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Workplace Safety and Health Technology, Innovation & Productivity and Sustainability

Workplace Safety and Health (WSH) Technology, Innovation & Productivity and Sustainability

22.1 CONSTRUCTION DIGITISATION

22.1.1 The Authority intends to digitise workflows to improve collaboration and communications between the Authority and the Contractor. The adoption of the following technology solutions will facilitate sharing of information and improve work efficiency.

22.1.2 Engineering Project Integration and Collaboration (EPIC) System or any other online platform

22.1.2.1 The Contractor shall comply with all requirements related to design submissions as described in **Appendix I** of the General Specification.

22.1.2.2 Where requested by the Engineer, the Contractor shall submit all the correspondences inclusive of documents, drawings, transmittals etc in digital format through the Authority's System, "EPIC" or any other online platform including but not limited to "InSIGHT". Hardcopy submissions for the above-mentioned correspondence are not required.

22.1.2.3 The Contractor shall allow for all cost and time for the adoption of any new procedures for document submissions including but not limited to provision of new or modification of existing hardware, software and internet connectivity.

22.1.2.4 The Contractor shall comply with the Engineer's procedures for submissions to be digitally signed by the Contractor's authorised persons.

22.1.2.5 In the event that the Authority's EPIC System or online portal malfunctions during its operation for any reason, all document submissions shall be made in compliance with the Engineer's procedures. The Contractor shall allow for all time and cost associated with this compliance.

22.1.3 Authority's Inspection Mobile Application

22.1.3.1 The Authority's inspection mobile application will be used by the Authority, the QP(S) Consultant, the Contractor and any other persons as directed by the Engineer to input observations, photos and comments for direct online exchange of inspection reports.

22.1.3.2 Upon the launch of the Authority's inspection mobile application by the Authority, the Contractor shall procure mobile devices capable of supporting the latest version of Apple iOS mobile operating system including all subsequent updates until the Completion of the whole of the Works (CWW) or any other date as requested by the Engineer, whichever is later. The Contractor shall ensure that his staff are adequately furnished with mobile devices for use in all inspection works.

22.1.3.3 The Contractor shall propose to the Engineer for acceptance of the number of mobile devices to be sent to the Authority or the Authority's appointed vendor for security configuration and installation of Authority's inspection mobile application. The payment for these mobile devices is at the Contractor's cost. The payment(s) for the cost of the initial security software license, installation and support are to be first made by the Contractor and subsequently reimbursed by the Authority based on actual invoices from the Authority's appointed vendor without mark-up and subject to proof of payment made.

22.1.3.4 The cost for replacement mobile devices and additional security software licence, configuration, installation and support required for these replacement mobile devices that are lost and/or damaged by the Contractor and his staff shall be borne by the Contractor.

22.1.3.5 The configured mobile devices shall have access only to the Authority's authorised applications and services needed for the Works. In the event the Authority's inspection mobile application malfunctions for any reason, the Contractor shall contact the Helpdesk Contact number provided by the Authority. The Contractor shall carry out all inspection works in compliance with the Engineer's procedures until the system's resolution. The Contractor shall allow for all time and cost associated with this compliance.

22.1.3.6 Upon the Completion of the whole of the Works or at any time where the mobile devices are no longer in use, the Contractor shall send these configured mobile devices to the Authority or the Authority's appointed vendor to uninstall the security software and the Authority's inspection mobile application.

22.1.4 Mobile Interactive Digital LED Touchscreen

22.1.4.1 The Contractor shall supply, install and maintain a mobile interactive digital LED touchscreen within the Authority's office to review Building Information Modelling (BIM) models, DAR submissions and drawings. The Contractor shall refer to **Clause 5** of the Particular Specification on the requirements.

22.2 ADOPTION OF TECHNOLOGY FOR CONSTRUCTION SUPERVISION

22.2.1 The Authority intends to leverage on Video Analytics (VA) to enhance safety supervision processes by automatically detecting safety non-compliance from recorded video feeds and trigger alerts for prompt intervention. It shall augment and allow better safety supervision, using predefined algorithms and safety rules to ensure safety compliance. The focus of VA shall target at high risk work activities and serve as additional control measures to mitigate related risks on Site. Customized solutions shall be established using machine learning methodology. Please refer to **Appendix AW** of the Particular Specifications for requirements of VA system.

22.3 ADOPTION OF TECHNOLOGY FOR MONITORING OF SPOIL DISPOSAL ACTIVITIES

22.3.1 The Contractor shall note the requirements for provision of CCTV System and Truck Recognition System in **Clause 12** of the Particular Specification. The Contractor shall be responsible for issuance of spoil disposal tickets in accordance with the Authority's requirements and the technology requirements are to enable auditing and monitoring of the Contractor's spoil disposal activities by the Engineer.

