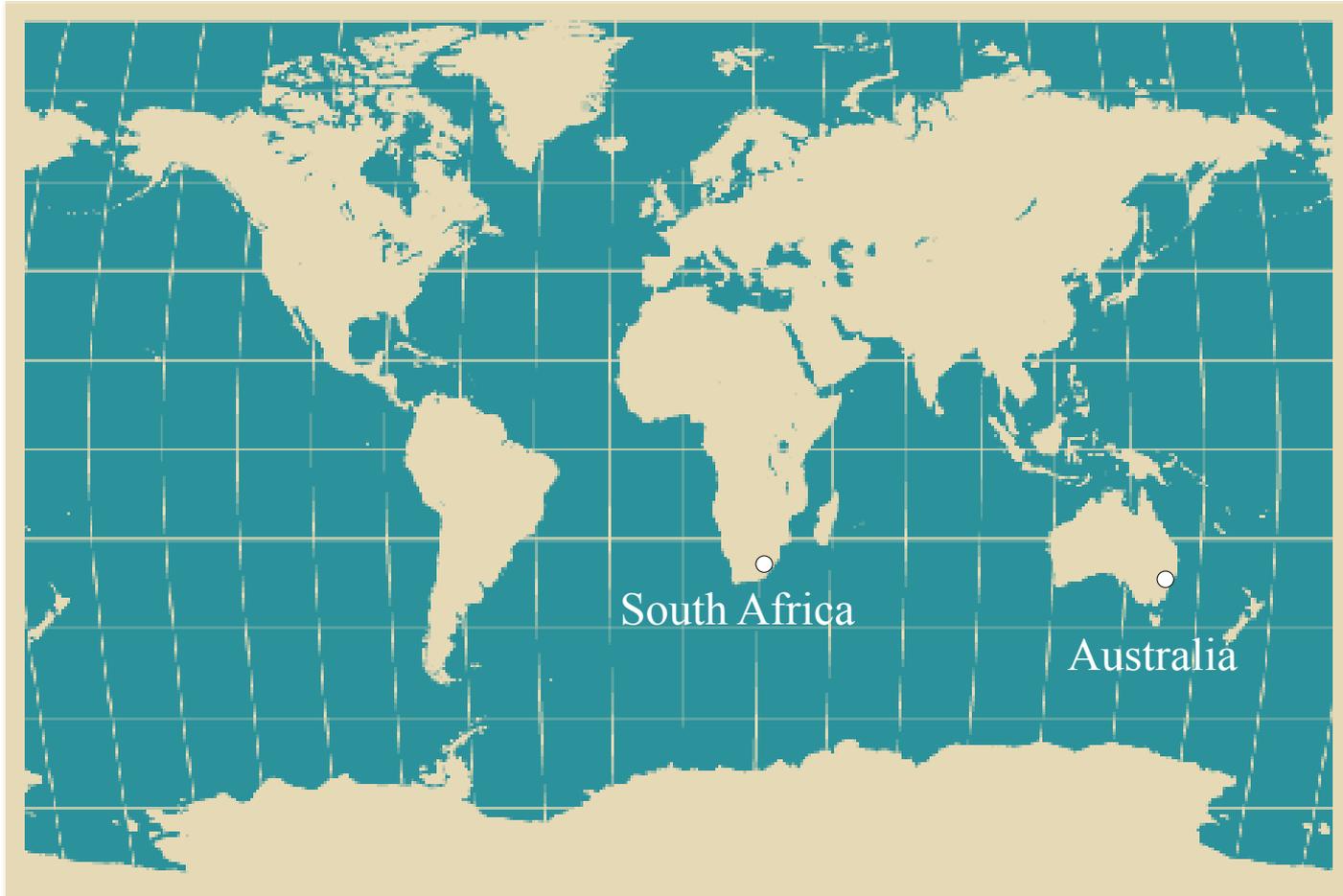# Status of the International Implementation of Proximity Warning Systems

Miguel Angel Reyes
Electrical Engineer
Office of Mine Safety and Health Research

Proximity Warning Systems for Mining Equipment
Charleston, WV
September 15, 2010

What is the rest of the world doing?

South Africa

Australia

South Africa

According to the World Coal Institute:

Top 10 Hard Coal Producers
Estimated 247 Mt (2009)

Top 5 Coal Exporters
Estimated 67 Mt (2009)

