

# ***NIOSH and MSHA Proximity Systems Efforts***



**William H. Schiffbauer – NIOSH**  
**Dave Chirdon - MSHA**

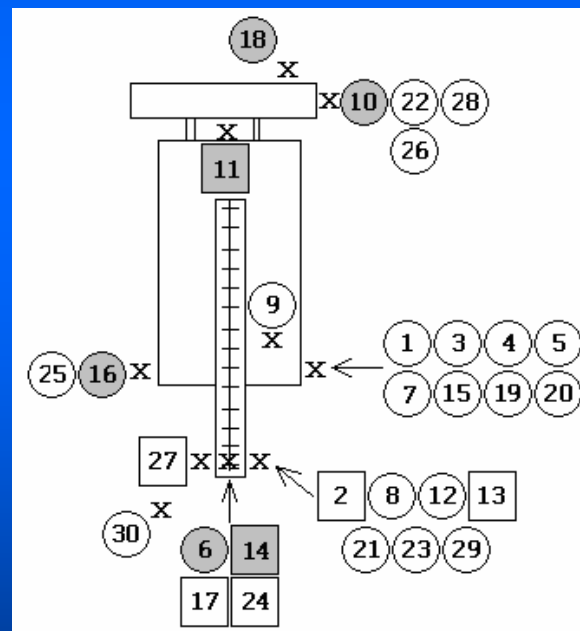
# What is A Proximity System?

**A safety system which determines when a worker is in an unsafe area and provides worker alerts and machine shutdown when required**