22.4 USE OF UNMANNED AIRCRAFT (UA) FOR AERIAL PHOTOGRAPHY, VIDEO TAKING, AND OTHER PURPOSES

22.4.1 The Contractor shall employ the use of UA or drones to conduct aerial photography and/or videography of works from a suitable height on a monthly basis or as and when requested by the Engineer. The photographs shall be taken from a top down and/or oblique angles and capable of forming a complete stitched panoramic photograph if required.

22.4.2 The aerial photographs shall be in full colour with a minimum of 8 megapixels, and a total of at least twenty-four (24) different photographs in digital format (.jpg) shall be provided by the Contractor for each flig0ht. The Contractor shall submit the softcopies of the photographs in digital format upon the request by the Engineer.

22.4.3 The aerial photographs shall form part of the Progress Photographs as specified in **Clause 21** of the General Specification.

22.4.4 The Contractor shall make reference and comply with the requirements of Civil Aviation Authority of Singapore (CAAS) in the safe use of the UA as outlined at https://www.caas.gov.sg/public-passengers/unmanned-aircraft-systems.

22.4.5 The Contractor shall also be responsible to make all the necessary arrangements, including obtaining the necessary permits and approvals

from CAAS and other authorities for the aerial photographs and videos to be taken. Before commencement of each flight, the Contractor shall be in possession of valid permits from CAAS. A copy of the permit shall be extended to the Engineer for his information. The Contractor shall note the flying restrictions of Security-Sensitive Locations (SSL), areas within 5km from aerodromes, any other prohibited or restricted areas, as well as CAAS rules and regulations.

22.4.6 The Contractor shall only operate the drone(s) within the scope and conditions stated on CAAS issued permits. The Contractor shall take all necessary measures and precautions to ensure that the flights of the drone(s) will not pose a hazard and/or cause injury or death to persons and/or damage to properties. The Contractor shall indemnify the Authority and provide the requisite insurance for the drone flights. All cost of the permit applications, required insurance, personnel to be provided and other associated cost to use drones for aerial photographs, video taking and other purposes are deemed included in the Contract Price.

22.4.7 The negatives/softcopies/hardcopies of the photographs and videos shall be the property of the Authority and while in custody of the photographer or his processor, no copies must be supplied to any person or otherwise made use of. All negatives/softcopies shall be handed over to the Engineer together with the submission of the hardcopy prints. Any copies that are required to be handed over to any agencies or authorities due to security or other sensitive reasons as specified in the permit shall be made known to the Engineer.

22.4.8 The Contractor shall also note that there are stakeholders within the vicinity of the aerial photographs and video taking locations and permission for these UA activities shall be obtained from these stakeholders.

22.4.9 In the event that the photographs and videos are of a quality that is unacceptable to the Engineer, they shall be retaken at the Contractor’s own cost.

22.4.10 Photogrammetry

22.4.10.1 Photogrammetry is a workflow to convert photographs or videos of a physical space into a virtual 3D model that can be measured and manipulated.

22.4.10.2 The Contractor shall create digital 3D models of the site using photogrammetry (Photogrammetry Models) with aerial photos and/or videos taken using drone(s) to update on site status and other purposes, with the aim to enhance construction productivity, if the site conditions allow.

22.4.10.3 The requirements for the Photogrammetry Model are as listed below:

a) The Photogrammetry Models shall be georeferenced using Ground Control Points (GCPs) with known SVY21 coordinates together with Singapore Height Datum (SHD), or other reliable methods, subject to the acceptance of the Engineer;

b) The georeferenced Photogrammetry Models shall achieve an accuracy of at least ±10 cm in the x-y-z directions or better;

c) The Photogrammetry Models shall be created or be able to be converted into a sharable file format for viewing and collaboration purposes; and

d) Provision for integration of the Photogrammetry Models with BIM software shall be made.

22.4.10.4 The Contractor shall employ their own staff and/or external service provider(s) to perform the photogrammetry works.

22.5 ADDITIONAL INITIATIVES TO BE PROPOSED BY CONTRACTOR

22.5.1 General

22.5.1.1 The Authority is aligned with the national target to reduce Singapore's workforce fatality rate achieving a sustained fatality rate of less than 1 per 100,000 workers by 2028 and for the push for sustainability under GreenGov.SG.

22.5.1.2 In addition to the Authority's requirements set out in clauses 22.1 to 22.4 and other relevant requirements in the Contract, the Authority will embrace the adoption of WSH technologies to improve WSH and innovative technologies and sustainable practices for the Works.

22.5.1.3 The Contractor shall innovate and may propose other suitable initiatives to enhance WSH Technology, Innovation & Productivity and Sustainablilty. The Contract Price shall be deemed to include these additional initiatives and the Authority reserves the right to omit from the Contract Sum for the proposed initiatives in the event that any were not implemented. The amount of omission shall be based on **Clause 57.2** of the Conditions of Contract. The following broadly categorise the factors to consider for the Contractor's additional intiatives with respect to WSH Technology, Innovation & Productivity and Sustainability.

22.5.1.4 The Contractor may propose innovative design and construction approaches, technologies and measures including but not limited to the following examples to be implemented under Contract CR205 main works.