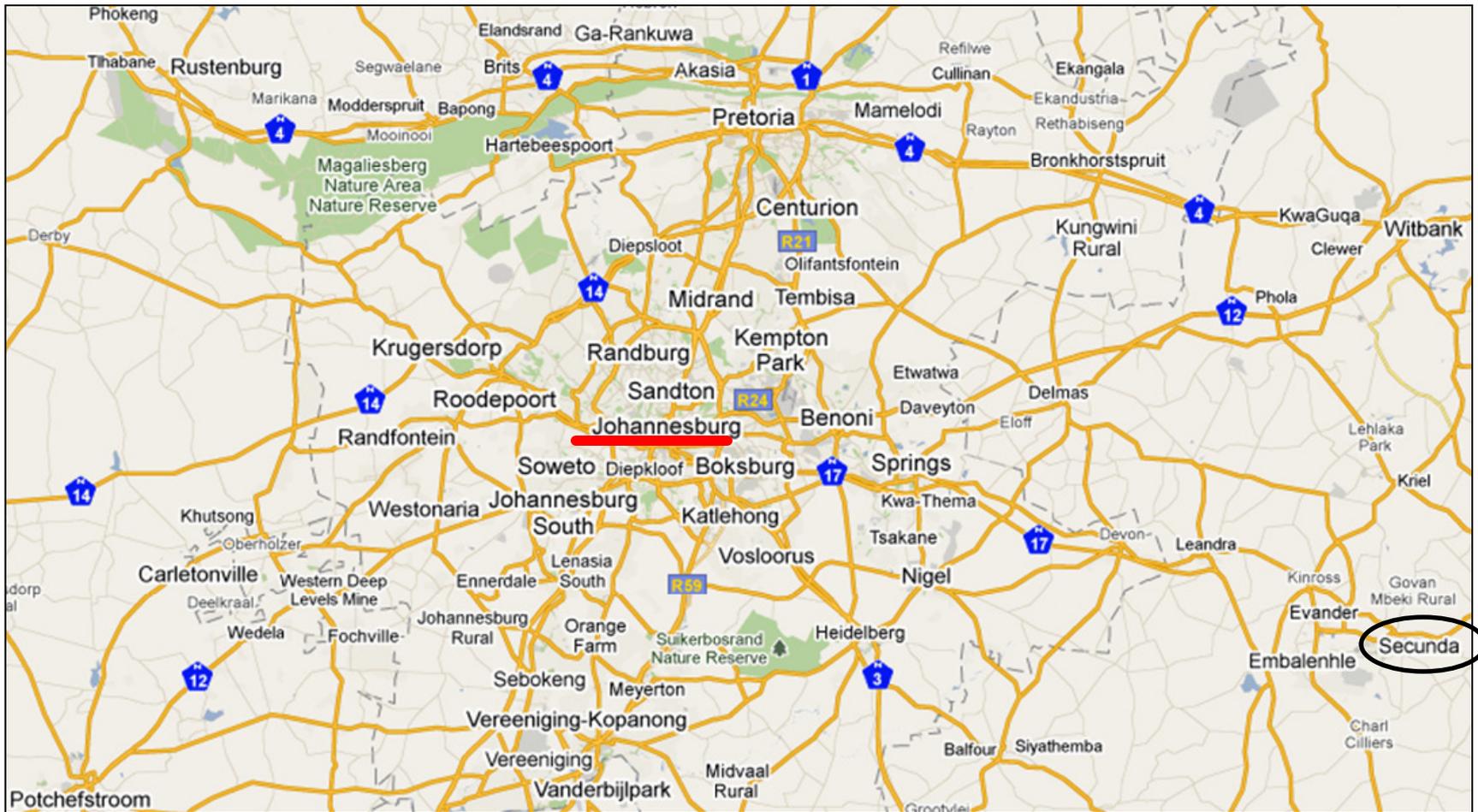93% of country's electricity is generated by coal (2008)

Magnetic Based System

HazardAvert Proximity Detection and Collision Avoidance

Johannesburg, South Africa

Mine:
Twistraai East Colliery

Location:
Secunda
(87 miles south east of Johannesburg)

Mineral Type:
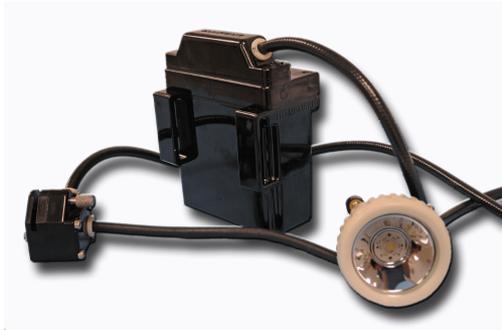Steam coal and synthetic fuels feedstock

Production:
45 Mt per year
(includes 5 underground coal mines)

