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Identification of Occupational Safety and Health Hazard and Risk Assessment for Installing Self-Climbing Platform (SCP) at High Rise Building in Construction Industry

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Abstract

Occupational hazards are a major concern in the construction industry, particularly for specialized operations like tiling where workers are exposed to many risks. These risks are often brought on by the physically demanding nature of the work, the use of dangerous materials, and the unsteady circumstances seen on building sites. This study aims to thoroughly investigate the occupational risks associated with installing self-climbing platforms, with a focus on identifying potential risks, conducting risk assessments, and suggesting suitable management mechanisms to reduce risks. The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) assessment form should be used to analyze the occupational hazards. The likelihood and severity were assessed using a risk matrix based on the inspection. A serious risk to health and safety was discovered. In order to accomplish the goal of this study, hierarchy control was used to recommend the best control measure for each detected hazard. The results of this study will be very helpful to the resource-constrained construction businesses that wish to increase productivity and lower all possible risks. In order to improve safety standards in the construction industry, this study provides a thorough analysis of the occupational hazards that employees face and presents workable solutions.

1. Introduction

According to Teo et al. (2021), construction sites can be complex and risky. Construction is a high-risk occupation for workers and can cause accidents for the general public. Construction projects often involve work-related accidents and injuries (Khor C.H, 2019). Workplace fatalities and injuries cause significant losses for both individuals as well as society (Benny et al, 2018). Haslam et al, (2005) found that inadequate risk control and management lead to accidents, indicating management failure. According to NIOSH (2019) and the 2nd International Conference on Built Environment in Developing Countries (ICBEDC 2020), accidents at construction sites can be avoided or minimized through effective risk management strategies such as hazard identification, assessment, and control (HIRARC).

In 2023, there were 45 fatal construction accidents in Malaysia (DOSH, 2023). This was a decrease compared to the previous years [1]. The number of deaths from construction accidents in the country has been

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declining since 2019. Undeniable, construction sites have exposed a lot of hazards and risks to workers, which has caused a high number of accidents. Occupational Safety and Health Act 1994 (OSHA94), which also covers the construction industry has been urging the implementation of occupational safety and health (OSH) in workplaces. Safety and Health Committee Regulations 1996 and the Safety and Health Officer Regulations 1997 are among the regulations that stress the importance of safe working places. The implementation of HIRARC is among the tools to achieve safe working place and therefore can reduce accidents effectively [2].

For this research, a specific work process selected for the research is installation of self-climbing platform (SCP) for high rise buildings. This main purpose for installation of SCP is to prevent falling objects and reduce risk during working at height. This method has become more popular in high rise building as proven this method is safer compare to convention method which is using scaffold. This operation process took 8 people including tower crane operators during lift operations. During work progress, the operation must be supervised by competent personnel such as engineer, supervisor, site safety and also project manager. Hydraulic self-climbing formwork can climb as a whole, characterised by stable motion, high safety performance, and fast speed, and so can decrease the labour intensity effectively.

This research was conducted in line with three [3] objectives that has been constructed and aim to determine the occupational hazard for self-climbing platform installation at the construction as well as conduct risk assessments based on the hazards associated during the operational of the installation. The first objective was to identify occupational safety and health hazard for SCP installation at construction industry, next to analyze the occupational hazard related with SCP installation by using HIRARC assessment form along with to recommend control measure of occupational safety and health for installation operations.

2. Causes of previous accident of SCP or scaffolding at Construction Industry

The most common contributing factors to the incidents are fall hazards contributed to incidents (for instance, unguarded ends or removed guards, climbing from the platform to a building opening, inadequate platform material or plank bearing and four fatalities ,loading issues, overloaded platforms or use of inadequate bridging, contributed to three incidents and five fatalities ,failure to use the correct mast climber components or faulty configuration contributed to two incidents and four deaths , instability of the mast climber during dismantling contributed to two incidents and four deaths and equipment failure contributed to one incident and one death, when two mechanisms failed simultaneously [3]. According to Jim K. et al., 2019, lack of training on the installation and use of this complex equipment is a critical factor in many mast climber incidents. The mechanics and methods of erecting, using, operating, installing and dismantling mast climbers are different from other scaffolding methods and require a great deal of expertise and skill. Another safety concern is the communication gap between the mast climber manufacturer and the equipment's end users [4]. Without effective lines of communication, critical safety warnings and operating updates may never reach the people who most need the information.