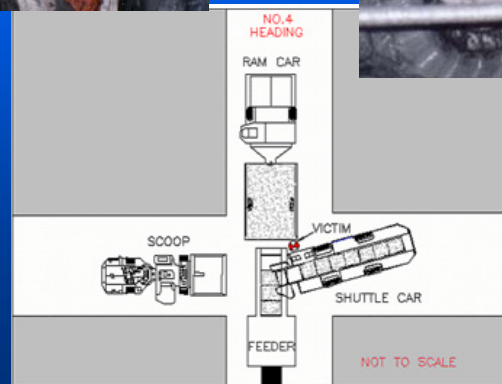
# Continuous Miners

30 Fatalities - (1984- 2008) MSHA



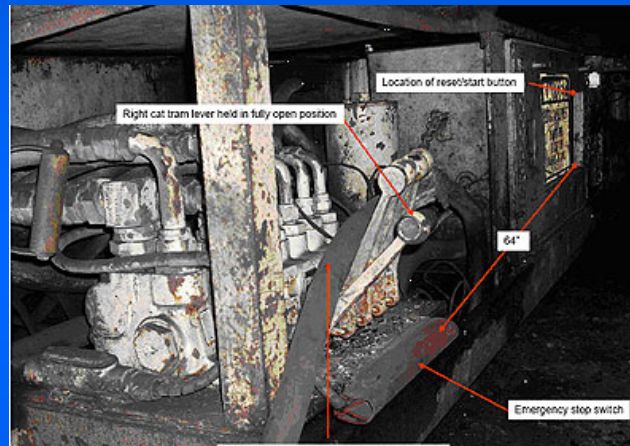
# Shuttle Cars

8 Fatalities (1995-2006) MSHA



# Conveyors

## 55 Fatalities (1995-2007) MSHA



# Haul Trucks

## 33 Fatalities – (1995-2007) MSHA



# NIOSH and MSHA Charge

- Address the problem and find solutions
- Transfer to industry

# **NIOSH - HASARD**

## **concept in 1992**

**Consists of ...**

**Magnetic Field Marker – on vehicle/area/person**

**Magnetic Field Detector – on vehicle/area/person**

**System Controller**

**Covered by ....**

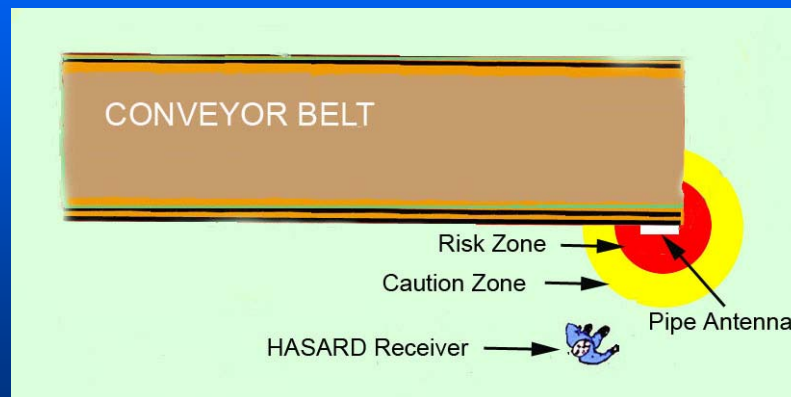
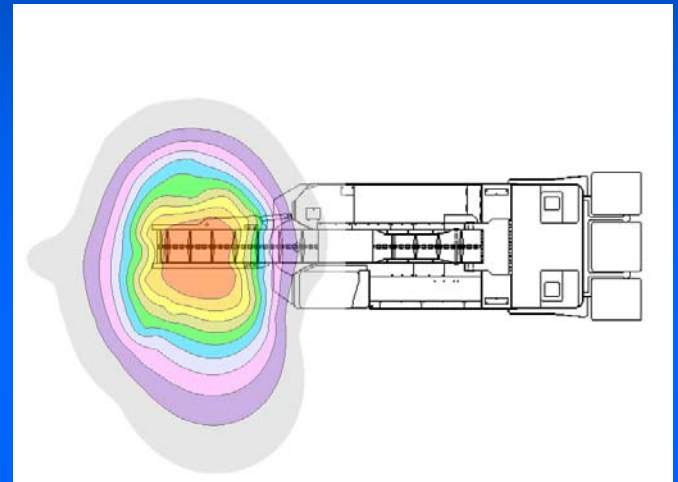
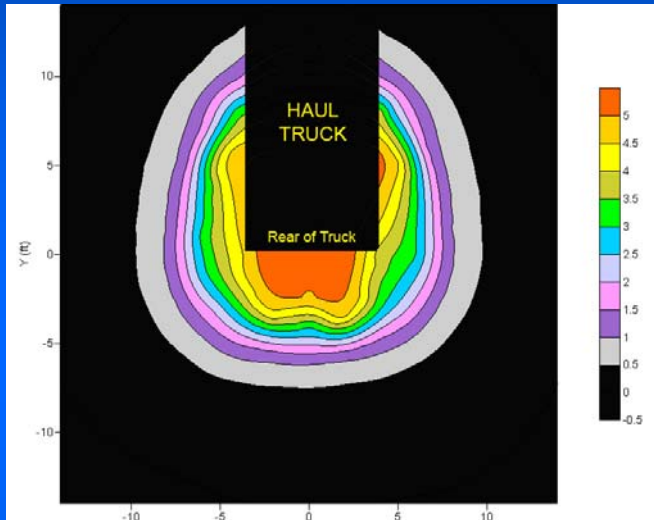
**Patent Number 5,939,986**

