adjacent to camera, and adjacent to local control units. For power supply to field devices, spur units at mains voltage shall be provided adjacent to the local field device units. The Contractor shall be responsible for the provision of transformers and rectifiers to suit the voltage pattern of the field devices, and also conduits and wiring for providing electrical power from the rectifiers to the field devices. The Contractor shall be responsible to submit drawings and schedules indicating the required location of the power supply points, their rating and the wattage and power factor of the anticipated load. In the event when the Contractor failed to provide the schedule, the Contractor shall be responsible for the extra cost of remedial work such as chasing and coring of concrete to make way for the electrical supply.

6. Equipment Functional Requirements and Performance Characteristics

6.1 Video Camera

- 6.1.1 Each video camera shall house the lens, image pickup devices, electronic circuitry and sync pulse generation circuit. The camera imaging devices shall be of the solid state CCD sensor or CMOS sensor and integrated with complementary colour mixing filters. The camera shall provide anti-smearing and anti-blooming capability. It shall also be provided with anti-aliasing capability using either optical or electrical filters.
- 6.1.2 The construction of the camera shall be rugged and compact suitable for mounting into the camera housing with other accessories. The camera may operate directly from 220 V a.c. mains or operate at a lower d.c. or a.c. supply voltage or Power over Ethernet (PoE) comply with the IEEE 802.3af or 802.3at.
- 6.1.3 The video camera shall exhibit minimum image lag, image retention and near zero geometric distortion under wide area of operating conditions.
- 6.1.4 The image transfer mechanism of the CCD sensor shall be either interline transfer (IT) or frame interline transfer (FIT); or CMOS sensor shall be using progressive scan technique. The choice of the dimension of the sensor shall satisfy the minimum luminance resolution requirements as depicted under Clause 6.1.16 of this Section. In general the number of active pixel contents of the sensor shall not be less than 1080p. Tenderer shall refer to the Particular Specification for the specified dimension and resolution requirements of the sensor.
- 6.1.5 The video camera shall be provided with white clip control. If this is not field adjustable, the white “clipper” shall be factory adjusted to clip at 110% of video level.
- 6.1.6 Not use.
- 6.1.7 The video camera shall be provided with the appropriate outlets and furnish the compatible electrical signals to drive the camera lens in the auto-iris mode of operation.
- 6.1.8 The video camera shall be provided with gamma correction circuitry. It is preferred that the range of gamma values lies between 0.5 and 0.6.
- 6.1.9 The video camera shall be well-shielded against radio frequency pickup. The construction of the camera shall satisfy the relevant emission and immunity requirements of the IEC 61000 series standard on electromagnetic compatibility. The sensor shall be firmly fixed to minimise microphonic interference.
- 6.1.10 The colour video camera shall be provided with automatic white balance control.

- 6.1.11 The camera, in conjunction with the lens, if installed for outdoor use, must be able to handle a scene contrast range of at least 60000:1.
- 6.1.12 Not use.
- 6.1.13 The sensitivity of the camera shall not be worse than 3 lux measured in accordance with IEC 61146-1. At low illumination levels, it shall be equipped with colour-noise cancellation circuits to improve picture quality.
- 6.1.14 The offer cameras shall meet at least the following shading requirements:-
- (i) With the lens capped, and with the automatic black level control, automatic gain control circuitries defeated and fixed at the respective nominal levels, the black level variation shall not be greater than 7% of the peak signal in both the horizontal direction (line rate) and vertical direction (field rate).
 - (ii) With the camera viewing a perfectly flat white object and with the illuminance or luminance of the object adjusted to give a lens opening of f/5.6 to f/11 to obtain peak video signal level, the white level variation shall not be greater than 20% of peak signal in both the horizontal (line rate) and vertical (field rate) directions.
- 6.1.15 The geometric picture distortions in cameras when measured with a high quality lens shall be better than:-
- (i) Zone 1 of picture area : 1%
 - (ii) Zone 2 and Zone 3 of picture area : 2%
- 6.1.16 The sub-clause defines the resolution and noise performances of the camera output (i.e. a combined evaluation on lens, image sensor and processing circuitry). As noise and horizontal resolution are inter-related, these should be measured under the same conditions. If there is aperture correction built into the electronic circuitry of the camera, this should be fixed and set at an optimum position. Other automatic controls shall be defeated and set at a nominal level. The illuminance on the test chart shall be set such as to produce full video output at a lens setting of f/5.6 +2 stop or -1 stop.
- 6.1.17 The camera shall exhibit no discernible registration errors anywhere in the picture.
- 6.1.18 The analog video camera shall be provided with the following scanning systems:-
- (i) horizontal frequency : 15.625KHz
 - (ii) vertical frequency : 50Hz
 - (iii) interlace : 2:1

- 6.1.19 The video camera shall be equipped with electronic shutter speed control mode (either manual or fully automatic) covering the range from 1/50 to 1/10,000 second.
- 6.1.20 The video camera shall be well-shielded against radio frequency pick-up.
- 6.1.21 The video camera requires to equip with Standard C mount or special CS lens mount or stipulated in the Particular Specification.
- 6.1.22 The glass cover for the video camera shall have tinted, clear, chrome colours or stipulated in the Particular Specification.
- 6.1.23 All power, control and video cables connecting the camera with the housing shall be in a plug-socket arrangement to facilitate easy removal of camera for maintenance.
- 6.1.24 For pan-tilt-zoom camera, its built-in motor shall be computer controlled and shall move quietly when seeking a preset location or at variable speeds when tracking a target during manual operation. The pan travel and tilt shall be 360° continuous and 90° respectively. Auto-pan function shall be included.
- 6.1.25 For dome-type camera, the camera cover shall be tinted so that the direction of camera pointing shall be hidden. Nevertheless, the quality of the image capture through that cover shall not be sacrificed under normal lighting condition.
- 6.1.26 For IP camera, the camera shall support multiple video streaming with individually configurable streams in H.264, H.265 or Motion JPEG or other specific compression standard with controllable frame rate and bandwidth as stipulated in the Particular Specification.
- 6.1.27 Access to all menus and screens of the control panel of the IP camera, and the corresponding capability for each screen, shall be controlled via operator and password for users.