Miami, Florida, 1995	**Kuala Lumpur, Malaysia, 2007**	**Cardiff, United Kingdom, 2000**	**Kuala Lumpur, Malaysia, 2021**	**Hamburg, Germany, 2023**
On March 4, 1995, at about 8:30 am, a mast climbing scaffold collapsed at a building construction site in Miami, Florida. As a result of the collapse three stucco contract employees were killed when they fell approximately 75 feet to grade	Two workers at a construction site were killed while ten others were injured when the scaffolding they were on collapsed from a height of 25 metres.	Twelve stories of scaffolding collapsed onto a road and railway in Cardiff, United Kingdom. The scaffold collapse happened as a result of design defects, unapproved changes in design, lack of anchor ties, improper anchor ties, and failure on the part of the contractor to perform the necessary safety checks.	Two construction workers were injured after metal scaffolding of a highway that was under construction in Malaysia collapsed on Saturday (June 19).	Five workers were killed in an incident at a major construction site in the city of Hamburg, in northern Germany, and several others were missing after scaffolding collapsed on Monday

***Table 1*:** Accident and Incident

According to Desianna and Yushananta (2020) the HIRARC approach, as well as the application of probability or likelihood of hazard and severity of the hazard, are adequate for assessing the risk of occupational accidents and diseases. the HIRARC method can be identified and controlled the hazard. These strategies can be used to identify risks and execute the best safety measures in the industry (Pradeesh T et al., 2019). This method of research was conducted by a numerous researcher, and they mostly use HIRARC to identify any hazards in their industries. Based on that, the recommendation provided according to the HIRARC analysis can be described as an easy approach that the company can successfully implement (M. Fathullah et al., 2021). In order to OSHA 1994, employers are required by regulation to ensure the safety, health, and welfare of their employees and other associated persons. Industries which have implemented HIRARC in the workplace recognize a significant improvement regarding their work practices because they have a better understanding of their working environment and implement the necessary corrective measures.

2.2 Methodology

In this study, two methodologies will be highlighted which is primary and secondary data. As an example, primary data will be used directly to recognize occupational safety and health hazards associated with the installation of a self-climbing platforms in the workplace. Furthermore, in order to achieve the objectives, HIRARC will use the HIRARC form to assess the hazards associated with this work activity, as well as conduct interviews with the SHO and professionals. Meanwhile, secondary data will be gathered from articles, journals, and sources from previous incidents that were consistently obtained, as well as websites and other reliable sources on the internet for related and aligned occupational safety and health hazards during the installation process. Data collection is the process of acquiring and analysing accurate information for research objectives using established procedures. The evidence obtained will be used to evaluate the researcher's findings. Data collecting is frequently the initial and most important element of the research process, depending on the topic. This research process is represented in the flowchart below.

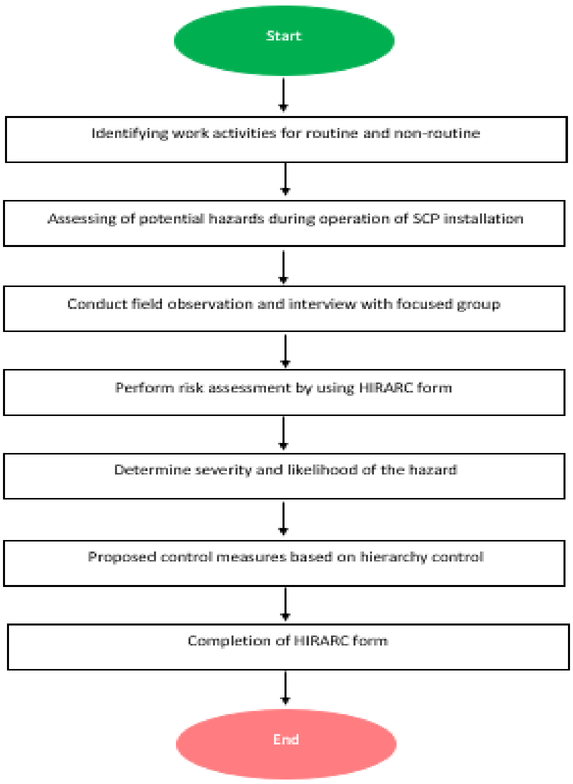

Fig. 2: Research process

The warehouse processes involved are loading and unloading crates or goods, lifting and many more. The analysis of the data that has been obtained will be evaluate by using the risk matrix. The safety awareness and accident related with MHE was studied based on the document review and data that has been provide by the HSE manager of the warehouse.

