

**Appendix Z - Executive Summary of "Portable Gas Detector Testing"**  
**U.S. Department of Labor**

Mine Safety and Health Administration  
Industrial Park Road  
RR1, Box 251  
Triadelphia, West Virginia 26059



January 26, 2007

MEMORANDUM FOR RICHARD A. GATES

District Manager, Coal Mine Safety and Health District 11

FROM:

JOHN P. FAINI   
Chief, Approval and Certification Center

SUBJECT:

Executive Summary of Investigation of Portable Gas Detectors  
Recovered from the Sago Mine

The Approval and Certification Center (A&CC), as requested by Coal Mine Safety and Health, conducted a laboratory investigation of gas detectors recovered from a fatal explosion at Wolf Run Mining Company's Sago Mine, Mine I.D. No. 46-08791 on January 2, 2006. These devices were:

- two (2) Industrial Scientific Corporation (ISC) Model iTX Multi-Gas Monitors;
- three (3) ISC Model LTX310 Multi-Gas Monitors; and
- seven (7) CSE Corporation Model 102LD Methane Detectors.

The two ISC Model iTX devices and one of the ISC Model LTX310 units, with Exhibit Numbers beginning with 'ACC', were recovered separately from the others. They were apparently not in the mine at the time of the explosion, but were taken into the mine by mine personnel during attempted rescue operations.

The investigation identified several permissibility discrepancies that were attributable to improper maintenance (overdue calibrations, carrying strap grommet displaced and holes in instrument case allowing dust to enter the instrument, and missing case securing screws) or manufacturing discrepancies that deviated from the approved design.

There was no evidence that any component of any of the pieces of evidence would have produced conditions that would have provided enough energy to ignite a flammable methane-air mixture.

The following sections summarize the testing and inspection of each of the twelve instruments.

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### ISC Model iTX Multi-Gas Monitor, ACC-2

This ISC Model iTX Multi-Gas Monitor, Serial No. 0408001-374, carried Unique Identifier "RH". Exhibit Number ACC-2 was assigned to this exhibit by A&CC personnel. The unit was marked with MSHA Approval Number 8C-78-0. It was inspected and compared with approval documentation. Operational and performance tests were also conducted.

The Software Version displayed by the monitor during startup was "2.4" and the display indicated that the battery was nearly fully charged. The following instrument Peaks were displayed during startup:

PEAK READINGS		
CH <sub>4</sub>	O <sub>2</sub>	CO
.2	.0	FAIL

The "Peak" oxygen reading stored in the monitor "as-received" is a minimum value that had been measured by the monitor; the reading indicated that the monitor was exposed to low concentrations of oxygen. The "Peak" methane reading stored in the monitor indicated that the monitor was not exposed to high concentrations of a combustible gas.

The monitor reported "No Data Available to download," indicating that it was not configured to log data. This means that no periodic readings of methane, oxygen, and CO were recorded during use. Therefore, it could not be determined when the 'Peak' readings occurred.

FRESH AIR READINGS:		
CH <sub>4</sub>	O <sub>2</sub>	CO
.0	OR (flashing)	FAIL

Prior to calibration, the unit indicated over range conditions at oxygen concentrations greater than 19.15%. At lower oxygen concentrations, the monitor read much higher than the sampled concentration. For example, at the lowest sampled concentration (13.04%) the monitor displayed 20.9. The monitor could not detect various concentrations of carbon monoxide (CO) as-received; it would only display "FAIL". The manufacturer's representative said that this most likely indicated that the monitor's calibration settings were adjusted in an environment that contained a high concentration of CO in air, resulting in a significant offset in the zero calibration.

The methane display readings were lower than the sampled concentration. Readings of

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methane concentrations that were 2% and greater were not within the limits of error specified in 30 CFR Part 22. After calibration of the monitor, it:

- detected methane within the allowable limits of error;
- detected oxygen within the  $\pm 0.5\%$  requirement; and
- accurately detected carbon monoxide.

The last calibration date for the monitor was given as 11-16-05. This was 47 days before the accident.

The time reading from the monitor was approximately one hour and 41 minutes ahead of the actual time.

There were minor discrepancies between this monitor and the documentation file. There were bar code labels on the various assemblies of the monitor that are not specified on documentation. There were two cylindrical pieces of foam used as "dummy" sensors in two unused sensor slots in the monitor that are not shown on the documentation.