6.2 Lens

- 6.2.1 The lens assembly shall contain, as minimum, the following controls:-
 - (i) iris;
 - (ii) focus; and
 - (iii) zoom.
- 6.2.2 Accuracy of equivalent focal length shall be within +/- 3%. If a zoom lens is required, the zoom ratio shall be accurate to within +/- 4%.
- 6.2.3 All auto-iris lenses shall handle a scene contrast range equivalent to relative aperture range of f/1.6 to f/360 (this may necessitate the use of

wedged-typed neutral density filter). A relaxation to the maximum relative aperture figure may be allowed for lenses with large zoom range.

6.2.4 Unless otherwise stated in the Particular Specification, the near focusing distance shall not be higher than:-

- (i) 1 m for fixed equivalent focal length lens;
- (ii) 1.5 m for zoom lenses

6.2.5 If the lens is motorised for remote control, the response time of the following adjustment shall not be worse than:-

- (i) full range iris control : 1.5 seconds
- (ii) full range focus control (1 m to infinity) : 11 seconds
- (iii) zoom control : speed of zoom shall be such as to double the field of view in less than 2.5 seconds.

Operation of motorised drives for these controls shall not cause any radio frequency radiation or interference to the video signal, e.g. patterning, noise streaks, etc.

6.2.6 The lens shall be manufactured with a high modulation transfer function which shall be several degrees of magnitude higher than the equivalent resolving power of the matching CCD sensor or CMOS sensor. The lens shall exhibit minimum chromatic aberration, both laterally and longitudinally. For zoom lens, it shall be manufactured to minimise zoom tracking error, both axially and laterally.

6.2.7 The video camera shall be equipped with a built-in or a detachable fixed lens which permits the following angle of view:-

Horizontal	:	Not less than 70°
Vertical	:	Not less than 50°
Diagonal	:	Not less than 80°

6.3 Camera Identifier

6.3.1 The camera identifier shall take the form of built-in alphabetical and numeric codes generator within the camera. The method of keying in the alpha-numeric information to individual cameras shall be proposed.

6.3.2 The camera identifier should be field adjustable to at least 12 digit alpha-numeric codes superimposing on the video signal. The setting of these codes should be easily programmable in the field and can be in any combination of digits. It is preferable that the camera identifier can be provided with on-screen menu and instruction for ease of use.

- 6.3.3 It is preferable that the sizes and positions of the alpha-numeric codes can be field-adjusted to anywhere in the picture. It is also preferable that the height of the codes can be adjusted within the range of 5%-15% of picture height.

6.4 Camera Housing

- 6.4.1 All indoor and outdoor cameras shall be fitted with protective housing. The housing shall accommodate the camera provided, complete with lens and other accessories. The outdoor camera housing shall be sturdy and tamper-proof and comply with IEC 62262 – IK10 impact-resistant casing or stipulated in the Particular Specification. Notwithstanding, with the aid of tools, operation and maintenance staff shall gain ready access to the camera and other accessory of the cameras or housing for maintenance, cleaning and/or water-filling purposes.
- 6.4.2 The field of view of the camera shall not be obstructed by the housing.
- 6.4.3 All power, control and video cables entering or leaving the housing externally shall be protected by a flexi-conduit.
- 6.4.4 The housing shall not cause degradation of the performance of the camera under any operating conditions.
- 6.4.5 The environmental protection rating of indoor camera housings shall be at least IP42; whereas, outdoor camera housings shall be at least IP67.
- 6.4.6 Outdoor protective housings except dome type shall be provided with the following facilities:-
- (i) window cleaning wiper;
 - (ii) window cleaning wash-fluid reservoir and water-jet;
 - (iii) sun shield.
- Activation of wiper and water-jet shall be remotely energised. The wiper shall automatically park out of view under off-power condition. The capacity of the was-fluid reservoir shall be at least 1.5 litres.
- 6.4.7 The weight of the housings, excluding the camera and its accessories, shall be less than 12 kg.

6.5 Camera Mounting

- 6.5.1 Each camera shall be provided with a camera mounting which mechanically couples the camera housing (or pan/tilt head) to a wall or ceiling or parapet or pole so that the camera assembly can be suitably and stably located.

- 6.5.2 The mounting design shall allow free motion of the pan and tilt movements of the camera housing. The design of the mounting shall also take into account of the structural or architectural support where the camera mounting is to be fixed.
- 6.5.3 Unless for cameras provided with remotely controlled pan and tilt heads, the mounting shall provide a field adjustable mechanism and a suitable mechanical joint so that the camera assembly can be swung or tilted to the appropriate surveillance direction and locked into this particular position.
- 6.5.4 The tensile strength of the mounting and the method used to connect the mounting to the architectural or structural support must withstand the total weight of the camera, plus housing and the pan and tilt head, and reasonable safety factors built into the design.
- 6.5.5 The colour of the camera mounting shall preferably be the same as that of the camera housing and the pan and tilt head.
- 6.5.6 The camera mount can be ceiling mount type, wall mount type or other appropriate method with due consideration on safety and surveillance requirements. If under the request from the Engineer, the Contractor shall, without additional cost, acquire certificate on the proposed mounting method from authorized personnel (e.g. Independent Checking Engineer) and/or adding supporting chains to the proposed mounting.

