PREFERRED RELIABILITY PRACTICES

OVER-SPEED PROTECTION SYSTEM FOR DC MOTOR-DRIVEN CRANES

Practice:

DC drive motor over-speed detection using a voltage sensing relay.

Benefits:

This design employs a simple method of providing protection against the effects of a crane operating at a higher than commanded speed while not introducing unwanted nuisance trips to the crane control system. This improves the reliability of the crane control system by preventing the crane from reacting to unwanted commands that are not operator initiated. The improvement allows the crane to be used with a higher degree of confidence that a critical failure will not result in damage to the load suspended from the load hook.

Programs Which Certify Use:

KSC Vehicle Assembly Building (VAB) 250-Ton and 175-Ton Bridge Cranes.

Center to Contact for More Information:

Kennedy Space Center (KSC)

Implementation Method:

The design provides protection against damage to a load resulting from a crane drive system experiencing a speed increase caused by an unexpected input created by a failure of the electrical circuitry used to convey the operator stick input to the drive motors. The voltage sensing relay is set to detect a voltage that is larger than the normal operating voltage of the DC motors in the selected speed (slow, medium, or high). When this voltage is experienced, the relay will shut down the crane operation and set the brakes. For example, at KSC while performing stacking and mating operations of the Solid Rocket Motors (SRM), External Tank (ET), or Orbiter during Space Shuttle processing, the crane must be operated in the slow speed mode when within close proximity of a structure. The voltage sensing relay is active during this mode to prevent the shuttle components from impacting a surrounding structure as a result of a control circuitry failure. The relay is deactivated while operating in the medium or high speed modes because the critical load is not near an obstruction. This allows the crane to be operated with a higher degree of confidence and reliability that a critical failure will not result in damage or loss of critical flight hardware during stacking and mating operations.

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Technical Rationale:

With a constant field/varied armature DC motor (more than one motor, the armatures wired in series) the voltage sensing relay coil should be placed in parallel to the motor armature(s) (see Figure 1.). The relay coil should be fed through a bridge rectifier to insure the input to the relay is consistent regardless of the voltage polarity and direction of current flow present in the armatures. The normally open relay contact should be wired in series with the power supplied to the crane and brake controls. When power is applied to the crane the contact should close and enable the drive control circuitry. The contact will remain closed when the voltage in the motor armature is below the predetermined threshold. When the limit is reached, approximately 115% of the full output of the speed range, the contact will open disabling the crane drive and setting the brakes to stop the crane. To avoid the crane shutting down when in the higher speed range, a time delay relay will be energized by the speed selector switch and by pass the voltage sensing relay. To prevent nuisance trips when the speed selector switch is repositioned from the higher to the lower speed range while the crane is moving, the time delay relay will disable the voltage sensing relay for a short predetermined time period when it is de-energized.

Impact of Nonpractice:

An increased potential would exist for a critical crane failure which could result in damage to flight hardware or serious injury/death to personnel.

References:

1. 69-K-L-11388: "Vehicle Assembly Building 250-Ton Bridge Crane #1 & #2 Electrical"
2. SAA09FY12-005: "System Assurance Analysis of the 250-Ton Bridge Cranes at the Vehicle Assembly Building, High Bays 1, 2, 3 & 4"
3. 67-K-L-11348: "Vehicle Assembly Building 175-Ton Bridge"
4. Crane Electrical. SAA09FY12-006: "System Assurance Analysis of the 175-Ton Bridge Cranes at the Vehicle Assembly Building"

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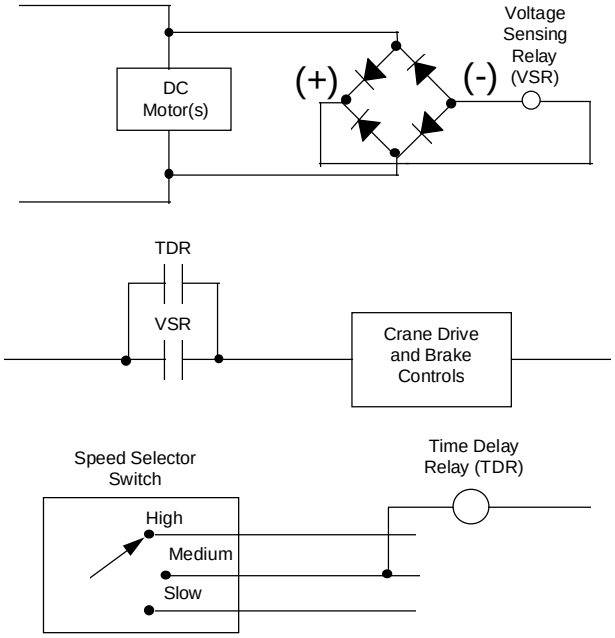

Figure 1. Simplified Diagram of the Over-Speed Voltage Sensing Relay Configuration