### ISC Model iTX Multi-Gas Monitor, ACC-3

This ISC Model iTX Multi-Gas Monitor, Serial No. 0309270-042 was assigned Exhibit Number ACC-3. The unit was marked with MSHA Approval Number 8C-78-0. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

The Software Version displayed by the monitor during startup was "2.2". The battery indicator status gave an indication of fully charged. The following Instrument Peaks were displayed during startup:

PEAK READINGS		
CH <sub>4</sub>	O <sub>2</sub>	CO
.2	20.3	FAIL

The "Peak" oxygen reading stored in the monitor, as received, indicated the monitor did not measure low concentrations of oxygen since the last calibration. The "Peak" methane reading stored in the monitor "as-received" indicates that the monitor was not exposed to high concentrations of a combustible gas. Since the monitor reported "No Data Available to download", it could not be determined when these Peak readings occurred.

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### FRESH AIR READINGS:

CH <sub>4</sub>	O <sub>2</sub>	CO
.0	20.9	FAIL

Prior to calibration, the unit detected four of the sampled oxygen concentrations within the  $\pm 0.5\%$  requirement. The only reading that was greater than  $\pm 0.5\%$  tolerance was the reading of 13.6 when sampling 13.04%. The monitor could not detect various concentrations of carbon monoxide "as-received". It would only display "FAIL". The methane display readings were significantly lower than the sampled concentration. For example, the monitor displayed 3.1 when sampling 4% methane. After calibration of the monitor, it:

- detected methane within the allowable limits of error;
- detected oxygen as it did before calibration with the only reading greater than  $\pm 0.5\%$  tolerance was the reading of 13.6 when sampling 13.04% Oxygen; and
- accurately detected carbon monoxide.

The last calibration date for the monitor was given as 3-1-04. This was 672 days before the accident.

The time reading from the monitor was approximately two hours and 6 minutes ahead of the actual time.

There were minor discrepancies between this monitor and the documentation file. There were bar code labels on the various assemblies of the monitor that are not specified on documentation. There were two cylindrical pieces of foam used as "dummy" sensors in two unused sensor slots in the monitor that are not shown on the documentation.

### ISC Model LTX310 Multi-Gas Monitor, ACC-1

This ISC Model LTX310 Multi-Gas monitor, Serial No. 9710027-116 was assigned Exhibit Number ACC-1. The unit was marked with MSHA Approval Number 8C-65-2. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the monitor did not operate due to a depleted battery. After charging, the monitor was in operational status. However, it was programmed to display the reading of combustible gas concentration as percent LEL (Lower Explosive Limit). The

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following Instrument Peaks were displayed during startup:

PEAK READINGS		
LEL/CH <sub>4</sub>	Oxygen	Toxic
+OR	18.4	+OR

The "Peak" oxygen reading stored in the monitor "as-received" indicated the monitor was exposed to a low concentration of oxygen since the last calibration. The "Peak" LEL/CH<sub>4</sub> reading stored in the monitor "as-received" indicated that the monitor was exposed to a high concentration of a combustible gas. The "Peak" carbon monoxide reading indicated that the monitor was exposed to a high level of carbon monoxide. It could not be determined when these Peak readings occurred.

FRESH AIR READINGS:		
LEL/CH <sub>4</sub>	O <sub>2</sub>	Toxic
0	20.9	CO-15

Prior to calibration, the unit detected five sampled oxygen concentrations within the  $\pm 0.5\%$  requirement. The monitor could accurately detect the two sample concentrations of carbon monoxide "as-received" even with the -15 offset in fresh air. The methane display readings were significantly lower than the sampled concentration and were displayed as percent LEL.

The monitor was programmed to display the combustible gas readings as % methane by volume, and the monitor was calibrated. After calibration of the monitor, it:

- detected methane within MSHA requirements at 0.25%, 0.50%, and 1.00% only. It read significantly lower at the higher sampled concentrations;
- detected oxygen within the  $\pm 0.5\%$  requirement; and
- accurately detected carbon monoxide and no longer had the zero offset.

A calibration label could not be found on the monitor. It could not be determined when the monitor was last calibrated.

There were minor discrepancies between this monitor and the documentation file. There were bar code labels on the various assemblies of the monitor that are not specified on documentation. There were labels on the monitor that were probably applied by the mine for identification purposes that are not on the documentation.

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### ISC Model LTX310 Multi-Gas Monitor, KLH-4

The serial number on this unit is 9609008-244. The unit was marked with MSHA Approval Number 8C-65-0. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the monitor did not operate due to a depleted battery. After charging, the monitor was in operational status. The following instrument Peaks were displayed during startup:

PEAK READINGS		
LEL/CH <sub>4</sub>	Oxygen	Toxic
1.7	18.7	59

The oxygen "Peak" reading stored in the monitor "as-received" indicates the monitor was exposed to a low concentration of oxygen. The LEL/CH<sub>4</sub> "Peak" reading stored in the monitor "as-received" indicates that the monitor was exposed to a high concentration of a combustible gas. The carbon monoxide "Peak" reading indicates that the monitor was exposed to a high level of carbon monoxide. It could not be determined when these Peak readings occurred.