6.6 Video Switcher

- 6.6.1 The video switcher offered must basically satisfy the switching scheme as depicted in the Particular Specification, taking into account the required number of video sources and switcher (switch) outputs and any expansion capability.
- 6.6.2 The video switcher shall cater for both manual and automatic sequencing modes of operation. In the manual mode, the operator may select any video source for display on any monitors. In the automatic sequential mode, all the outputs of the video switcher are cycled through with different input sources in accordance with the input sequence (i.e. generally different cameras) and dwell times defined by the operator.
- 6.6.3 Dedicated illuminating indicators and proper labels shall be provided for indication of the power-up condition, camera inputs, video outputs switching schemes, etc.
- 6.6.4 The switching scheme shall not be prioritised. Under manual mode of operation, the video switcher shall be able to switch to any mode of the switching matrix in any order successfully.
- 6.6.5 The video switcher shall provide a panel with soft-touched but positive-action push buttons for activation of manual selection or

activation of any automatic switching sequence. Sufficient illuminants shall be provided to show the video and sequence being displayed. For more intelligent video switcher, this can be replaced by keypads and LCD/LED message displays. In all cases, either the push-button or keypads shall be durable and reliable with a MTBF of more than 100,000 activations.

- 6.6.6 In any automatic sequencing mode, the dwell time of the cameras shall be operator-adjustable from 5 seconds to 120 seconds.
- 6.6.7 If the video switcher employs microprocessor and software to control the selection and sequencing of video sources amongst the respective outputs, the programmability features of such a video switcher shall be referred to the Particular Specification.
- 6.6.8 The contractor shall ensure that cameras, plus any accessories and the distribution system are designed, manufactured and configured so that all video signals are synchronised at the input to the video switcher. Under any mode of switching, no “break up”, “frame-rolling”, “line-pulling” or “line jittering” shall occur to the video picture immediately after switching.
- 6.6.9 The performance of the video switcher shall be better than :-
 - (i) Bandwidth: 10MHz
 - (ii) Differential Phase: 2°
 - (iii) Differential Gain: 2%
 - (iv) Signal-to-Noise Ratio: 50 dB unweighted
- 6.6.10 In order to provide flexibility in system wiring, each input shall preferably contain two terminals, of the high impedance bridging type, with switchable 75 Ohm terminating resistance.
- 6.6.11 With all the unused inputs and outputs properly terminated, the performance of any of the possible signal paths between input and output of the video switcher shall be better than:-
 - (i) 2T pulse response: 2%
 - (ii) Frequency response: 50 Hz to 5 MHz +/- 1 dB w.r.t. 100 kHz
- 6.6.12 With one of the bridging inputs terminated by a high precision 75 Ohm resistor, the return loss ratio as measured on the other input shall be better than 35 dB, 0 to 5 MHz.
- 6.6.13 At any combination of the two inputs, with the rest of the input terminals properly terminated, the signal to cross-talk ratio measured at any of the

possible outputs shall be better than 46 dB within the frequency range 50 Hz to 5 MHz.

6.6.13 Isolation between any of the output terminals of the video switcher shall be better than 35 dB within the frequency range 50 Hz to 5 MHz.

6.6.15 Video matrix shall be a specific type of video switcher which shall provide independent switching for any inputs to any combination of outputs with at least the following features:

- Any output shall be tied to any input at any time independently
- Any output shall be breakaway from the tie with any input at any time
- Any input shall be tied to more than one (1) output
- Any output shall be muted at any time

6.6.16 For Digital Video Transmission, the video switcher shall meet the following requirements:

- (i) A network access switch shall be used for the switching of digital video transmission based on Internet Protocol.
- (ii) The network access switch shall have enough switching capacity and packet forward rate to allow each of its output channels (including the spare channels/capacities) to view multiple video images from different input simultaneously without degrade of performance.
- (iii) Power over Ethernet (PoE) power supply shall be provided if there are equipment powered by PoE, so that it can provide power to the PoE type equipment.
- (iv) The network access switch shall at least support 1000BASE-T networking standard. Console and member ports shall be of RJ45 type. The cable for connecting the access switch and other devices shall meet the requirement of at least Cat. 5 Unshielded Twisted Pair (UTP) under the EIA-568-A standard.

6.7 Colour Video Display

6.7.1 The requirements for the colour video display are depicted as below:

- (i) The colour video display shall be capable to handle both digital and analogue television / video signal. These shall be liquid crystal display (LCD) type, Light emitting diode (LED) type or digital light processing (DLP) type and the requirement shall be referred to the Particular Specification.
- (ii) Unless other specific requirements stated in particular specification,

the colour video display shall meet, but not be limited to, the following performance requirements

- a. Horizontal and Vertical Viewing Angle 150° or larger
- b. Native Resolution 1920 (H) x 1080 (V) or better
- c. Brightness Not less than 250 cd/m²
- d. Contrast Ratio 1000 : 1 or better
- e. Input Terminal HDMI, VGA, BNC, composite video, component video, S-video, or stipulated in the Particular Specification.
- f. Power Source 220V AC ± 10%, 50/60 Hz
- g. Support Languages for On-screen instruction English and Traditional Chinese

- (iii) The mounting of the colour video display shall be desk mount, ceiling mount installation, wall mount installation or floor standing installation.

6.8 Video Multiplexer and Quad Display

- 6.8.1 The video multiplexer provides the simultaneous recording and display of multiple video signals (normally camera signals) without the need for excessive numbers of monitors in the control room.
- 6.8.2 The video multiplexer shall be operated in duplex mode and utilize full digital techniques and time multiplex the digital streams of the video signals for encoded recording and multi-screen display on a recorder and monitor simultaneously.
- 6.8.3 The detailed number of acceptable inputs and various combination of signals for recording, playback and display shall be referred to the Particular Specification.
- 6.8.4 The quad unit shall accept colour video signals and provide at least four (4) video channel inputs showing on one monitor at the same time. It shall also be able to display each channel picture sequentially with adjustable switching time, typically from 0 to 10 seconds.

