

Drone Applications in Construction Safety

In his paradoxical way with words, Yogi Berra is quoted to have said, “You can see a lot by observing”. That wisdom applies heavily to most of life’s activities and not less to managing safety. Safety in construction is especially challenging because each project brings a unique situation, a varying line up of contributors, tasks that evolve rapidly, and pressure to perform in the least amount of time and money. It’s no wonder that construction companies are constantly looking for ways to be more efficient and effective in every way.

The potential for improving construction safety via drone photography is easily recognized, but converting that potential into action has been elusive. This “green paper” is a thought development consideration of how to start putting drone photography to work improving construction safety performance.

The first step is to convert the aerial images into useful data. The table below was derived for that purpose from a checklist of OSHA compliance requirements for construction from the South Carolina OSHA Office of Outreach and Education. A line by line review by the author of over 300 compliance requirements found that slightly over one-third of them are observable by drone photography at one time or another during a project. Hot button items such as fall protection, PPE, trenching, and heavy equipment are almost fully inspectable from the air.

Once it’s clear what to inspect from a drone capture of a construction site, several options become available for how the data can be used locally in site safety programs or managed globally across multiple job sites.

Contact Bob Russell at (803) 487-5308 or at rrussell@comporium.net if you have questions or want to discuss next-step ideas on how to use drone imaging to improve safety in your projects. If you need additional imaging support for your projects, we provide progress photos and video for construction sites across the midlands and upstate South Carolina. Portfolio samples and client feedback are available at our web site below.

This checklist may be used freely by anyone interested in generating safety improvement data from aerial imaging in construction. Download is available at our web site here: <https://hawk-i.us/downloads-%26-links> .

Bob Russell
July 18, 2019
rrussell@comporium.net
www.HAWK-i.us

<p style="text-align: center;">Construction Safety Checklist Items</p> <p>These checklist items were extracted from South Carolina’s Occupational Safety and Health Standards for the Construction Industry, as adopted from 29 CFR (Code of Federal Regulations) Part 1926 and other selected General Industry Safety and Health Standards (Article VI, Part 1910) having applicability to construction work. The complete original checklist can be found at the following link: http://www.scosha.llronline.com/PDFS/OSHA%20CHECKLIST%20FOR%20THE%20CONSTRUCTION%20INDUSTRY.pdf</p> <p>The representations in this table are the opinions of the author, Bob Russell, and in no way constitute standards or advice.</p>	<p style="text-align: center;">Number of Items in OSHA checklist</p>	<p style="text-align: center;">Items Partially or Fully Observable by Drone at Various Stages of Construction</p>
<p style="text-align: center;">Administrative Requirements</p>	<p style="text-align: center;">5</p>	<p style="text-align: center;">0</p>
<p style="text-align: center;">General Safety and Health Provisions</p> <p>Is form and scrap lumber with protruding nails and all other debris kept cleared from work areas, passageways, and stairs?</p> <p>Are employees required to wear appropriate personal protective equipment when there is an exposure to hazardous conditions?</p>	<p style="text-align: center;">5</p>	<p style="text-align: center;">2</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p>
<p style="text-align: center;">Occupational Health and Environmental Controls</p> <p>Are potable (drinking) water and adequate toilet facilities available at the jobsite?</p> <p>Are employees provided with light not less than the minimum illumination while any work is in progress?</p> <p>Does the employer ensure that concentrations of hazardous substances such as dusts, fumes, mists, vapors, or gases produced in the course of construction work does not exceed the limits specified in 1926.55(a)?</p> <p>Any operation in employee’s area where hazards chemicals may be present? {fuel}</p> <p>Are containers of hazardous chemicals, labeled, tagged, or marked?</p> <p>{Paraphrasing: Common operations that may create exposure to lead hazards include demolition, welding, application and removal of coatings. One method of determination of potential exposure is visual observation for corrosion resistant paint colors (red, yellow, orange)}</p>	<p style="text-align: center;">31</p>	<p style="text-align: center;">6</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p>
<p style="text-align: center;">Personal Protective and Life Saving Equipment</p> <p>Are protective helmets (hard hats) worn at all times where there is a possible danger of head injury from impact, falling or flying objects, or electrical shock and burns?</p> <p>Are ear protection devices provided and used wherever it is not feasible to reduce noise levels?</p> <p>Are employees provided with and required to use eye and face protection when exposed to eye or face hazards?</p>	<p style="text-align: center;">6</p>	<p style="text-align: center;">6</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p> <p style="text-align: center;">✓</p>