FRESH AIR READINGS:		
LEL/CH <sub>4</sub>	O <sub>2</sub>	Toxic
-.8	20.4	CO-45

Prior to performance testing, the monitor no longer displayed a reading for the oxygen sensor and oxygen accuracy testing could not be conducted.

Prior to calibration, the monitor could not accurately detect two sampled concentrations of carbon monoxide. It gave a display reading of 198 with 50ppm of CO applied and a display reading of 402 with 100 ppm of CO applied. The methane display readings were higher than the MSHA limits of error at 0.50%, 1.00%, and 2.00%.

After calibration of the monitor, it:

- did not detect methane within MSHA requirements at 0.50%, 1.00%, and 2.00%. It read higher at all the other sampled concentrations;
- accurately detected carbon monoxide; and
- the oxygen sensor could not be calibrated due to the blank display for oxygen.

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A calibration label could not be found on the monitor. It could not be determined when the monitor was last calibrated.

There were minor discrepancies between this monitor and the documentation file. The part number of the combustible gas sensor (1704-6269) did not agree with the part number (1704A1856) shown on the approval documentation. The part number 1704-6269 sensor assembly is approved in other ISC instruments and the 1704A1856 sensor is a sub-assembly of the part number 1704-6269 sensor assembly. One of the case securing screws was missing.

### ISC Model LTX310 Multi-Gas Monitor, KLH-15

The unit was marked with MSHA Approval Number 8C-65-2. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the monitor did not operate due to a depleted battery. After charging, the monitor was in operational status. The following instrument Peaks were displayed during startup:

PEAK READINGS		
LEL/CH <sub>4</sub>	Oxygen	Toxic
+OR	14.6	+OR

The "Peak" oxygen reading stored in the monitor is a minimum value that had been measured by the monitor; the reading indicated that the monitor was exposed to a very low concentration of oxygen. The "Peak" LEL/CH<sub>4</sub> reading stored in the monitor indicated that the monitor was exposed to a high concentration of a combustible gas. The "Peak" carbon monoxide reading indicated that the monitor was exposed to a high level of carbon monoxide. It could not be determined when these Peak readings occurred.

FRESH AIR READINGS:		
LEL/CH <sub>4</sub>	O <sub>2</sub>	Toxic
-.3	21.3	CO-1

Prior to calibration, the monitor detected the five sampled oxygen concentrations within the  $\pm 0.5\%$  of reading requirement. The monitor could not accurately detect the sampled concentrations of carbon monoxide. It gave a display reading of 102 with 50ppm of CO applied and a display reading of 191 with 100 ppm of CO applied. The methane display readings were lower than the sampled concentrations and not within MSHA limits of error at all sampled concentrations. After calibration of the monitor, it:

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- detected methane accurately at all sampled concentrations;
- accurately detected carbon monoxide; and
- accurately detected the various oxygen concentrations.

A partial calibration label was found on the monitor with only the month (7) and day (22) legible on it. It could not be determined when the monitor was last calibrated.

There were discrepancies between this monitor and the documentation file. The identifying part number on the buzzer in the monitor (PB-1220P) did not agree with the buzzer part number (QMB-11PXI) specified on the documentation. There was a jumper wire on the bottom side of the main PCB that is not shown on the documentation. One of the case securing screws was missing. The part number on the oxygen sensor in the unit (1703-5114) did not agree with the part number (1702-3516) specified for the sensor on the documentation.

### CSE Model 102LD Methane Detector, KLH-2

The serial number on this unit is 4421. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.0 in fresh air and 2.3 with 2.5% calibration gas applied. It detected all sampled methane concentrations accurately except for the 4.00% methane concentration. It read low (3.6) at the 4.00% concentration.

After calibration, the instrument detected methane accurately at all sampled concentrations.

A CSE calibration label was found on the instrument with a calibration date of 12/21/05. At the time of the accident, this instrument had a valid calibration meeting the MSHA requirement of being calibrated every 31 days.

There were minor discrepancies between this Detector and the documentation file. The revision level of the main PCB assembly in the instrument was marked Revision C. The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 4310R-102-124 which disagrees with the documentation which specifies part number 43-06-R-102-124.