Very low frequency (VLF) magnetic marker generators

Personal alarm device (PAD) in-line with cap lamp cord

Diagnostics display

Source: http://www.frederickmining.com

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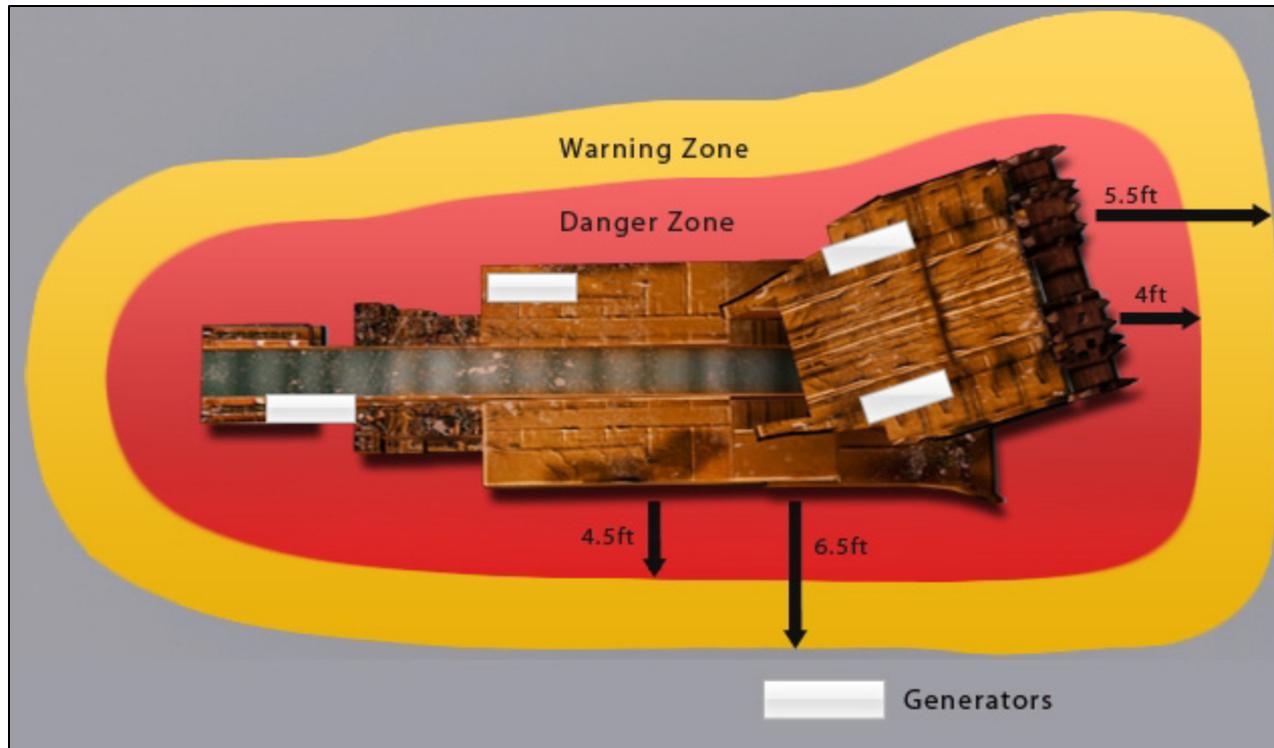
• Generator configuration

• Magnetic marker footprints

Challenge	Solution
Severed cables	Cable routing methods changed to avoid pinch points
Miners not taking ownership of system	Limits on duration of support team's stay
Education level	Six-tier training module

- Three active sections outfitted (April 2010)
  - Continuous mining machine (1)
  - Shuttle cars (3)
  - Roof bolter (1)
  - Feeder Breaker (1)
  - LHD (1)
- Full scale deployment planned within 3 years:
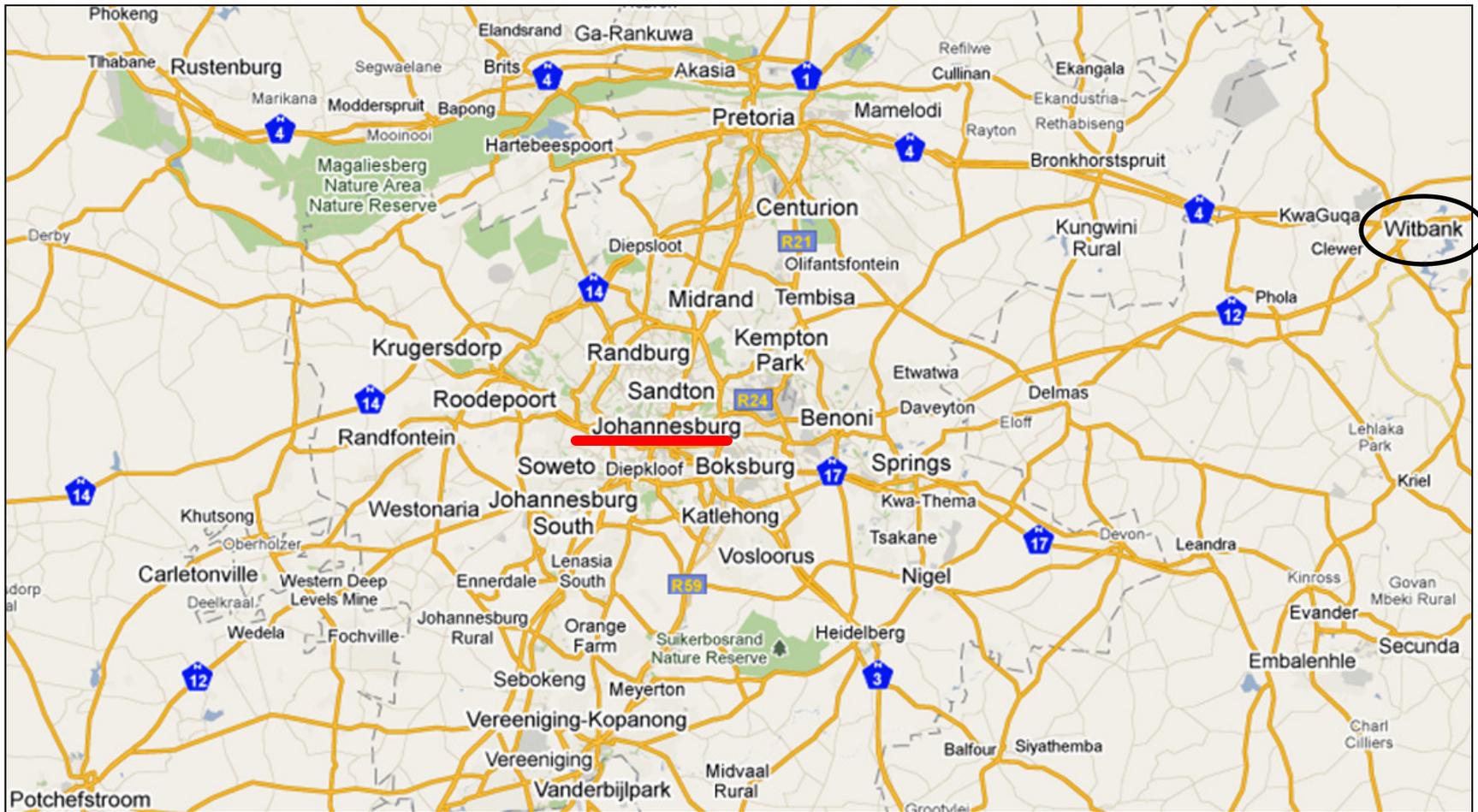 - 50 sections in 5 underground mines