<p>Is the employer requiring the wearing of appropriate personal protective equipment by employees in all operations where there is an exposure or potential exposure to hazardous conditions ... ?</p> <p>Are employers provided with and use appropriate respiratory protective devices?</p> <p>Are employees working over or near water provided with and use U.S. Coast Guard-approved life jacket or buoyant work vests and are ring buoys with at least 90 feet of line and at least one lifesaving skiff provided?</p>		<p>✓</p> <p>✓</p> <p>✓</p>
<p style="text-align: center;">Fire Protection</p> <p>Is firefighting equipment conspicuously located?</p> <p>Are all flammable liquids stored and handled in approved containers and portable tanks?</p> <p>Is at least one portable fire extinguisher with a rating of not less than 20-B:C located within 75 feet of each pump, dispenser, underground fill pipe opening and lubrication or refueling service area?</p>	9	3
<p style="text-align: center;">Signs, Signals and Barricades</p> <p>Do all traffic control signs or devices used for workers' protection conform with (standards)?</p> <p>Are signaling by flaggers and the use of flaggers, including warning garments worn by flaggers, in conformance with (standards)?</p> <p>Are barricades used for protection of workers in conformance with (standards)?</p>	4	3
<p style="text-align: center;">Materials Handling, Storage, Use, and Disposal</p> <p>Are materials which are stored in tiers either stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse?</p> <p>Are materials being stored beneath power lines being moved or unloaded?</p> <p>Are safe procedures utilized when unloading pipes?</p> <p>When forming eyes in wire rope are U-bolt clips properly spaced ...?</p> <p>Are waste materials disposed of properly?</p>	11	5
<p style="text-align: center;">Tools, Hand and Power</p> <p>Are employees provided with eye and face protection when machines or operations present potential eye or face injury...?</p>	13	2

Do all portable circular saws have a guard above the base plate and a guard below the base plate?		✓
Welding and Cutting	21	6
When transporting or storing compressed gas cylinders, are cylinders secured and caps in place?		✓
Are cylinders secured in a vertical position when transported by vehicles?		✓
Are all compressed gas cylinders secured in an upright position at all times?		✓
Are welding and cutting operations shielded by noncombustible or flameproof screen whenever practicable?		✓
Is suitable fire extinguishing equipment immediately available in the work area and ready for instant use?		✓
Are employees who are performing any type of welding, cutting, or heating protected by suitable eye protective equipment?		✓
Electrical	19	3
Is sufficient working space provided to permit safe operation and maintenance of electrical equipment?		✓
Are flexible cords and cables protected from damage?		✓
Are contractors/subcontractors (painters) using aluminum extension handles (or ladders) around electrical power lines?		✓
Scaffolding	16	6
Are scaffold platforms fully planked?		✓
does employer ensure that scaffold is restrained from tipping?		✓
Is safe access to scaffold platforms provided , attachable ladders positioned correctly, rest platforms provided at 35-foot max intervals)?		✓
Are employees who are working from a scaffold more than 10 feet above a lower level protected from falling to that lower level?		✓
In addition to wearing hard-hats, are employees provided with protection from falling objects, e.g., toeboards, screens, guardrail systems, nets, or structures that contain or deflect the falling objects?		✓
Are workers in aerial lifts equipped with standard guard rails and also wearing fall-restraint devices connected to manufacturer suggested tie off points on the boom or basket?		✓
Fall Protection > 6 Feet	11	10
Are employees on walking/working surfaces with unprotected sides and edges protected by guardrails, safety nets or personal fall arrest systems?		✓
Are employees who are constructing leading edges protected by guardrails,		✓