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### CSE Model 102LD Methane Detector, KLH-10

The serial number on this unit is 1870. The unit was marked with MSHA Approval Number 8C-37-4. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.1 in fresh air and 1.9 with 2.5% calibration gas applied. The only sampled methane concentration that it read accurately was the 0.25% methane concentration. It read low at all the other sampled concentrations.

After calibration, the instrument detected methane accurately at all sampled concentrations.

A CSE calibration label was found on the instrument with a calibration date of 11/7/05. This was 56 days before the accident.

There were very minor discrepancies between this Detector and the documentation file.

### CSE Model 102LD Methane Detector, KLH-21

The serial number on this unit is 4277. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.1 in fresh air and 3.4 with 2.5% calibration gas applied. The instrument did not read any of the sampled methane concentrations accurately. It read high at all sampled concentrations.

After calibration, the instrument detected methane accurately at all sampled concentrations.

A calibration label could not be found on the instrument. It could not be determined when the instrument was last calibrated.

The revision level of the main PCB assembly in the instrument was marked Revision C.

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The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 4310R-102-124 which disagrees with the documentation which specifies part number 43-06-R-102-124. The grommet that surrounds the carrying strap was displaced from the case and was not located as shown on the documentation.

### CSE Model 102LD Methane Detector, GH-45P

The serial number on this unit is 2064. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.0 in fresh air and 1.4 with 2.5% calibration gas applied. The only sampled concentration that the instrument read accurately was the 0.25% methane concentration. It read low at all other sampled concentrations.

After calibration, the instrument read accurately at the 0.25%, 0.50%, and 1.00% methane concentrations. It read low at the other higher concentrations.

A CSE calibration label was found on the instrument with a calibration date of 06/10/05. This was 206 days before the accident.

The revision level of the main PCB assembly in the instrument was marked Revision C. The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 10X-2-124-9287 which disagrees with the documentation which specifies part number 43-06-R-102-124. The two screws that secure the detector assembly to the instrument are flat head instead of the specified Phillips head.

### CSE Model 102LD Methane Detector, GH-55P

The serial number on this unit is 4588. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.0 in fresh air and 2.6 with 2.5% calibration gas

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applied. It read accurately at all sampled concentrations.

After calibration, the instrument continued to read all sampled concentrations accurately.

A CSE calibration label was found on the instrument with a calibration date of 12/12/05. At the time of the accident, this instrument had a valid calibration meeting the MSHA requirement of being calibrated every 31 days.

The revision level of the main PCB assembly in the instrument was marked Revision C. The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 4310R-102-124 which disagrees with the documentation which specifies part number 43-06-R-102-124.

### CSE Model 102LD Methane Detector, GH-86P

The serial number on this unit is 4961. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation. Operational and performance tests were also conducted.

As-received, the instrument did not operate due to a depleted battery. After charging, the instrument was in operational status.

Prior to calibration, the instrument read 0.2 in fresh air and 2.2 with 2.5% calibration gas applied. The only sampled concentrations that were within the MSHA limits of error were the readings at 1.00%, 2.00%, and 3.00%. It read low at the other measured concentrations.

After calibration, the instrument read all sampled concentrations accurately.

A CSE calibration label was found on the instrument with a calibration date of 10/18/05. This was 76 days before the accident.

The revision level of the main PCB assembly in the instrument was marked Revision C. The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 4310R-102-124 which disagrees with the documentation which specifies part number 43-06-R-102-124.

### CSE Model 102LD Methane Detector, GH-87P

The serial number on this unit is 4843. The unit was marked with MSHA Approval Number 8C-37-7. The unit was inspected and compared with approval documentation.

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Operational and performance tests were also conducted.

As-received, the instrument had sufficient charge on the battery and was in operational status.

Prior to calibration, the instrument read 0.0 in fresh air and 2.4 with 2.5% calibration gas applied. The only sampled concentration that was not within the MSHA limits of error was the reading at 4.00%.

After calibration, the instrument read all sampled concentrations accurately.

A calibration label could not be found on the instrument. It could not be determined when the instrument was last calibrated.

The revision level of the main PCB assembly in the instrument was marked Revision C. The latest revision level of the documentation on file for the main PCB is B. The markings on R3 on the main PCB in the instrument are 4310R-102-124 which disagrees with the documentation which specifies part number 43-06-R-102-124. One of the two screws that secure the detector assembly to the instrument was a flat head instead of the specified Phillips head.

Comprehensive test results can be obtained from the Chief of the A&CC, RR 1, Box 251, Industrial Park Road, Triadelphia, West Virginia 26059.