6.9 Video Recorder

6.9.1 Digital Video Recorder

- (i) The digital video recorder shall be an embedded video processor design or PC-based for stable and reliable operation. The digital video recorder shall record video in a digital format to hard disk drive, networked mass storage device, recordable digital versatile

disc (DVD), USB flash drive, memory card, solid-state drive (SSD) or other storage device, these shall be stipulated in the Particular Specification.

- (ii) The digital video recorder shall record at a minimum resolution of 720 x 576 pixels for all channels using compression technique ITU-T H.264/MPEG-4 Advanced Video Coding (AVC) and/or ITU-T H.265 / MPEG-H Part 2 High Efficiency Video Coding (HEVC) standard or better for high quality freeze image.
- (iii) One connector shall be provided for remote control via an RS-485 communication bus. The maximum distance, using twisted pair cabling, is 4000 feet (1200 meters). Connectors shall be provided for alarm inputs and relay outputs. The number of alarm inputs shall match with the number of video inputs.
- (iv) A standard USB (Version 2.0 or later) style connector shall be available, on the rear panel that interfaces with any USB hard disk drive for video backup functionality. The USB video backup feature shall save images in a self-executable format that contains the required video player program making it unnecessary to install software on the reviewing PC.
- (v) The digital video recorder shall incorporate video motion detection for each video input with at least 16 x 12 blocks motion detection zones to set up and configurable sensitivity and minimum size for triggering.

Where other detection methodologies are used, e.g. automatic tracking or video analytics, these shall be stipulated in the Particular Specification.

- (vi) The digital video recorder shall be able to control various speed domes or receivers via RS422 control port, RS485 control port or Ethernet network connection. It can control the action of the PTZ device via the buttons on the front panel or through the video management software.
- (vii) The status and control of the multi-channel digital video recorder shall be operable through the front panel control or software:
 - Indicate system operation.
 - Turn on and off system power.
 - Select and display the on-screen alarm list.
 - Start/stop recording.
 - Control pause, playback, fast forward/reverse and playback speed.
 - Control step forward/reverse playback.
 - Stop playback.
 - Access on-screen search functions.

- Access/select the on-screen menu functions.
 - Split screen function 1, 4, 8, 12 and 16.
- (viii) The system shall provide a menu for configuring site information. This information should include a site description (up to 20 characters) and a language selection menu (English). This menu shall also display the amount of disk used with the start/end recording times.
- (ix) On-screen Display shall be configurable to include the following: date, time, status icons, and position of the information on the screen.
- (x) The digital video recorder shall be able to configure the system's time and date display. It is desirable to support Network Time Protocol (NTP) for clock synchronization with the master clock system. This information shall include time, date, holiday setup, date format, time format, time zone and daylight savings time. It shall allow date format of dd/mm/yyyy to be displayed or other format shall be referred to the Particular Specification.
- (xi) Access to all menus and screens, and the corresponding capability for each screen of the digital video recorder, shall be protected by passwords with different authorization levels. The digital video recorder shall allow at least two (2) different authority levels to define the rights to access to the control, operate, playback and backup functions of the digital video recorder.
- (xii) The digital video recorder shall incorporate automatic video compensation for each video input and optimized video shall be recorded without the need for calibration of camera phase and input signal strength.
- (xiii) The system shall allow for the selection variety of recording mode configurations. This information shall include the following: end of disk (stop recording when hard disk is full or overwrite oldest images first [FIFO]) and recording mode (simplex [record or playback] or duplex [record and playback simultaneously]).
- (xiv) The system shall allow the user to select from a variety of recording speeds during standard operation. Function of selecting recording speed for each channel shall be available.
- (xv) The system shall allow the user to define independent image record rate and picture quality setting during an alarm.
- (xvi) The digital video recorder shall allow a user to define the duration of an event recording. This setting shall be configurable for pre-event as well as post event from a minimum of one second to a maximum of 300 seconds.

- (xvii) Physically separated hard disks shall be used for system & program storage and image storage. The image storage hard disks shall have on-line redundant configuration, i.e. RAID 1 or RAID 5.

6.9.2 High Definition Video Recorder (HD Video Recorder)

- (i) The HD Video Recorder shall support 1080p and other High Definition video format including 1920x1080p, 1920x1080i, 1280x720p, 720x576p and 720x576i. Compression technique of H.264 or equivalent HD standard shall be provided. The video resolution and compression technique shall be stipulated in the Particular Specification.
- (ii) The system shall support decoding of H.264 and/or H.265 High Definition video format.
- (iii) The system shall provide HDMI or DVI output ports or other output ports, e.g. Composite Video, VGA, S-video, stipulated in the Particular Specification.
- (iv) The system shall be able to record and backup videos on USB hard disk, DVD-RAM, DVD±R (Double Layer), DVD±R or DVD±RW.
- (v) The HD Video Recorder design shall be an embedded video processor design for stable and reliable operation. The HD Video Recorder shall digitize video images and store them in the system's video database on its internal hard disk drive with at least 250 GB or other storage size stipulated in the Particular Specification.
- (vi) A standard USB (Version 2.0 or later) style connector shall be available for interfaces with any USB-SATA or SSD hard disk drive for video backup. The USB video backup feature shall save images in a self-executable format that contains the required video player program making it unnecessary to install software on the reviewing PC.

6.10 Video Distribution Amplifier (DA)

- 6.10.1 The video DA's are used to buffer and distribute video signals in the system highway. In general, video DA's should be used whenever the required video path transverses more than one bridging input.
- 6.10.2 The front panel shall provide light illuminated indicators for the presence of power supply.

For analog video DA:

- 6.10.3 Each video DA shall contain an input with internal 75 ohm terminating

resistance. It shall provide at least four (4) isolated outputs.