Furthermore, for the workplace hazard identification data from GEMBA Walk Inspection Checklist, the data that have been gathered have been analyzed by using qualitative method. In this research, field observation and workplace inspection are conducted along with the focused group.

All hazards discovered during the workplace inspection utilizing the risk assessment method were evaluated on their characteristics through corresponding data, tables, and their expected occurrences and risk involved using this matrix. Risk assessment entails determining the likelihood and severity of injury caused by specified hazards. Besides, this method assists in risk ranking and establishing suitable control measures for risk control. It usually entails calculating the likelihood of an incident occurring as well as the potential effects.

In addition, the recommendation for risk control have been evaluated by using the hierarchy control that have been outlined based on the Guidelines from DOSH.

3. Results and Discussion

The analysis of the data is highlighted in relation to the research findings, those are based on data collection according to consideration of the previous objectives and goals. The objective in this research which is set as a goal throughout the research aimed to identify the risks and hazards that connected with the main work activity at the selected industry. Hence, the list of the hazard that has been identified are come out with a specific strategy to control the risk associated to the warehouse industry and already been accessed by using HIRARC form and Inspection Checklist. Hence, the findings and outcomes from Inspection are listed in **APPENDIX A.** This research was carried out by evaluating the risk associated with routine and non-routine occupational activities, particularly by SCP installation operation at construction industry. Figure 3 below present five (7) main work activity related to SCP installation operation.

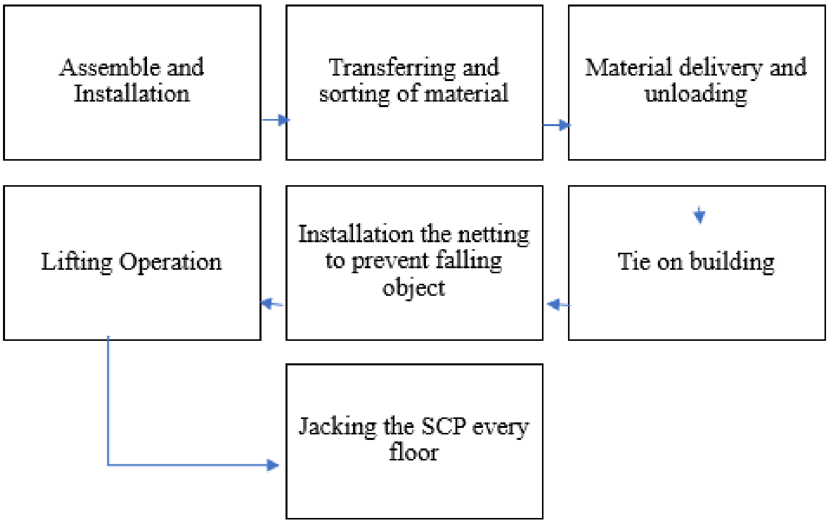

Fig. 3: Main work activity that related to SCP installation operation

The following Table 1 was a HIRARC form according to the DOSH guidelines that use to assess hazard during SCP installation activity in the selected industry. All the associated hazard that has been identified was based on seven (7) main work activities during the operation of installation in construction. Table 2 shows the hazard identification during SCP installation operation at construction site.

Table 2: Hazard Identification during SCP installation at construction.

