NGR Draft Proposals

1. **Establish Standard Procedures/Testbeds that will Enable to Prove and Certify the Safety of Robots.**

A standardized sequence of safety tests could be established for the safety testing and ranking of a particular type of robot. This could be similar to the automobile safety testing and ranking system, which is conducted by the Insurance Institute for Highway Safety's Vehicle Research Center (VRC). A prototype research testbed might have to be established in order to provide guidance in the development of such a facility.
May address need #: 1

2. **Control Panel-to-Safeguarded Workspace Integrated Biometric Identification and Human Presence Monitoring System for Robot Safety.**

This system should start from the robot controller consul, pass the safeguarded space gate and continuously monitor the restricted space for authorized or unauthorized human presence. It should be easy to use, close to 100% reliable, it should not generate annoying visible light flashes or scans and it should be inexpensive relative to the cost of an industrial robot. Simple and safe biometric identification sensors could replace the elaborate procedures and tools used today to activate the lockout tagout mode and to unlock the workcell fence doors. Once inside the safeguarded space simple camera or Ladar vision systems with sophisticated imaging analysis algorithms could keep track of the motion of humans, robots, tools and other machinery. Communication with the workcell controllers could help distinguish between expected and unexpected motions and actions.
May address needs #: 1, 2

3. **Controlled Electrical and Mechanical Braking for Smooth Emergency Stopping of Robots.**

Electrical braking is used on electrical trains and automobiles for many years in order to save energy and to generate smoother and more effective stopping conditions. Perhaps it is time to experiment with a similar system for the emergency stopping of robot arms and their tools. This might be a more effective stopping system than today's spring loaded brakes and it might also reduce the strain on the robot arm and its tools.
May address need #: 3

4. **Optimum Weak Servo Drives Robot Arms.**

According to the NGR workshop participants weak servo drives have been used on a material casting application robot. It is not known though whether this servo design will be appropriate for other robot applications. It is probably necessary to develop an optimum weak servo design procedure, which will take into account the geometry of the robot arm mechanism, its dynamic model, workspace, the tools and the intended uses of this arm.
May address need #: 4

5. **Sensors which can Measure the Position and Orientation of a 3D Space Moving Robot Arm Equipped with Tools Even When it is Obstructed from Direct Line of Sight View.**

External target tracking or imaging sensors cannot always monitor the position and orientation of a robot arm because of obstructions, smoke, sparks etc. Single or dual joint encoders can monitor the position and orientation of a robot arm, but not the tools mounted on the arm. One possible solution to this problem might be tool position sensors embedded in the robot arm, with standard interfaces on all tool-mounting plates. These sensors could be optical, electromagnetic, etc., which can be directed to track the tool motions and thus bridge the gap between the encoder arm sensors and the various arm tools.

May address need #: 5

6. **Compliant and Wireless Non Contact Safety Blankets for Robot Collision Protection.**

Several companies and research laboratories have been developing contact or non-contact collision detection or touch sensors for various applications. Some of these sensors may be used for cloth texture sensing, the monitoring of infant or sick people breathing, space robot skin, etc. An inexpensive, non contact collision detection sensor array on a flexible surface might be more practical for an industrial environment. This flexible surface sensor could be mounted on a robot arm between the human operator and the arm with the active sensor side facing the operator. The non contact sensors could use passive or active proximity sensing electro optics, optical fibers, microwave RFID sensors, small radars, etc. Although this type of sensors could be wired to a workcell safety controller, it should be more convenient to operate in a wireless mode, with a communications interruption safety alert.

May address need #: 6

7. **Develop Robot-Human Interface (Collision) Pain Data.**

Various biomechanics research groups have been developing mathematical models and have been conducting cadaver experiments in order to understand the severity of injuries, which can be generated by various automobile accidents. It is possible that these techniques can be used in order to generate Robot-Human Interface (Collision) Pain Data, which are necessary for the development of safety standards.

May address need #: 7

8. **Lightweight Worker Distress ID and Location Notification Device.**

An inexpensive wristband device could monitor vital human biological signs and generate an alert signal when a distress state is detected. An embedded Radio Frequency ID (RFID) could identify the individual person in the distress state. All workcells should be covered with RFID receivers. The one with the highest reception signal will identify the location of the individual.

May address needs: 8

NGR High Priority Needs

1) Research that will enable to prove and certify the safety of NGR. The best safety equipment and standards will not be worth very much if the regulators, managers and labor unions do not accept and promote them.
2) Easy lock out that would make it as easy as pulling a gate plug.
3) Alternatives to initiating an immediate stop (E-Stop), which generates significant amounts of stress on the robot and the tools suspended or in contact with the robot arm.
4) NGRs built with inherently weak servo drives, which generate enough torque to perform the desired work, but not enough to injure humans.
5) Sensors, controllers, or calibration tests that can prevent an unwanted and unexpected robot arm motion and measure the position and orientation of a 3D moving robot arm even when it is obstructed from direct line of sight view in an industrial environment.
6) Collision detection devices designed to prevent collision with hardware (objects), should be redesigned to include human collision detection capability.
7) There is a lack of robot-human interface pain data.
8) Personal protective equipment that also alerts the robot controller of the identity, presence, location, status, training, and health condition of a human who has entered its restricted space.