6.10.4 The DA shall contain gain adjustment to vary the video level up to 6 dB. Preferably it shall also be provided with some form of high frequency compensation circuitry.

6.10.5 The video DA performance shall be better than:-

- (i) Frequency response 50 Hz to 5 MHz +/- 0.5 dB w.r.t. 100 kHz
- (ii) 2T pulse K factor 1%
- (iii) Signal-to-noise ratio (unweighted) greater than 50dB
- (iv) Differential gain: 1%
- (v) Differential phase: 1 degree

6.10.6 Output isolation shall be better than 35 dB up to 5 MHz.

6.10.7 Return loss ratio shall be better than 35 dB up to 5 MHz.

For digital video DA:

6.10.8 Each video DA shall provide at four inputs four (4) isolated HDMI or DVI outputs.

6.10.9 Each video DA shall provide RS-232 serial port, USB 2.0 port or other ports for control and configuration.

6.10.10 Each video DA shall provide the video resolution at least 1080p or better.

6.11 Radio Frequency Distribution System

6.11.1 For long distance between camera and the monitors for which video relay cannot be implemented in compliance with this specification, radio frequency distribution via copper coaxial cables may be used.

6.11.2 If cable connection is not feasible due to site constraint, video relay via off-air radio frequency transmission shall be utilized. It may also be employed on economical grounds when a large number of receivers have to be provided to cater for a large number of viewing position.

6.11.3 In the case of 6.11.1, transmission using HF or low VHF is preferred to minimise cable loss effects. The exact radio frequency used shall be proposed by the tenderer and subject to the agreement by OFCA. The video performance as measured between the modulator input through radio frequency repeater(s), and the demodulator output shall be better than :-

- (i) frequency response : 50Hz to 5MHz +/- 2 dB w.r.t. 100kHz
- (ii) 2T pulse to bar ratio : 5%
- 2T pulse response : 8%
- 2T bar response : 6%

- (iii) Luminance linearity : 8%
- (iv) Differential phase : 10 degrees
- (v) Differential gain : 10%
- (vi) Signal to noise ratio : 45 dB weighted in accordance with ITU-T J.61

6.11.4 In the case of 6.11.2, UHF frequencies broadcast bands IV and V may be used to suit television receivers for sale in Hong Kong. The exact frequency used shall be proposed by the tenderer and subject to the agreement by OFCA. All types of radio equipment shall be type-approved by OFCA. Using a high-grade standard demodulator, the UHF distribution network shall also perform the requirements under sub-clauses 6.11.3 (i) to (vi).

6.11.5 For digital video transmission, the Radio Frequency Distribution System shall meet the following requirements:

- (i) Wireless local area network (WLAN) such as IEEE 802.11 should be for digital video transmission or stipulated in the Particular Specification.
- (ii) The WLAN shall be encrypted with up-to-day air interface encryption standards, such as WPA2 or WPA3.
- (iii) The SSID of the WLAN shall not be broadcasted.
- (iv) The details of the wireless network design shall include the network architecture with bandwidth calculation to support the design is effective for digital video transmission. The exact frequency of the digital video transmission network used shall be proposed by the tenderer and subject to the agreement by OFCA.

6.12 Fibre Optics Transmission System

6.12.1 The optical fibre as transmission link shall be able to convey single and multi-channel video signals over long distance.

6.12.2 The fibre optic transmission system shall satisfy the following:-

6.12.2.1 Single-mode fibres

- (i) wavelength of transmission 1300 nm or 1500 nm;
- (ii) loss to be less than 0.5 dB per km with bandwidth > 1000 MHz-km;
- (iii) optical loss budget > 9 dB.

6.12.2.2 Multi-mode fibres

- (i) wavelength of transmission 1300 nm;
- (ii) loss to be less than 1.5 dB per km with bandwidth > 500 MHz-km;

(iii) optical loss budget > 17 dB.

6.12.3 It is preferred that the performance of the fibre matches those as specified under the ITU-T G.650 series of specifications.

6.12.4 The optical transmitter shall be semiconductor source which fall into one of the following categories:-

- (i) Light-emitting diodes (LED),
- (ii) Injection-laser diodes (ILD), and
- (iii) Superradiant diodes (SRD).

6.12.5 Low loss fusion splicing shall be used. The spliced fibre junctions shall be coated and protected in a sealed enclosure. The enclosure shall contain a splice organiser that holds and protects the spliced fibres and maintains the proper bend radius.

6.12.6 Each of the cable shall be properly marked and labelled at both terminating ends.

6.12.7 Tenderers shall provide samples of cable, cable joint, terminals and all equipment proposed for signal transmission network along with samples if requested during the tender evaluation.

6.13 Camera Motion Control and Control Schemes

6.13.1 Pan and Tilt Head

(i) The mechanism shall be capable of panning and tilting a camera and lens combination mounted within its housing, as a minimum the following ranges:-

Pan : up to 360°

Tilt : up to + 45° to -60° from the horizontal plane

(ii) Upon maximum load condition, the pan and tilt speed shall not be less than 7 degrees and 5 degrees per second respectively.

(iii) The mechanism shall not turn by more than 2 degrees beyond the point reached at the instant of the interruption of the control signal.

(iv) The construction of the pan and tilt head shall be made from corrosion-resistant metallic material.

(v) Outdoor pan and tilt heads shall be completely sealed weatherproof in accordance with the IP65 standard or better for environmental protection.

(vi) The design of the pan and tilt control circuitry shall be such that

damages to the head and overloading of the power driver shall not occur when the operator tries to activate the pan and/or tilt movement beyond the respective end stops positions, or a failure occurs in the end limit switches.