**Patent Number 6,810,383**





# HASARD Prototypes



# Three Licensees

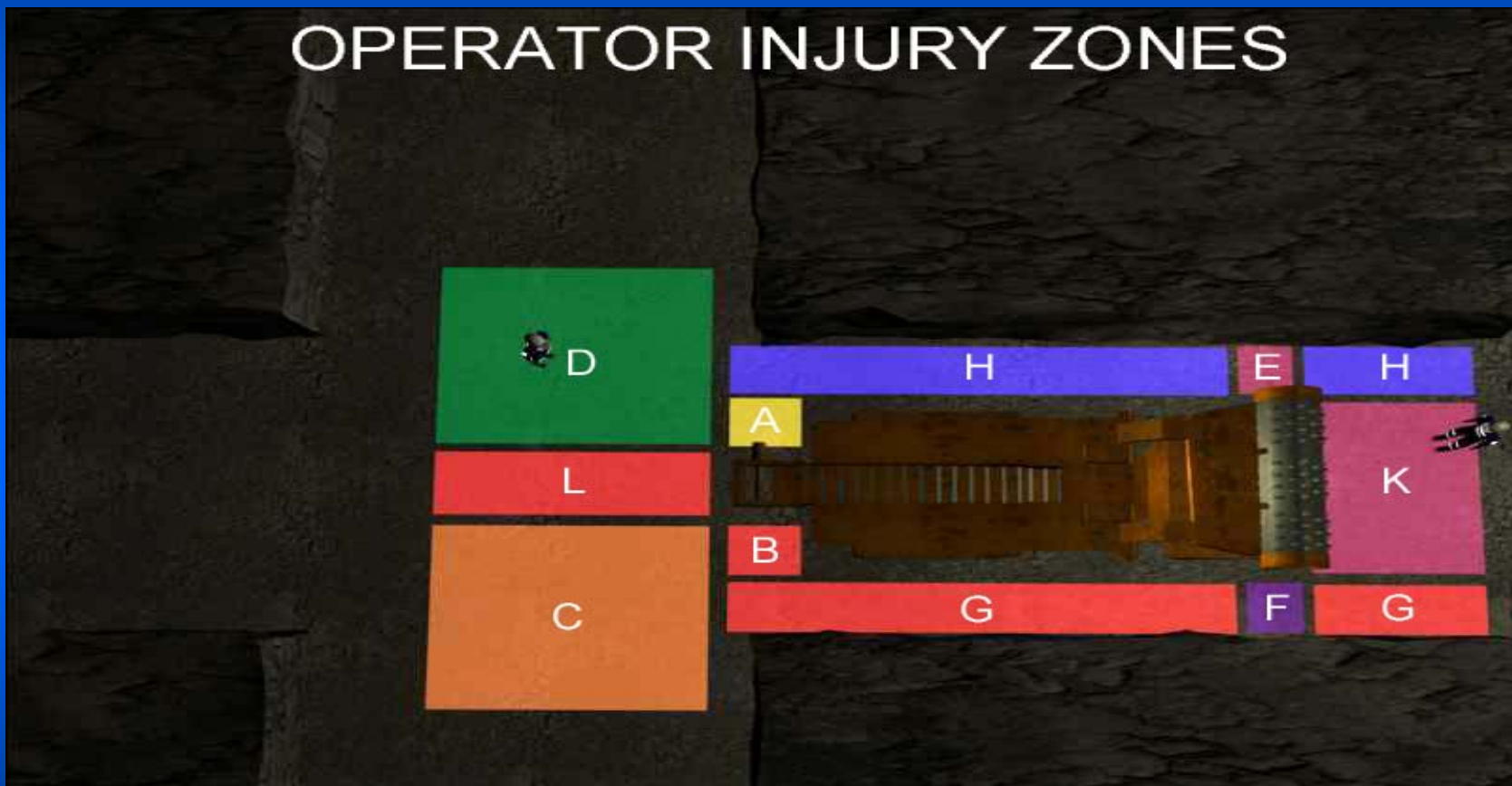
- **ICG Addcar**
- **Geosteering**
- **Alliance**

## One CRADA

- **Air Sun Auto – South Africa**

# CM - Where Injuries Occurred (2000-2006) MSHA

## OPERATOR INJURY ZONES



INJURY ZONE PERCENT OF POSITION RELATED ACCIDENTS

A	B	C	D	E	F	G	H	I	J	K	L
tail left	tail right	center right	center left	drum left	drum right	rib right	rib left	position unknown roof supported	position unknown roof unsupported	front	rear
3.37%	11.11%	5.95%	2.18%	0.40%	1.59%	12.50%	1.98%	45.44%	0.40%	0.40%	14.68%

# Recent NIOSH Efforts

NIOSH studied the workplace relationships between CM operators and tramming tasks of the equipment using motion capture data, operator response times, and field of view data to evaluate the factors influencing operator-machine struck-by events in a virtual environment

**Motion analysis data collected from 10 CM operators work postures and escape paths (mimic getting away from moving CM)**



**Tests conducted - kneeling on two knees, squatting and standing postures representing 36, 48 and 60 inch seam heights**

# Human Data and CM Simulation Parameters Used in Study

- Operator direction of escape
- Operator facing orientation (ref. to CM)
- Operator posture
- Operator distance to CM
- Operator anthropometry
- Machine speed
- CM operational characteristics
- Environmental constraints

# Results from 14,000 Simulations with 10,000 Struck-by Events

- Operator distance to CM – 3' shows a significant reduction
- Almost linear reduction – as CM speed is reduced
- Greater incidents when CM rotates CCW and operator near the tail
- Operator upper body struck most often
- Operator stature not significant influence on risk
- Squatting 2.5 times more risk than standing
- Kneeling has least risk