<p>safety nets or personal fall arrest systems if feasible?</p> <p>Is each employee in a hoist area protected by either guardrails or personal fall arrest system?</p> <p>In hoisting areas, is the employee protected by a fall arrest system when leaning through the access opening or over the edge when any portion of the guardrail is removed to receive materials?</p> <p>Are employees exposed to falling through holes (including skylights) protected by fall arrest systems, guardrails or covers?</p> <p>Are employees on walking/working surfaces protected from tripping or stepping into holes by covers?</p> <p>Are employees on walking/working surfaces protected from objects falling through holes by covers?</p> <p>Are exposed employees working on the face of form work or reinforcing steel protected by fall arrest systems, safety nets, or positioning device systems?</p> <p>Are exposed employees working on ramps, runways or other walkways protected by guardrail systems?</p> <p>When excavations, wells, shafts, pits, are not readily seen (shrubs, plants, etc.), are employees protected by guardrails, fences, or barricades?</p>		<p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p>
<p style="text-align: center;">Cranes and Derricks</p> <p>Are accessible areas within the swing radius of the rear rotating superstructure of the crane barricaded?</p> <p>Working within 20 feet of powerlines must meet special requirements.?</p> <p>Before leaving crane unattended, is the boom securely fastened?</p> <p>Are booms which are being assembled or disassembled on the ground, with or without support of the boom harness, securely blocked to prevent dropping of the boom and boom sections?</p> <p>Are cranes or derricks used to hoist employees on a personnel platform only when conventional means are more hazardous or impossible?</p>	<p style="text-align: center;">12</p>	<p style="text-align: center;">5</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p>
<p style="text-align: center;">Hoists and Elevators</p> <p>Are hoistway entrances protected by substantial gates or bars?</p> <p>Are hoistway door or gates on personnel hoists at least 6 feet 6 inches high?</p> <p>Are overhead protective coverings provided on top of hoist cages or platforms?</p>	<p style="text-align: center;">6</p>	<p style="text-align: center;">3</p> <p>✓</p> <p>✓</p> <p>✓</p>

<p style="text-align: center;">Conveyors</p> <p>Where conveyors pass over areas or aisles, have guards been provided to protect employees from falling materials?</p>	3	1 ✓
<p style="text-align: center;">Motor Vehicles, Mechanized Equipment, and Marine Operations</p> <p>Are bulldozer and scraper blades, dump bodies, etc., fully lowered or blocked when being repaired or not in use?</p> <p>Are all high lift rider industrial trucks equipped with overhead guards?</p> <p>Is all equipment used in site clearing operations equipped with proper rollover protection?</p>	20	3 ✓ ✓ ✓
<p style="text-align: center;">Excavations</p> <p>Are all surface encumbrances that may create a hazard removed or supported as necessary to safeguard employees?</p> <p>In trenches 4 feet deep or more, are stairways, ladders, or ramps located so that travel to them is no more than 25 feet?</p> <p>Are employees exposed to vehicular traffic wearing warning vests made of reflectorized or high visibility material?</p> <p>Is a warning system such as barricades, hand or mechanical signals or stop logs used when mobile equipment approaches the edge of the excavation?</p> <p>Are excavated or other materials or equipment kept at least 2 feet from the edge of the excavations?</p> <p>Are employees in an excavation 5 feet deep or more, or with the potential for cave in, protected by an adequate protective system?</p>	9	6 ✓ ✓ ✓ ✓ ✓ ✓
<p style="text-align: center;">Concrete, and Masonry Construction</p> <p>Is all protruding reinforcing steel, onto or into which employees could fall, guarded to eliminate the hazard of impalement?</p> <p>Are respirators provided for employees who engage in sandblasting operations?</p> <p>Is proper personal protective equipment (PPE) provided for employees engaged in cutting brick, block, or when using acid to clean brick?</p> <p>Are employees prohibited from riding concrete buckets?</p> <p>Are cement mixers guarded properly?</p> <p>Are precast concrete wall units, structural framing, and tilt-up wall panels supported to prevent overturning and collapse until permanent connections are made?</p>	20	8 ✓ ✓ ✓ ✓ ✓ ✓