- (vii) The power feeder shall be suitably fitted with over voltage suppressors and radio frequency sufficiently screened from electromagnetic radiation. Activation of pan and tilt movements shall not cause radio frequency radiation and other forms of interference affecting the video signal generated from the camera e.g. patterning, noise streaks, etc.
- (viii) Any wires leading from pan and tilt head shall be guarded to prevent cable snarling when pan and tilt motions take place. Wiring connections are preferably made through retractile cord to eliminate any wire fatigue.
- (ix) The base of the pan and tilt heads shall be suitable for fixing to a building bracket, pole, etc.

6.13.2 Control Panel

- (i) The remote camera control unit shall be capable to control the pan/till/zoom including auto pan of any camera/camera head/housing under its management. If the camera is fitted with remote controls on zoom, focus and iris function, these controls may also be housed in the same unit. The remote camera control units shall be capable to work in parallel. Each remote camera control unit shall be capable to control more than one camera.
- (ii) The pan and tilt functions shall preferably be operated by “joystick” type of control.
- (iii) All “joystick”, push-buttons, knobs and other switches must be easy to operate and sufficient labeling shall be provided on the control panel to indicate the functions of the control and displays. Labeling shall be fixed in such a manner to resist torn-off by frequent contact with operator’s finger tips. Engraving is therefore preferred. Other methods shall be subject to the approval of the Engineer.
- (iv) If a number of cameras are provided with similar types of pan and tilt head, the control functions may be multiplexed so that one control panel with one set of control buttons and “joysticks” may control a number of cameras and their pan tilt heads, one at a time. If this is the case, a camera source selection switch shall be provided.
- (v) The controls, when not activated, shall not cause any residual drift in the pan and tilt movements of the pan and tilt head, or other

functions of the camera.

6.14 Video Codec

- 6.14.1 The digital video codec shall use of compression technology conforming to the appropriate ITU-T H.264/MPEG-4 Advanced Video Coding (AVC) standard or other standard which is capable of achieving the same image quality and frame rate of H.264 with a lower bit rate. It shall also be capable of streaming video images from one camera input at minimum 25 fps under all conditions of motion within the image, at a minimum resolution of 576 horizontal lines (704x576 pixels) or other resolution stipulated in the Particular Specification.
- 6.14.2 The digital video codec encoder shall be a video transmitter capable of digitally encoding a full motion PAL video format with the selected compression technology. The digital video codec decoder shall be a video decoder capable of accepting digitally encoded digital stream and converting it into standard PAL video format.
- 6.14.3 The digital video codec shall support PAL signal format with a programmable resolution. The bandwidth used by the digital video codec module shall be programmable and the requirement shall be stipulated in the Particular Specification.
- 6.14.4 The digital video codec shall be fully transparent to data protocols and no user adjustments shall be required for data transmission.

6.15 Equipment Rack

- 6.15.1 The equipment cabinet shall be floor-standing type made of hard steel and with good finishing.
- 6.15.2 Front door shall be key lockable. Side panels and rear panels shall be quick release lockable.
- 6.15.3 Depth of the equipment rack shall be sufficient to accommodate all the equipment located inside, including the servers and network devices and shall be at least 600mm.
- 6.15.4 The internal layout shall be professionally designed for mounting various pieces of industrial standard 19” equipment of at least 15U high for wall mounted or 27U high for free stand.
- 6.15.5 The cabinet shall be supported by a 100mm height plinth.
- 6.15.6 The cabinet shall be equipped with cooling fan at appropriate location for effective cooling and air circulation within the cabinet. The design shall allow easily fan replacement.
- 6.15.7 It shall have built-in minimum 12 nos. of 13A mains sockets and cable trays / hoops for internal cable management.
- 6.15.8 The cabinet shall be provided with the following adjustable and removable shelf: one sliding shelf supporting up to 20kg load and three shelves each supporting up to 50kg load
- 6.15.9 All shelves (front panel, rear panel and side panels) shall have ventilating slots to allow air circulation within the cabinet.
- 6.15.10 Each rack and frame shall be provided with a full earth kit. All doors, gland plates and other removable panels shall be electrically bonded to the main cabinet earth.

6.16 Video Management System

- 6.16.1 A Video Management System (VMS) shall include the following functions:-
 - (i) Collects video stream from cameras and other video sources;
 - (ii) Video recording and storage;
 - (iii) View live videos and recorded videos; and
 - (iv) System management and administration.

Open international standard such as open network video interface forum

(ONVIF) and physical security interoperability alliance (PSIA) is preferred to make the system interoperability more easily. The tenderer shall provide the system details and the life-cycle costs such as cost of specialised maintenance equipment and spares etc. for consideration.

6.16.2 Tenderer shall submit the following VMS details in accordance with the system scope and scale as stipulated in the Particular Specification:-

- Operating system platform;
- Software architecture and control scheme;
- Hardware requirements such as CPU, Monitor, Video Display card, Memory sizes, etc.;
- Video switching and control;
- Interfacing;
- Data logging and reporting;
- System redundancy;
- Video compression technology; and
- Software Development Kit (SDK) for interface development by other system supplier.

6.16.3 Tenderer shall submit the network design details for the VMS and other connected CCTV equipment in accordance with the system scope and scale as stipulated in the Particular Specification :-

- Network Topology and System Composition;
- Core switch or/and Access switch;
- Data Transfer rate on full load conditions;
- Control Profile and Interfacing;
- Image performance; and
- Types of Cabling.

7. Installation Requirements

7.1 Earthing

- 7.1.1 All consoles, operator panels, equipment chassis, camera housing, monitor housing that are constructed from metal shall be suitably earthed against electric shock.
- 7.1.2 If the system design or equipment configuration requires the signal circuit common (applicable to video, radio frequency or control circuitry) to be earthed to minimise interference and/or electromagnetic pick-up, these shall be earthed at a single point to avoid hum loops.
- 7.1.3 Earthing arrangements shall be in accordance with IET Wiring Regulations.