# **NIOSH interviewed 78 seasoned CM operators. The results indicate**

- **Operators used visual, audible and tactile cues to operate the CM with visual being the most important**
- **Non-visual cues used as substitutes when visual information was obscured or restricted**
- **Operators monitor many visual attention locations (VAL's) (general area, specific point, mobile object, person, etc.)**
- **VAL's play a major role in where operator decides to stand**
- **Data indicates operator's would position themselves in hazardous areas to see VAL's**

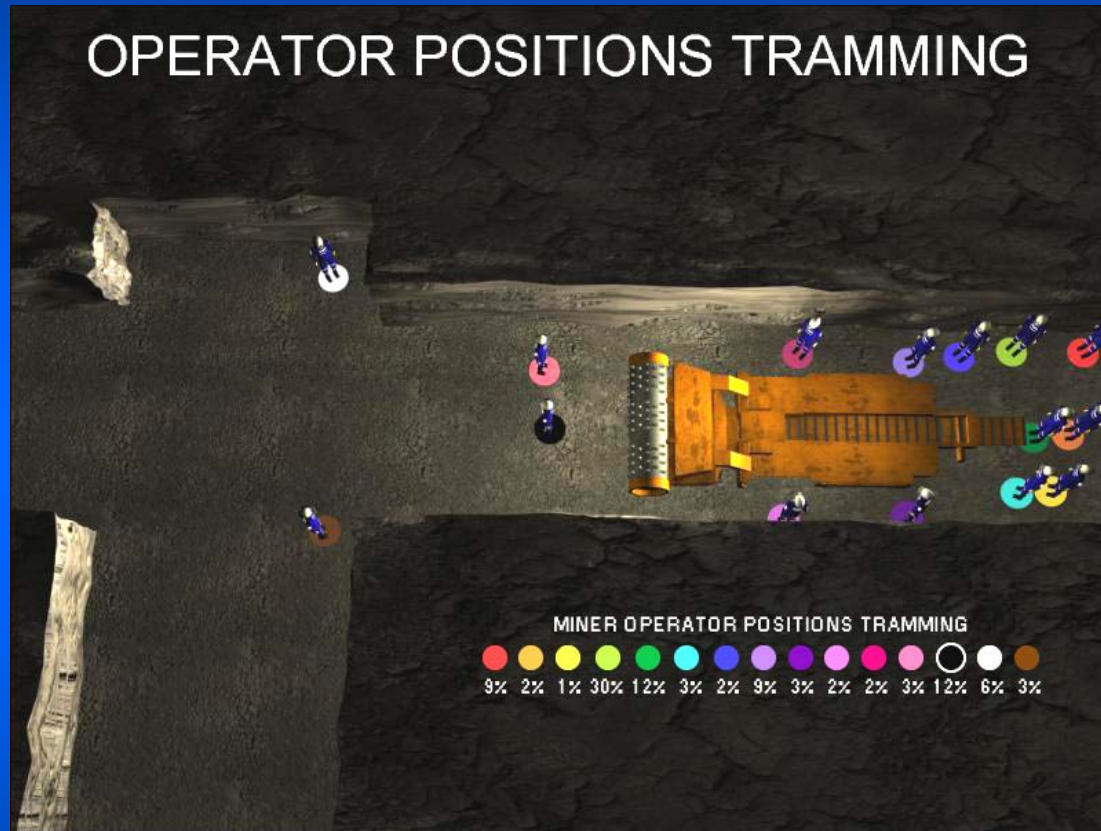


# Where 78 CM Operators said they stand



**NIOSH - validated through observations**  
**Positions chosen by operators were not all safe locations**

# Where 78 CM Operator's said they stand



**NIOSH - validated through observations**

# Ongoing NIOSH Efforts

- Joy14 CM instrumented with a controller, proximity system, motion sensors, control devices, etc. integrated into a CM system which is aware and responsive to the CM position and the position of people around it
- Operator commands to the machine will be evaluated and the controller will provide warnings and make decisions whether to proceed or halt commands being initiated
- Determine efficacy of system to improve safety of miners