No.	Work Activity	Hazard	Effect
1.	Material delivery and unloading	a) Moving with overcapacity materials b) Unstable loads c) Falling objects d) Limitation work space	a) Overturning and cause serious body injuries. b) Collapse of improperly stacked materials c) Collisions with workers, other vehicles, or equipment

No.	Work Activity	Hazard	Effect
			d) Tools or materials falling from height
2.	Transferring and sorting of material	a) Slips, Trips and Falls b) Sharp Edge or Protrusions c) Inadequate lighting d) Exposure to dust	a) Injuries caused by uneven surfaces, cluttered work areas, or spilled materials. b) Cuts or puntures c) Poor visibility
3.	Assemble and Installation	a) Working at height b) Electrical Hazard c) Falling Objects d) Vibration	a) Fall from height b) Collapse of partially assembled formwork c) Electric shocks or burns d) Tools or materials dropping from height
4.	Lifting Operation	a) Falling loads b) Overloading c) Inadequate rigging d) Improper ground condition e) Pressure of weight	a) Structural or mechanical failure of lifting b) Improper attachment of loads c) Crane or lifting equipment instability due to uneven or weak ground
5.	Tie on building	a) Working at height b) Weather condition c) Improper anchoring or tie installation d) Falling tools or materials	a) Falls from height b) High winds, rain, or other adverse weather increasing risk of slips, falls, and system instability. c) damage due to dropped tools or components.
6.	Installation the netting to prevent falling object	a) Working at height b) Weather condition c) Fatigue from repetitive actions	a) Reduced focus or physical strain b) High winds increasing the risk of instability, falls, or difficulty in securing netting. c) Failure of the netting system leading to instability or falling objects.
7.	Jacking the SCP every floor	a) Equipment malfunction or failure b) Improper manual handling of equipment c) Repetitive movement	a) Collapses or instability during jacking b) Platform tilting or slipping c) Structural stress or mechanical failure d) Strains, sprains, or musculoskeletal injuries

3.1 Risk Assessment

Risk could be addressed through methods that present the analysis' findings and facilitate the decision for a risk control. Presenting the results in the form of a risk matrix provides an efficient way for explaining the spatial distribution of the risk among the facility and areas in a workplace when conducting risk analysis that hires likelihood and severity within a qualitative method. Table 3 below represents the risk assessment for overall activities during SCP installation operation at construction for high rise building.

Table 3: Hazard Identification during SCP installation operation at construction

Risk Assessment

Type of Hazards	Hazard	Likelihood	Severity	Risk	Value
Safety Hazard	Moving with overcapacity materials	3	4	12	Medium
Safety Hazard	Unstable loads	4	3	12	Medium
Safety Hazard	Falling objects	4	3	12	Medium
Safety Hazard	Limitation work space	2	2	4	Low
Safety Hazard	Slips, Trips and Falls	4	3	12	Medium
Safety Hazard	Sharp Edge or Protrusions	4	3	12	Medium
Health Hazard	Inadequate lighting	2	2	4	Low
Health Hazard	Vibration	3	3	9	Medium
Health Hazard	Exposure to dust	4	4	16	High
Safety Hazard	Working at height	4	4	16	High
Health Hazard	Electrical Hazard	2	4	8	Medium
Safety Hazard	Inadequate rigging	3	2	6	Medium
Environmental Hazard	Improper ground condition	3	3	9	Medium
Health Hazard	Pressure of weight	4	3	12	Medium
Environmental Hazard	Weather condition	3	3	9	Medium
Health Hazard	Repetitive movement	2	3	6	Medium

According to the risk assessment that has been gathered through the HIRARC form, there was 16 hazards that related with self-climbing platform installation. Each hazard was clearly identified hazards, there are eight (8) safety hazards that was been recorded which is moving with overcapacity materials, falling objects, unstable loads, limitation work space, slips, trips and falls, sharp edge or protrusions and inadequate rigging. Referred to (HIRARC 2008), any force that is sufficient to cause danger or property damage is considered as a safety hazard. A safety hazard-related injury tends to be noticeable. An employee could possibly, for instance, be poorly cut.

Moreover, in terms of health hazard, there was six (6) hazards that associated with inadequate lighting, vibration, exposure to dust, electrical hazard, pressure of weight and repetitive movement. Besides, another additional two (2) environmental hazards that which was weather condition and improper ground condition. All the hazards that are mentioned were occurred from seven (7) main work activities during the operational of self-climbing platform installation for three towers.

3.2 Risk Control

Once a hazard is initially identified, and risk assessment has been conducted, the most appropriate plan of action to address the concern can be established to control all the hazards. Elimination, substitution, engineering control, administrative control, and personal protection equipment are the five main categories of control measures [6]. It represents the risk control for SCP installation operation at construction based on the hierarchy control measure from least effective to the most effective. The proposed risk control has been listed in table 3 as per below.