7.2 Lightning Protection

Lightning arrestors shall be incorporated to protect the video feed between an outdoor camera and the terminating equipment, in areas of high probability of lightning discharge. Tenderers should refer to IEC 62305 for details.

7.3 Equipment Fixing

- 7.3.1 All equipment except portable equipment shall be firmly held in place. Fastenings and supports shall be adequate to support their load with a safety factor of at least 3. If cameras, monitors, etc. are to be mounted on poles, walls and ceilings of considerable height in public area, a safety chain shall be securely fixed such that, should the main supporting method fail or to be disengaged, the item concerned cannot fall to the danger of any member of the public.

7.4 Cabling and Connections

- 7.4.1 Video and radio frequency cables shall be run in conduits separated from power and control cables. If surface wiring of video and radio frequency cables has to be performed, they shall maintain a distance of at least 100 mm from power conductors.
- 7.4.2 Connection of cables between equipment and a wall-mounted adapter box; or between the equipment rack or console and the cable conduit or trunking shall be protected by flexi-conduit to comply with BS731.
- 7.4.3 Internal wiring within console or equipment racks shall be neatly run and held fixed in cable ducts by non-rusting cleats or cable ties.
- 7.4.4 Cable connections to an equipment or console or control panel shall, as far as possible, be provided with plug-socket configuration. Where direct entry of a cable through a metallic cover or panel of an equipment rack is unavoidable, the hole through the metallic cover or panel shall be

protected by rubber grommets to avoid cuts.

- 7.4.5 All cables shall be run within conduits and trunking specially provided for the purpose by others. If there are short lengths without these provision, the contractor is required to provide the supplementary conduits, trunking, rackways and adapter boxes to complete the installation.
- 7.4.6 Cable jointing shall be avoided as far as possible. Where a cable joint is considered acceptable by the Engineer all cables shall be jointed by properly designed connectors or inside joint boxes.
- 7.4.7 The installation and handling of the cables shall be undertaken at all times by adequate staff trained and supplied with all the necessary equipment and tools. The arrangement of the cables and all method of laying shall be approved by the Engineer and shall be in an orderly manner, free from unnecessary bends and crossing which will permit the removal of any cable without undue disturbance to adjacent cables.
- 7.4.8 Coaxial cables, when installed on the surface, shall have a separation of at least 100 mm from light or power conductors not in conduit or cable, or be permanently separated from conductors of the other system by a continuous and firmly fixed non-conductor in addition to the installation on the wires.
- 7.4.9 Control cables shall be of the multicore type. Each core shall make up of stranded annealed copper conductors with PVC insulation. The whole cable shall be screened with copper tape or copper braid and shall have an overall sheath of PVC. Control cable shall satisfy the following minimum characteristics:
- i. strand diameter to be not less than 0.2 mm;
 - ii. conductor resistance to be less than 90 Ω /km;
 - iii. insulation resistance to be better than 20 M Ω /km measured between core or between core and screen;

7.5 Surface Wiring

- 7.5.1 All cables shall be run in a vertical or horizontal direction. Only cables required to feed a point on a ceiling may be fixed to the ceiling.
- 7.5.2 When cables pass through walls or columns, a piece of PVC sleeve of adequate size shall be inserted into the wall or column, and the cables shall be drawn therein. Holes so created around the sleeve shall be fitted up with cement and touched up with paint. Colour of paint shall match to the walls or columns nearby.
- 7.5.3 Rubber grommets or insulated bushes shall be used to protect the cables when passing through metal covers of distribution board, boxes or any other metal work.

- 7.5.4 Unless otherwise authorised by the Engineer, cables shall be secured flat to the surface of walls and ceiling by means of buckle clips or cable saddles.
- 7.5.5 Buckle clips shall be of heavy gauge, heavily tinned brass with counter-sunk fixing holes, and shall be fixed by means of non-corrosive pins or screws of 10 mm minimum length secured to plaster, concrete etc. the plug shall be made from teak dwelling of parallel length. Every fixing hole in buckle up will be deemed to require a pin or screw. The heads of the screws or pins shall be level with the surface of the clips that no damage to the sheath of the cables can occur.
- 7.5.6 Spacing of the clips shall not exceed 150 mm in horizontal direction and 225 mm in vertical direction.
- 7.5.7 A clip shall be provided not less than 75 mm and not more than 100 mm from any bend or termination and cables shall be set so that they lie flat against the surface.

7.6 Surface Conduit

- 7.6.1 Surface conduits shall be fixed by galvanised heavy spacing saddles, and shall run only in a perpendicular or horizontal direction. On straight run 20 mm and 25 mm conduits shall be supported by not less than one saddle every 1 metre in addition to support provided by any structure, box or fittings.
- 7.6.2 For 32 mm and larger conduit, saddle may be placed not more than 1.2 metres apart. Angle bends shall in all cases be supported by two saddles as near thereto as possible. Heavy spacing galvanised saddles shall be fixed with brass screws in rawl plugs, or other approved methods.
- 7.6.3 Conduit bends shall have a radius of four times the outer diameter of the conduit.
- 7.6.4 A saddle shall be provided not less than 150 mm and not more than 200 mm from any bend or termination.
- 7.6.5 Steel conduit systems shall be mechanically and electrically continuous through-out, and efficiently earthed.
- 7.6.6 Chassis for conduit in wall shall be perpendicular or horizontal.
- 7.6.7 Joints in runs of steel conduits shall be made by means of a coupler into which the ends of both conduits are to be inserted and tightened up.
- 7.6.8 An adequate number of suitably sized hot-dipped galvanised cast iron draw-in boxes shall be provided in conduit runs to enable cables to be drawn in easily and without damage. Draw-in boxes shall be fitted after every two bends, or after a maximum straight run of 15 meters.