Magnetic Based System

Booyco Collision Warning System 800
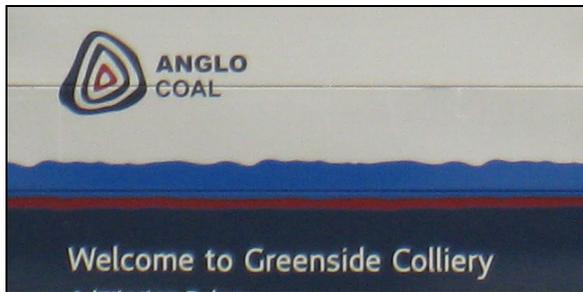
Johannesburg, South Africa

Magnetic Based System

Welcome to Greenside Colliery

Mine:
Greenside Colliery

Location:
Witbank
(79 miles east of Johannesburg)

Mineral Type:
Hard coal reserved for export

Production:
1 Mt per year

- VLF magnetic marker generators

- Cap lamp with RFID Tag, audible and visual alarm

- Machine-mounted display unit

System Details: Implementation Challenges

Challenge	Solution
Generator placement	Placement selected to compensate for operator's blind spots
Personnel training and acceptance	Change management and operator feedback
Nuisance alarms and alarming methods	In-line device vs electroluminescent vest

ANGLO COAL

Greenside Colliery
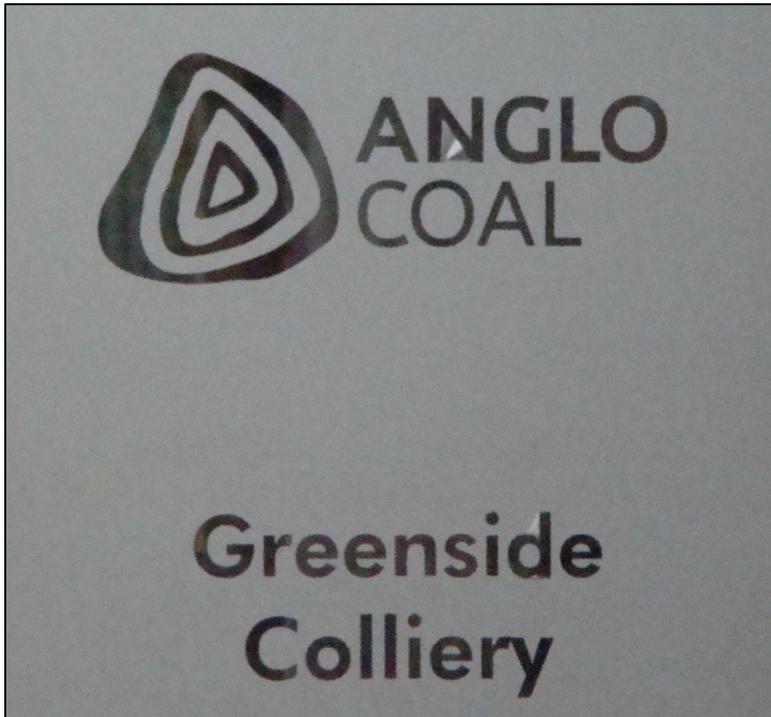
- Successful installation of system on shuttle cars, feeder breakers, and maintenance trucks

