C33 Evaluation of Detection Systems for Large Mobile Equipment

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After attending this presentation, attendees will understand methods that operators of mobile equipment can use to detect and identify objects or obstructions proximate to their machines in order to avoid contacting them when the machines are in motion.

This presentation will impact the forensic science community by describing the methodology used to test detection systems as well as the results, and by promoting dialogue and discussion regarding the efficacy of using detection systems on large mobile equipment with areas around them outside of the operator's normal field of view (i.e., blind spots).

Three different detection systems were evaluated for their ability to either sense objects and alert the operator or allow the operator to perform a timely visual assessment of the objects' proximity to the machine: one that was radar-based; a camera with a monitor; and, a parabolic mirror. For the purpose of this research, an excavator was selected because of the large field lateral to and aft of the cab and engine (house) that was not readily viewable by the operator. Each system was evaluated with the use of a 20ft by 30ft grid.

The research study provided a basis for analysis of the field of view/detection of various systems. In reviewing the line-of-sight testing methodology in SAE J1091 and ISO 5006, it was determined that similar evaluations of the mirror, camera and proximity sensor required modification, because the near field testing performed was different than the 12-meter threshold used by the SAE and ISO tests. Quantification and repeatability of the tests were enabled by using a grid system behind the excavator. The grid was a 12 inch by 12 inch matrix. The furthest aft center point on the excavator was the machine reference, and a plumb bob dropped from that point was used as the origin for the X and Y axes on the grid.

The proximity sensor consisted of an alarm attached to the detector via a cable between the rear of the machine and the cab. The alarm used colored lights and varying beep frequency to warn the operator how far an object was within the detection zone. The detector was affixed to the aft end of the excavator and located 52in. Above Ground Level (AGL). A person approached until the alarm began to emit beeps. The corresponding location of the detection threshold on the grid was then documented.

The camera system consisted of a waterproof camera and black and white LCD monitor. It was mounted to the top of the aft end of the excavator at a height of 85 inches and angled downward so that the bottom of the image in the monitor corresponded to the edge of the excavator tracks. Prior to testing, it was decided that determination of the visual field would be based on the threshold of 36 inches AGL. A subsequent series of tests were performed to quantify the range of the visual field as part of the error rate analysis. The same methodology was used. The lower boundary of the visual field was determined based on a threshold of 4 inches AGL.

The mirror system was a convex parabolic mirror with an effective diameter of 10 inches, mounted on a curved rod with a base intended to mount on the house. With the operator sitting in his seat and looking over his right shoulder, the mirror was located within his line of sight and angled to maximize his view of the area of the rear of the machine. The center of the mirror was 93 inches. AGL and positioned in the "passenger-side" rear quadrant of the house. Prior to testing, it was determined that either a 36-inch-tall object or "that's a person" would be the threshold for establishing the presence of objects.

Detection patterns from the tests of the three systems are presented with an error rate analysis.

Although the efficacy of the systems may be cause for debate, they can assist an operator of mobile equipment in detecting objects proximate to the machine. They work best when used in combination. Obstructions or objects in the blind spot would cause the proximity sensor to alert the operator, who would then confirm their presence visually using the mirror or looking at the camera monitor.

Detection Systems, Blind Spots, Machine Safety

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