<p>Is a limited access zone established prior to constructing a masonry wall?</p> <p>Are all masonry walls over eight feet in height braced or supported to prevent collapse?</p>		<p>✓</p>
<p align="center">Steel Erection</p> <p>Has the controlling contractor provided and maintained adequate access roads inside the construction site; keeping them, properly graded, drained, and firm?</p> <p>Is the headache ball or hook used to transport personnel?</p> <p>Are routes for suspended loads preplanned to ensure that no employee is required to work directly below a suspended load?</p> <p>Are fully planked or decked floors or nets maintained within two stories or 30 feet, whichever is less, directly under any erection work being performed?</p> <p>Are roof and floor holes and openings decked over? Are metal decking holes and openings not being cut until immediately prior to being permanently filled?</p> <p>Are employees engaged in steel erection activities on a walking and working surface with unprotected sides or edges more than 15 feet above a lower level protected by guardrails, safety nets or personal fall arrest systems?</p> <p>Have perimeter safety cables been installed at the final interior and exterior perimeters of floors as soon as the metal decking is installed?</p> <p>Is there more than 3,000 square feet of unsecured decking in a Controlled Decking Zone?</p>	<p>19</p>	<p>8</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p>
<p align="center">Underground Construction, Caissons, Cofferdams, and Compressed Air</p>	<p>10</p>	<p>0</p>
<p align="center">Demolition</p> <p>If employees are exposed to the hazard of falling through wall openings, are the openings protected to a height of approximately 42 inches?</p> <p>If debris is dropped through holes in the floor without chutes, is the area onto which the material is dropped completely enclosed with barricades at least 42 inches high and at least 6 feet back from the projected edge of the opening above?</p> <p>Are all floor openings, not used as material drops, equipped with a properly secured Cover ...?</p> <p>Is any area where material is dropped outside the exterior walls of the structure effectively protected?</p> <p>Are workers engaged in razing the steel after floor arches are removed protected by planking?</p>	<p>8</p>	<p>5</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p>

<p style="text-align: center;">Blasting and Use of Explosives</p> <p>Is every vehicle or conveyance used for transporting explosives marked on both sides, front, and rear with placards reading "EXPLOSIVES" in red letters not less than 4 inches high on white background?</p> <p>Are motor vehicles transporting explosives always attended?</p>	12	2 ✓ ✓
<p style="text-align: center;">Power Transmission and Distribution</p>	7	0
<p style="text-align: center;">Rollover Protective Structures (ROPS); Overhead Protection</p> <p>Are all rubber tired, self-propelled scrapers, rubber-tired front end loaders, wheel type agricultural and industrial tractors, crawler tractors, crawler type loaders, and motor graders (with or without attachments) equipped with rollover protective structures?</p>	2	1 ✓
<p style="text-align: center;">Stairways and Ladders</p> <p>Is a ladder or stairway provided at all personnel points of access where there is a break in elevation of 19 inches or more?</p> <p>Is there always at least one clear point of access between levels of a building or Structure?</p> <p>Is each stairway having four or more risers or rising more than 30 inches equipped with: (a) at least one handrail; and (b) at least one stairrail system along each unprotected side or edge?</p> <p>Are the unprotected sides and edges of stairway landings provided with a guardrail System?</p> <p>Are ladder rungs, cleats, and steps parallel, level, and evenly spaced when the ladder is positioned for use?</p> <p>Does each stepladder have a metal spreader or locking device?</p> <p>Do portable ladders used for access to an upper landing surface have side rails that extend at least 3 feet above the landing?</p>	11	7 ✓ ✓ ✓ ✓ ✓ ✓
<p style="text-align: center;">Toxic and Hazardous Substances</p> <p>(Several detailed requirements for evaluation of exposure to asbestos, cadmium and silica -- see standards).</p>	Testing Required	Observe known construction activities creating potential exposure
<p style="text-align: center;">Confined Spaces in Construction</p> <p>If Permit Spaces are present, have employees been informed by posting danger signs or equally effective means?</p>	10	1 ✓