- Focus shifting to roof bolters and continuous mining machines

- Plans to outfit 1,000+ vehicle units and 15,000 personnel tags

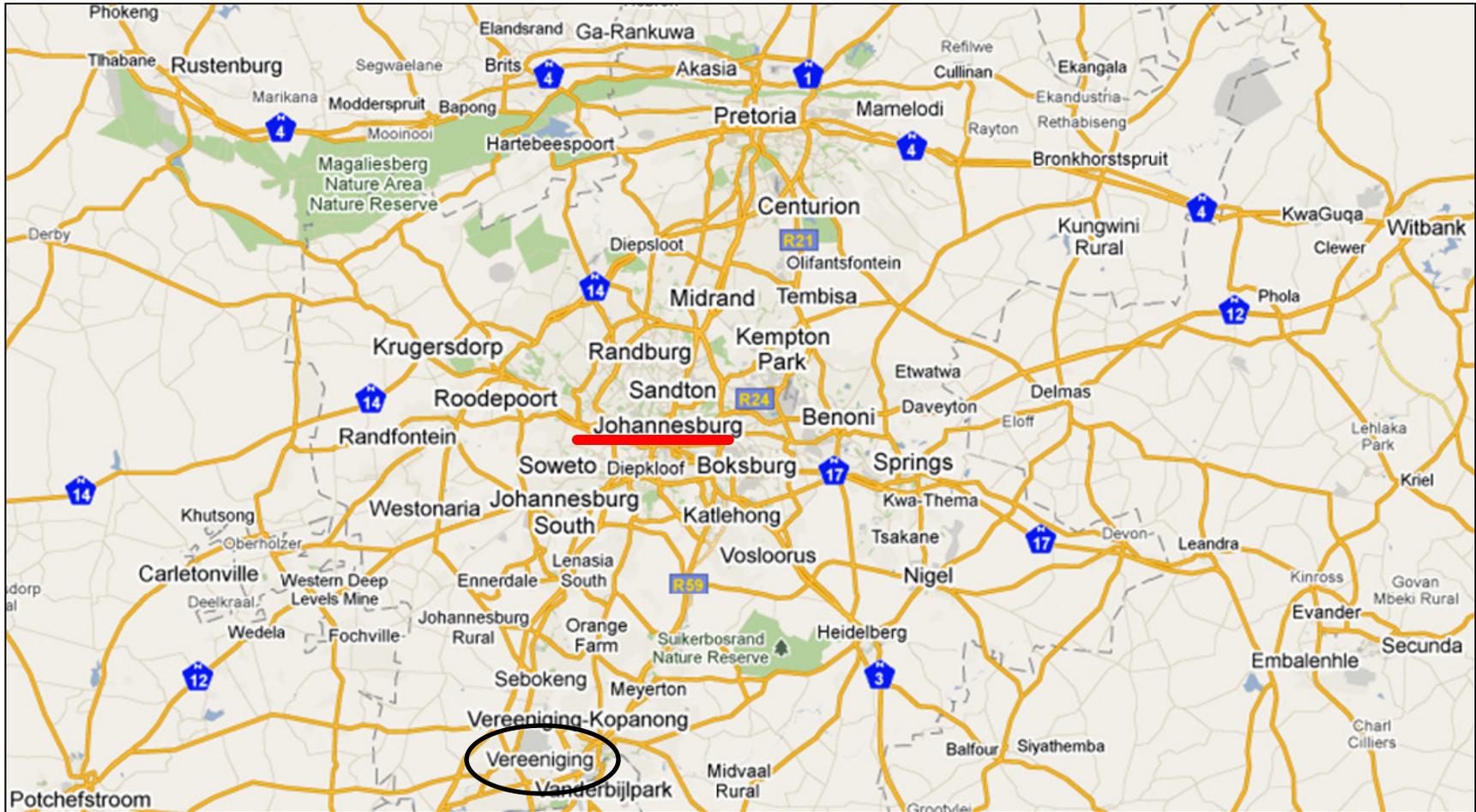OFFICE OF MINE SAFETY AND HEALTH RESEARCH

GPS Based System

SafeMine Traffic Alert and Collision Avoidance System

Johannesburg, South Africa

Mine:
New Vaal Colliery

Location:
Vereeniging
(50 miles south of Johannesburg)

Mineral Type:
Low grade coal supplied to local
power station

Production:
15 Mt per year

• Small profile GPS antenna and communications link

• Test station unit for diagnostics

- Alarm and LED display used to alert drivers

- Diagnostic LED indicators display system status

- Alarming features

Challenge	Solution
GPS precision limitations	Investigated supplementary technologies
Severed wires	Wire routing methods changed for new installations

- Initial testing started (August 2008)

- Trials successfully completed (October 2008)

- System installed in 700 vehicles (November 2009)