***Table 4*:** Risk Control for SCP installation operation at construction

HAZARD	ELIMINATION	SUBSTITUTION	ENGINEERING CONTROL	ADMINISTRATIVE CONTROL	PPE CONTROL
Moving with overcapacity materials			Install lifting equipment	Training, Schedule work	Vest, gloves, steel-toed boots, and back-support braces
Unstable loads			Use load-stabilizing devices	Develop strict protocols, Training, Clear communication protocols	Gloves, helmets, and steel-toed boots
Falling objects			Install protective barriers, Use equipment with built-in restraints	Training, Designate exclusion zones	Use fall-resistant clothing or body armor
Limitation work space			Use technology like drones or cameras, Install unloading aids	Limit the number of workers, Schedule deliveries	Wear helmets, gloves, and steel-toed boots
Slips, Trips and Falls		Replace manual handling with mechanical aids	Use edge protection, guardrails, or barriers	Use signage to highlight hazards, Develop a housekeeping policy, Training	Provide workers with slip-resistant footwear and gloves
Sharp Edge or Protrusions	Redesign components	Use materials with rounded or smoothed edges	Cover sharp edges and protrusions with protective guards, caps, or padding	Use clear labels or markings, Training	Provide workers with cut-resistant gloves and sleeves
Inadequate Lighting			Install fixed lighting systems, use portable or mobile lighting towers, Design the worksite layout to minimize shadow	Provide visual aids	Equip workers with headlamps or wearable LED lights
Exposure to dust		Substitute manual sorting with automated systems	Install dust extraction systems or local exhaust ventilation (LEV)	Dust management plan, limit the number of workers in dusty areas	Equip workers with dust masks or respirators, provide safety goggles to protect eyes
Working at Height		Substitute manual climbing with mechanical systems	Install guardrails, edge protection, or barriers, Use fall-arrest systems	Training on working at height, fall prevention, and emergency rescue procedures.	Provide workers with full-body harnesses and lanyards
Electrical Hazard		Use battery-operated tools, Replace older, high-voltage equipment with low-voltage	Lockout/tagout procedures, Weatherproof and insulated coverings for electrical components	Lockout/tagout program, Schedule electrical work, Regular inspections	Provide workers with rubber-insulated gloves and boots, use arc-rated clothing, Equip workers with dielectric helmets and face shields
Vibration		Replace hand-held power tools with those designed to minimize vibration	Install vibration-damping materials or vibration isolators, Use tool handles	Limit the duration of time workers, Training	Provide workers with vibration-reducing gloves

Inadequate rigging		Use newer, well-maintained, and certified rigging equipment	Use lifting devices with built-in safety features	Develop a comprehensive lifting plan, Training, Create a checklist for pre-lift safety assessments	Helmets, high-visibility clothing, and steel-toed boots
Improper ground condition		Replace cranes with aerial lifts, forklifts, or other equipment	Use crane mats, steel plates, or timber supports, Conduct ground compaction or reinforcement, Install slope stabilization systems	Develop a lifting plan, Training, Schedule lifting operations	Equip workers with helmets, safety boots, and gloves
Pressure of Weight		Use lighter-weight materials or modular systems	Use load-spreading devices, Install load-monitoring systems	Develop a detailed lifting plan, Assign a competent lift supervisor	Provide workers with steel-toed boots and gloves
Weather Condition	Plan work seasons or phases		Ensure proper drainage systems, Install non-slip surfaces on walking and working areas	Implement a work permit system, Training, Develop contingency plans	Provide weather-appropriate clothing, such as insulated jackets, waterproof gear, and gloves
Repetitive movement		Substitute manual jacking with semi-automated systems	Install automated or remote-controlled jacking systems, Use counterweights or assistive lifting devices	Rotation schedule, Training, Early signs of repetitive strain injuries (RSIs)	Provide back support belts if the task involves awkward postures or lifting

Hence, all the control measures to manage the risks and the risk causes must be identified by the risk assessment team (or individual assessor). The controls that are put in place must comply with laws, regulations, and codes of practice. Achieving an acceptable level of risk involves selecting and implementing controls that reduce risks to within the acceptable level of risk characteristic as low as reasonably practicable (ALARP) and evaluating risk to be within a tolerable range. Control measures are then successfully implemented by those carrying out, supervising, and approving the work after being reviewed, accepted, and put into place.