# Proximity Detection Systems

- Nautilus International “Buddy System”  
(MSHA Approved)
- Geosteering Mining Services TramGuard®  
(MSHA Approved) and HazardAvert®
- Matrix Design Group M<sup>3</sup> 1000 System

# Nautilus - “Buddy System”



- Stand alone person wearable alarm device
- Machine mounted electro-magnetic antenna
- MSHA approved
- Field tested extensively at Massey Spirit Mine

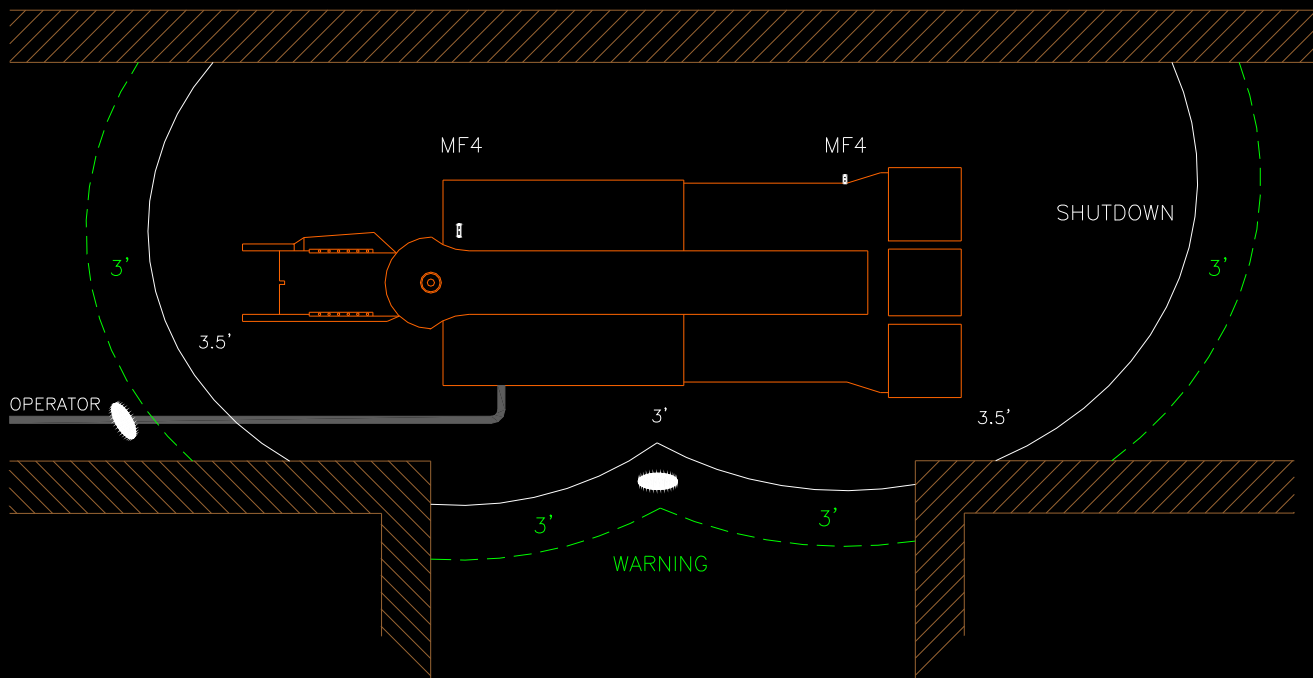
# Nautilus “Buddy System”

- Cap lamp version
- Not yet MSHA approved
- Person warn transceiver incorporated into cap lamp battery
- Smaller lithium battery
- Also remote control option being pursued



# Nautilus “Buddy System”

TYPICAL SHUTDOWN & WARNING ZONES



# Geosteering TramGuard®



- Developed and manufactured by Geosteering Mining Services, LLC (GMS)
- Approved by MSHA
- Successfully tested by Peabody at Black Beauty, ICG at Viper, and CONSOL at Jones Fork and Buchanan.
- SASOL in South Africa purchased TramGuard® systems to demonstrate a complete underground section test.



# Frederick Mining Services HazardAvert®,



- Developed and manufactured by Frederick Mining Controls, LLC (FMC)
- Successfully tested on various types of surface vehicles including haul trucks, fork lifts and a dragline.