8. Environmental Conditions

- 8.1 Outdoor cameras with housing shall be designed so that it may continuously operate at an ambient temperature: -10°C to 55°C and relative humidity: 100%.
- 8.2 Outdoor cameras shall be designed and should be tested in accordance with BS2011 / IEC 60068 or the certificate of proving the proposed camera complied with BS2011 / IEC 60068 given to the Engineer for approval.
- 8.3 Outdoor equipment shall be protected by a housing of environmental protection rated at IP67.

9. Testing and Commissioning

- 9.1 Test plan and procedures shall be stipulated in the Particular Specification. If a “standard lens” and other test tools are required for camera testing purpose, this shall be supplied by the contractor, on loan to the Engineer at no extra charge.
- 9.2 The Contractor shall submit a Test Plan to the Engineer for approval. The Test Plan shall include detailed descriptions about the Contractor’s plan in carrying out the tests including schedules, documentation and specifications.
- 9.3 The test schedules and test procedures shall contain: -
- (i) Description of the purpose of the test with a summary of the main functionality and/or performance parameters to be checked and test methodologies applied;
 - (ii) Clear cross-referenced contract clauses or paragraphs numbers as per the Particular Specification;
 - (iii) Proposed test sheet for each test item of the test with detailed procedures to conduct the tests, including set up, schematic diagram, test environment, list of test equipment, instrument and tools to be used, parameter settings and preparation details, simulation hardware and software, step-by-step testing procedures, acceptance criteria and nominal / expected results;
 - (iv) Time, location and expected duration of each part of the test;
- 9.4 For analog video, the following items shall be included in the test.
- (i) If some of the parameters in the Specification are affected by the average picture level (APL), the Engineer shall reserve the right to measure at the worst case results, corresponding to any APL value within the range of 10% to 90%.
 - (ii) Unless otherwise specified in the Particular Specification, either transmissive type or reflective type test charts with correlated colour temperature within the range of $3100\text{ K} \pm 100\text{ K}$ shall be used for video camera evaluations.
- 9.5 For digital video, the following items shall be included in the test.
- (i) The camera shall produce a clear picture with a resolution no less than the specified requirement.
 - (ii) The camera shall maintain a clear picture and automatically compensate for changing light conditions including day/night mode change.
 - (iii) The bandwidth of the digital video transmission via the data network shall be measured.
 - (iv) The system configuration such as addition and removal of the camera using

the video management software shall be performed.

10. Documentation and Training

10.1 Documentation

10.1.1 The Contractor shall supply the operation & maintenance documentation as detailed in clause 2.11 of the "General Requirement for Electronic Contracts ESG01".

10.1.2 The Contractor shall submit the operation and maintenance manuals to the Engineer for approval before commencement of Defects Liability Period (DLP).

10.1.3 Operation Manual

10.1.3.1 The Operation Manual shall comprise a clear description of operation procedures to operate the system but not be limited to the following: -

- (i) Clear and detailed description on the principle of operation; configuration and the functions of various parts of the system;
- (ii) Comprehensive description of all the equipment provided and how they are connected to form the system;
- (iii) Detailed description of the operating procedures, sequences and commands for various parts and components of the system;
- (iv) Detailed system start-up and shut-down procedures;
- (v) Sizes, capacities and capabilities of all the major equipment and components of the system;
- (vi) List of initial system settings and other adjustable variables of the system;
- (vii) Faults identification procedures of hardware and software;
- (viii) List of anticipated anomalies/remedies;
- (ix) List of implications of alarm displays and error codes;
- (x) Detailed description of errors and anomalies recovery procedures, such as the handling steps of system malfunctions, data recovery from system crash and power failure;

- (xi) Safety guidelines for the system operation; and
- (xii) Other requirements as stipulated in the Particular Specification.

10.1.4 Maintenance Manual

10.1.4.1 The Maintenance Manual shall meet the requirements as stated, and include at least but not be limited to the following:-

- (i) Overall descriptions of the concept, configuration and operation of the system including, normal operation sequence list, block diagram and flow chart;
- (ii) Full technical descriptions and details of every unit / component / module of the system including: -
 - its functions, applications and operating principles
 - block diagrams showing the flow and interaction data
 - logic diagrams with status values
 - schematic diagrams with details of the system components
 - layout diagrams showing assemblage, identification and location of every unit
 - wiring diagrams and schedules showing the interconnection between equipment
 - mechanical drawings
- (iii) Equipment specification and interface parameters;
- (iv) Initial system settings and other adjustable variables of the system;
- (v) Full installation details, including wiring schedules, all equipment installed completed with type/model numbers and serial numbers;
- (vi) Maintenance and servicing procedures and routines including detailed procedures for system checking, calibration, alignment, cleaning, installation units, changing components and replacing parts;
- (vii) Trouble-shooting of the systems, supplemented by flow charts and diagrams;
- (viii) Performance test, measurement and alignment procedures together with schematic diagrams of test set-ups as well as clear annotated diagrams showing test points with nominal waveforms/readings;

- (ix) Safety guideline and special precautions for carrying out maintenance and servicing procedures;
- (x) As-built drawings; and
- (xi) Other requirements as stipulated in the Particular Specification.

10.2 Training

- 10.2.1 The Contractor shall provide customized training facilities and separate training courses for technical and operational staff to acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, routine and preventive maintenance, fault diagnosis and rectification of the system.
- 10.2.2 All the training courses shall be conducted at designated venue by the Engineer, the Contractor's and/or sub-contractor's or manufacturer's premises and on site. The Contractor is required to provide training facilities, teaching aids and self-learning packages.
- 10.2.3 The Contractor shall submit a detailed training proposal to the Engineer for approval prior to conduct the training courses.
- 10.2.4 Other requirements as stipulated in the Particular Specification.

*** End ***