- Over 1,500 units, including contractor vehicles installed (April 2010)
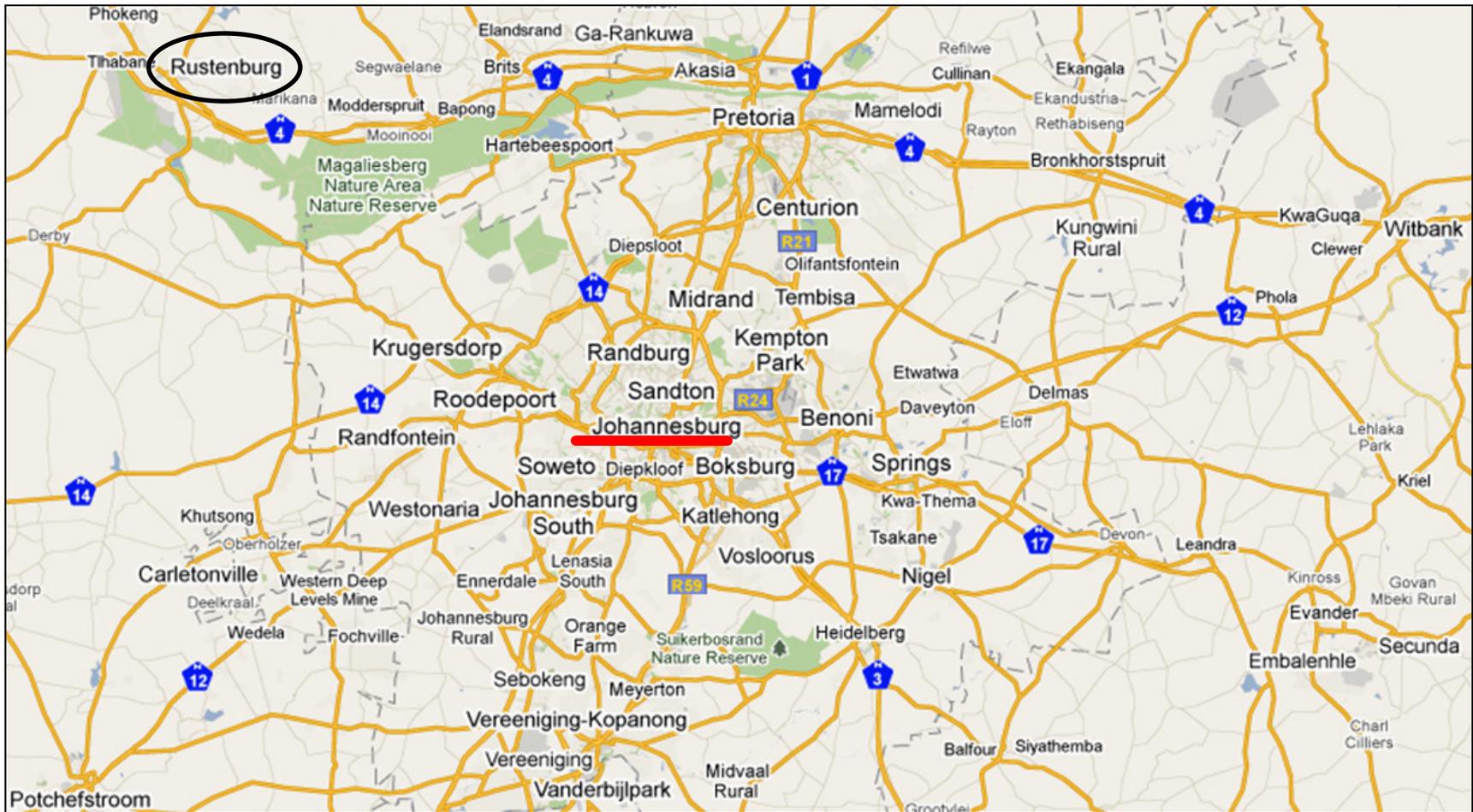
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Becker Collision Avoidance System

Johannesburg, South Africa

Mine:
Kroondal

Location:
Rustenburg
(75 miles north west of Johannesburg)

Mineral Type:
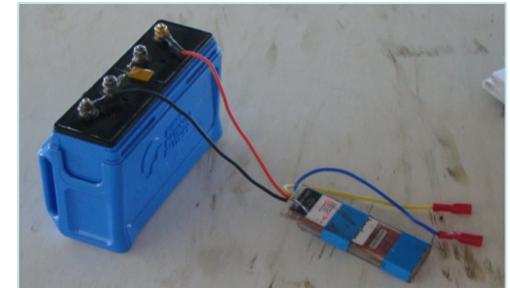Chromite

Combination system employs three different technologies:

- UHF transceivers
- VLF magnetic marker generators
- RFID tagging
- Wi-Fi (pending approval)

System Details: Implementation Challenges

Challenge	Solution
Nuisance alarms	Prioritization of machine movements and alarming methods
Intrinsic safety standards	Hazardous area design

- Directive set for full scale implementation of system across alloy division

Australia

According to the World Coal Institute:

Top 5 Hard Coal Producers
Estimated 263 Mt (2009)

Top Coal Exporter
Estimated 259 Mt (2009)

77% of country's electricity is generated by coal (2008)