# HazardAvert™ Forklift Installation

- The HazardAvert™ Forklift System warns people that they are entering a hazardous zone of a forklift. The most important application is to alert the operator when a pedestrian enters his/her zone of the forklift.
- For more information:  
[http://www.frederickminingg.com/fmcweb\\_002.htm](http://www.frederickminingg.com/fmcweb_002.htm)



# Matrix Design Group “M<sup>3</sup> - 1000”

- Transmitter worn on worker - approx. 3.5” x 2.5” x 1.25”
- 3 to 4 receivers mounted on the CM
- Controller – mounts on the CM
- Currently testing at the Warrior Mine



# OTHER PROXIMITY DETECTION APPLICATIONS

- The following accident scenarios make up approximately 20% of all mining fatalities and could be addressed by proximity detection technology:
  - Surface and underground mobile equipment
  - Unsupported top
  - Dump points
  - Conveyor guarding
  - Energized cables

# Proximity Related Accident Data (2000-2006)

- Includes only pedestrian struck-by and vehicle collision
- 60% occurred at coal mines
  - 42% underground
  - 18% on surface
- 40% occurred at non-coal mines
  - 38% on surface
  - 2% underground

# Proximity Related Accident Data (2000-2006) – Coal Mines

- 98 pedestrian struck-by mobile machinery accidents – eight fatal
- Two-vehicle collision accidents (38) and two fatalities (both on surface haul trucks)
- CMs had highest fatality rate
- LHDs highest number of total accidents (fatal and nonfatal)
- Conveyors and shuttle cars had highest number of disabling injuries

# Proximity Related Accident Data (2000-2006) – Non-Coal Mines

- Five (5) pedestrian struck by accidents
- 54 vehicle collision accidents – 7 fatal
- 5 LHD accidents
- Highest disabling accidents occurred on conveyors (18)
- Highest days lost accidents occurred on conveyors (63) and wheel loaders (21)
- One disabling forklift accident

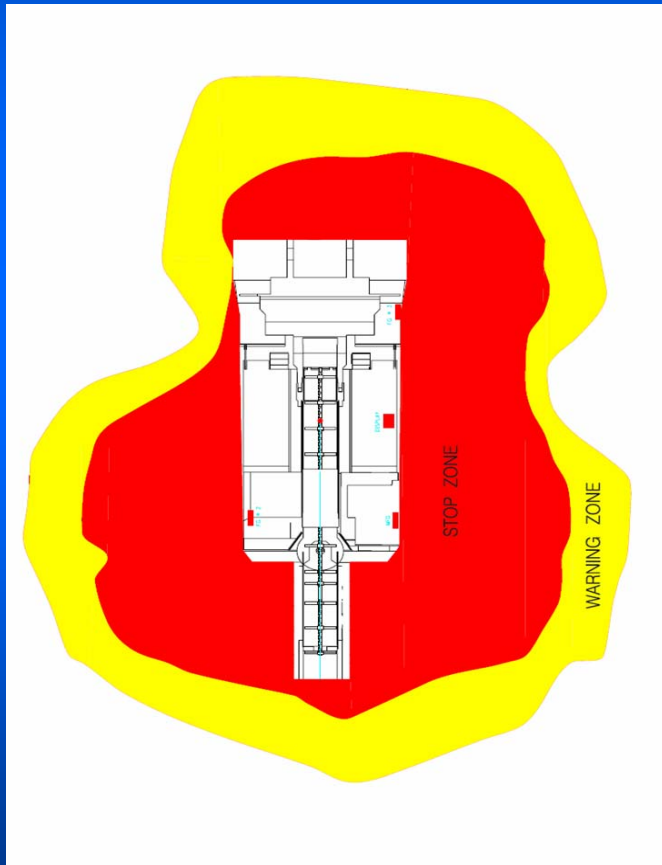
# CONCLUSIONS

- Proximity detection / collision avoidance technology has been proven in use to be reliable and durable.
- Only application specific implementation issues remain to be addressed.
- Unacceptable accidents, both serious and fatal, continue to occur.
- Proximity detection technology must be adopted if the industry hopes to achieve zero accidents.



QUESTIONS?

# Proximity Detection



Location of Remote Control Victims With Respect to Machine