4. Conclusion

In conclusion, to begin with the first objective was to identify occupational hazards for installation of SCP. there were 16 hazards that related with self-climbing platform installation. Each hazard was clearly identified hazards, there are eight (8) safety hazards that was been recorded which is moving with overcapacity materials, falling objects, unstable loads, limitation work space, slips, trips and falls, sharp edge or protrusions and inadequate rigging. Referred to (HIRARC 2008), any force that is sufficient to cause danger or property damage is considered as a safety hazard. A safety hazard-related injury tends to be noticeable. An employee could possibly, for instance, be poorly cut. Moreover, in terms of health hazard, there was six (6) hazards that associated with inadequate lighting, vibration, exposure to dust, electrical hazard, pressure of weight and repetitive movement. Besides, another additional two (2) environmental hazards that which was weather condition and improper ground condition. All the hazards that are mentioned were occurred from seven (7) main work activities during the operational of self-climbing platform installation for three towers.

Next, the second objective of this research is to analyze the occupational hazards related with SCP installation by using HIRARC. The objective has also been achieved with the implementation of the risk matrix to determines the likelihood and severity of the occurrence from high to low-risk value. The risk associated with the SCP installation were classified from low, medium until high risk. Moreover, based on the hazard that had been spotted, there were only two (2) hazards had been identified as high levels both are from the activities. During the process, falling from height is one of the most critical hazards for safety hazard and dust exposure categorized as most critical hazard for health hazard.

Last but not least, the third objective was to recommend control measure of occupational safety and health for SCP installation operation. By selecting the most suitable control for each work activities based on the hazard that has been identified, risk control has been proposed by following the requirements of hierarchy control and will be highlighted to the safety department. Additionally, the third objectives straightly been achieved.

To conclude, this study provides an alternative risk analysis procedure with analyzing and categorizing hazards and rating them based on their relevance. Besides, it helps construction management by proposing and recommending an appropriate control measure for occupational safety and health for SCP installation that refers to hierarchy control based on the current guidelines and regulations. Hence, when control measures were applied, it will be reducing the number of accidents and incidents in the workplace and provides a safe working environment for all employees at the selected construction industry. By selecting the most suitable control for each work activities based on the hazard that has been identified, risk control has been proposed by following the requirement of hierarchy control and will be highlighted to the safety department. Additionally, the third objectives constantly been achieved. For recommendation of future study,

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

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APPENDIX

FIELD OBSERVATION

	
	

KERJAYA PROSPEK

HEALTH, SAFETY AND ENVIRONMENT INSPECTION CHECKLIST

PROJECT		**BBCC S5**	Date		
LOCATION GR		Block: Zone/GR: Level:	Person-in-charge		
No	**Component Checklist**	**Main Content**	**Result**		
			Pass	**Rectify**	**Comment/Remarks**
1	Electrical chain hoist/Hydraulic power-pack	**Testing in idling** condition before jacking operation			
		Chain length in **smooth and not entangle**, no cracking and well lubricated			
		Hanging hook in **active mode with no crack**, axle and sealing plates are in good condition			
		Bolts and nuts are in **tightened** condition			
		Hydraulic oil, lubricants wastage /leakage well managed			
2	Attached support	Anti-falling mode is in **active and effective**			
		Positioning tubes are in **good condition**			
		Bolts and nuts are in **tightened** condition			
		Number of attached supports are sufficient for jacking operation			
3	Adapter block	**Install wire rope** on any >800mm adapter block			
		Bolts and nuts are in **tightened** condition			
4	Guide Rail	Netting condition opening /closure			
		No obstruction between frame and structure/scaffolding/flapping board must be close during lifting			
		Safety net **must be installed** and in good condition (beneath SCP, double layer*)			
		Platform SCP **must clean** from debris /concrete/plaster/rebar/aluminum/other rubbishes			
5	Tie-back /loading platform area	**Wire rope installation** before and after jacking			
6	Safety alert and obstruction management	Inform the related person-in-charge on operating condition			
Result inspection		**Inspector,**		Comment	
		Reviewed by,		Comment	
		Verified by,		Comment	
		Acknowledged by,		Comment	