GPS Based System
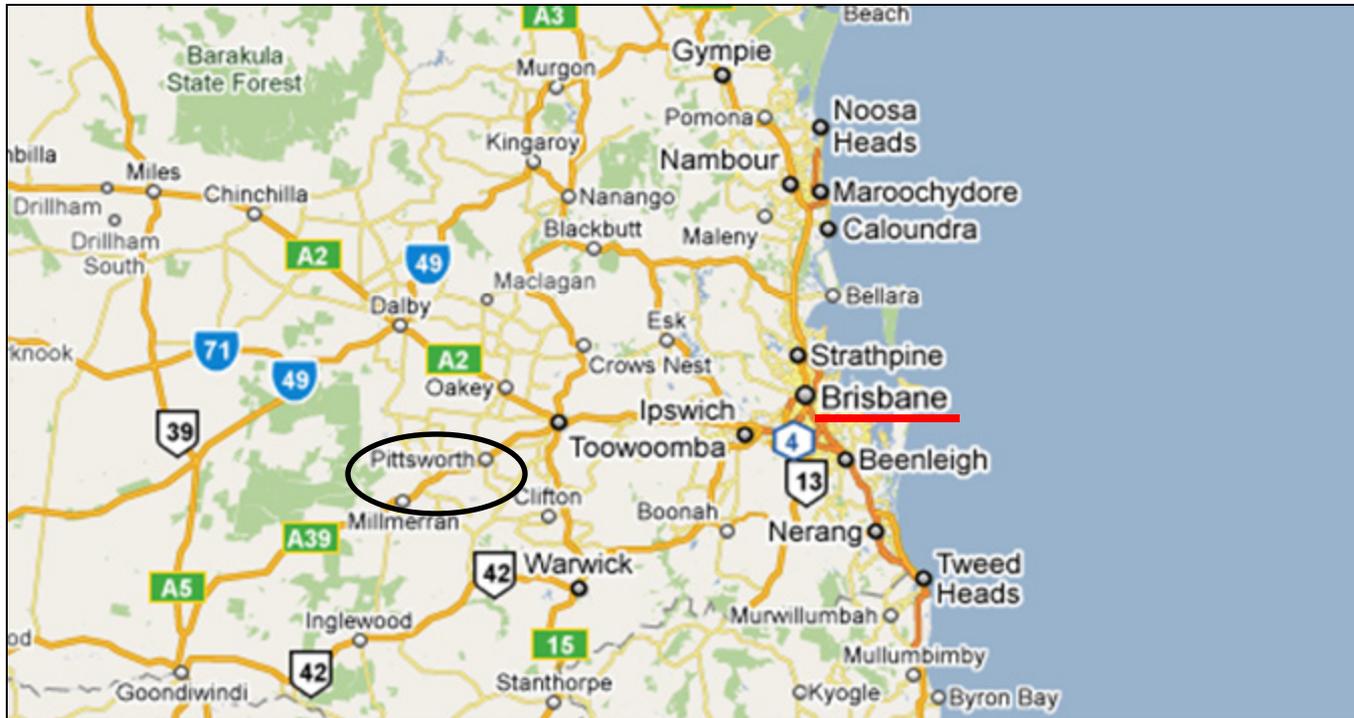
SafeMine Traffic Alert and Collision Avoidance System

Darling Downs, Queensland

Mine:
Commodore

Location:
Darling Downs, Queensland
(129 miles west of Brisbane)

Mineral Type:
Raw coal supplied to local
power station

Production:
3.6 Mt per year

Contractor Unit:

- Magnetic base

- Quick installation

- All contractor vehicles outfitted before entering mine

- Alarm and LED display used to alerts drivers

- Diagnostic LED indicators display system status

- Alarming features

Challenge	Solution
Operator feedback on alarming methods	Voice alerts deactivated
Lost GPS tracking near ash bins	Positioning of antennas changed
Ash buildup around connections and hardware damaged by water	Hardened connections and implemented waterproofing methods

- Initial implementation failed due to change management

- Commodore mine became test site for next implementation

- Full deployment planned within 2 years:
    - 11 mines in Australia
    - 1 mine in New Zealand

RFID Based System

CAS CAM/RF

Hunter Valley, New South Wales

Mine:
Drayton

Location:
Upper Hunter Valley, New South Wales (124 miles north of Sydney)

Mineral Type:
Thermal coal for export and domestic markets

Production:
5 Mt per year

CAS-CAM system:

- RF Sensors

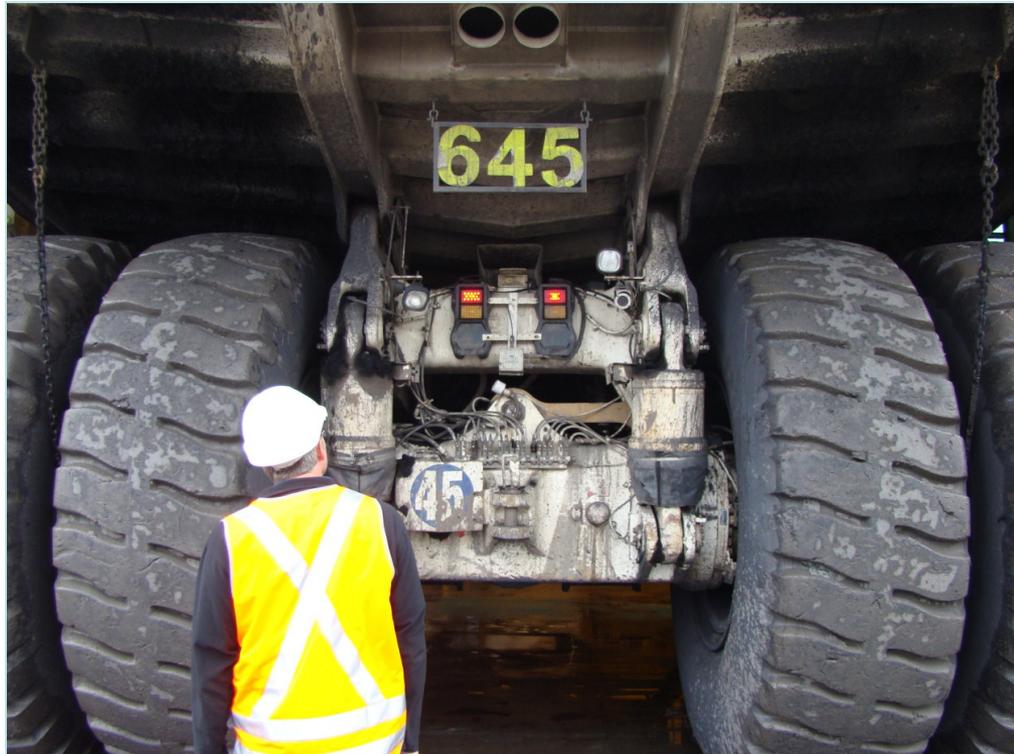- Machine-mounted cameras

- Camera monitor

Challenge	Solution
Overloading operators	Display switches to camera angle with highest priority vehicle interaction
Nuisance alarms	Alarms only for high risk interactions

- Four out of five Anglo Coal surface mines outfitted with AMT

- Fifth to be outfitted fourth quarter of 2010

Radar Based System

PreView Radar System

Peaks Down, Queensland

Cooperative System

Mine:
Saraji

Location:
Peaks Down, Queensland
(132 miles south west of Mackay)

Mineral Type:
Hard coking coal

Production:
8 Mt per year

- Pulse radar sensors mounted around machine's perimeter

- Detects stationary and moving objects in blind spots

- Designed to handle all weather conditions and temperature extremes as well as withstand constant vibrations

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- In-cab display alerts through LED arrays

- Proximity information relayed by illumination of LEDs

- Audible alarms activated upon detection of object

- Camera system used as supplement to provide visual detection and identification of vehicle interactions

Challenge	Solution
Multiple displays overloading operators	Camera screens to be combined with PreView system displays
Multiple vehicle interactions	Split screen on camera system display

- Researching supplementary technologies to extend range (GPS, RFID)

- Sensitivity of radar system being explored

GPS Based System

AcuMine Collision Avoidance Safety System (ACASS)

Source: : http:// www.AcuMine.com

Location: Indonesia, Chile, Australia

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Source: : http:// www.AcuMine.com

- High-level capability to determine objects as imminent threats and distinguish them from low risk interactions

- Cooperative system (GPS and RFID) to identify position and context of vehicles and personnel around a machine and assesses threat levels

- Combines different technologies for long and short proximity detection

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Lessons Learned

Source: MSHA

Source: MSHA

Source: NIOSH
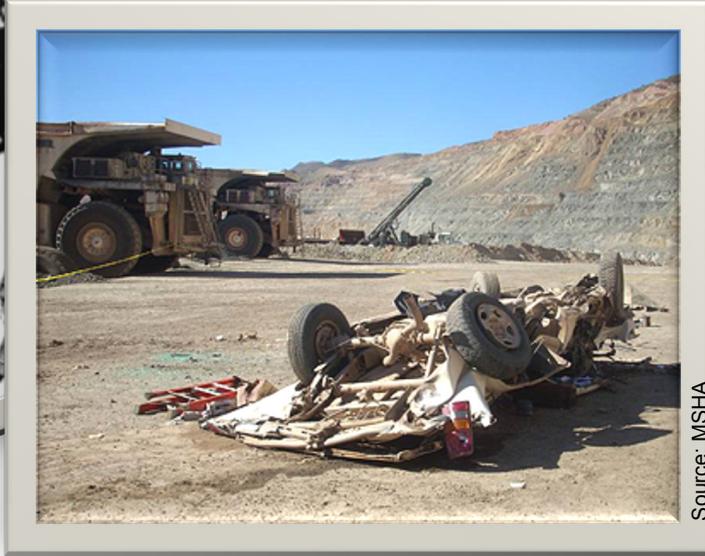
- Importance of human factors
    - Change management
    - Operator feedback
    - Training
    - Nuisance alarms

- Combination systems for extended coverage

- Safety culture and proactive approach to safety and training systems

- Parallel research being conducted between countries

Disclaimer

The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of NIOSH. Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

Presented By: Miguel Angel Reyes

Contact info:
Ph: 412.386.5072
Email: mareyes@cdc.gov

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