22.5.2 WSH Technology

22.5.2.1 Wherever practical, the Contractor shall consider the use of smart technology to enhance safety management of the worksite which include but not limited to the following:-

i. Drones/360 cameras to carry out confined space inspection, track project progress and identify worksite hazards;

ii. Personal wearables devices for workers' location tracing, geofencing etc and health monitoring;

iii. On-site sensors to measure environmental conditions to monitor workers' exposure;

iv. Robotics applications to eliminate workers' exposure to safety hazards;

v. Improved dust control in station using approved industrial vacuum, misting, air filter machines, etc;

vi. Use of enhanced PPE such as noise cancelling headphones for noisy works, respiratory dust masks, exoskeleton robotic suit for workers;

vii. Implementation of special noise control initiatives to reduce noise emission from equipment and construction activities;

viii. Augmenting safety supervision using video analytics in additional to listed outcomes beyond Appendix AW: Video Analytics (VA) Requirements Specifications; and

ix. Any other Smart Technologies to enhance Workplace Safety Management.

22.5.3 Innovation & Productivity

22.5.3.1 Wherever practical, the Contractor shall consider the use of automation and mechanization, or innovative and efficient plant and machinery to improve productivity in his construction works. Where the site and ground conditions are suitable, the Contractor may explore the use of efficient methods in his design and construction of the ERSS to improve the productivity of his underground construction works. The Contractor shall seek the Engineer's acceptance of his proposal prior to the implementation of the productivity measures.

22.5.3.2 The Contractor may propose and implement mobile technology for real-time monitoring of the prefabrication/precasting process when such manufacturing and production of the prefabricated/precast components are carried out outside Singapore. The monitoring system shall be suitable to assist in the quality assurance and supervision of the processes by the QP(S).

22.5.3.3 The Innovation and Productivity practices include and are not limited to following:-

i. Use of tubular struts to reduce king posts, bracing and welding;

ii. Precast concrete elements, prefabrication of structural and architectural elements and prefabricated rebars (such as rebar carpet, rebar cage and rebar panels);

iii. Use of system/modular formwork, and prefabricated formwork elements;

iv. Use of specialised tunnelling machinery for subways;

v. Use of robotic equipment;

vi. Use of electric gantry cranes;

vii. Use of water cutter / hydro-demolition and other non-percussive demolition methods;

viii. Enhance access to the worksite and structures e.g. use of passenger hoist into underground station during construction, truck mounted working platform;

ix. Productivity analysis and internal bonus schemes for achieving realistic goals using data from real-time labour tracking (over and above the current provisions of biometric tracking);

x. Grade control system for earthworks, automatic levelling for road paving machines, automatic tack coat sprayer for road pavements, rollers with real time compaction data displays;

xi. Automatic cone laying/picking machine, automatic road marking, traffic signs placed using robotic machine, automatic signal for traffic control at work zones, automated washing of truck wheels;

xii. Subsurface object scanner for utility detection;

xiii. Excavator with electromagnet attachment for moving steel plates;

xiv. Computer software / mobile applications to monitor and manage the movement of machinery, equipment, materials, logistics, etc. within the site and interface with suppliers for deliveries;

xv. Tile laying by the use of robotic technology;

xvi. Spray painting works, automatic mechanised plastering of walls;

xvii. 3D printing for cladding panels, ceiling tiles and other elements;

xviii. Avoidance of transfer beams, seal spaces and high voids;

xix. Standardisation of floor to floor heights and door structural sizes;

xx. Use of power float concrete floor for back of house areas; and

xxi. Standardisation of signage.

22.5.4 Sustainability

22.5.4.1 In addition to the Authority's requirements, whenever practical, the Contractor shall submit:-

a) corporate carbon disclosure, green certification/accreditation and green project awards; and

b) analysis on the environmental benefits and emission impact for the use of innovative environmental mitigation measures and sustainable construction practices, such as Environmental Product Declaration (EPD).

22.5.4.2 The Contractor shall consider innovative environmental mitigation measures and sustainable practices that include and are not limited to following:-

i. Whole Life Carbon (WLC) assessment of the Contract;

ii. Low-carbon building materials, such as green steel, concrete containing cement with high GGBS replacement level (>36%) and CO_2 mineralised concrete. For green steel, the Contractor should provide information such as the source and properties of the steel, manufacturing process, percentage of scrap/recycled content, carbon factor, environmental production declaration and accreditation, etc.

iii. Use of certified green building products and materials for the Works (above and beyond the Greenmark requirements); and

iv. Use of electrified construction equipment, vehicles, machineries and processes;

v. Renewable energy during construction, such as installation of photovoltaic system at worksites;

vi. Implementation of special noise control initiatives to reduce noise emission from equipment and construction activities;

vii. Smart monitoring and control for treatment of silty water;

viii. Eco-friendly waste management proposals including sustainable consumption (reduce, reuse and recycle) and waste segregation (above and beyond the Greenmark requirements).