

National Personal Protective Technology Laboratory

New CO₂ Dead Space Test System Final Correlation Test Results

Policy and Standards Development Branch

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New CO₂ Dead Space Test System Final Correlation Test Results

- **Previous updates at December, 2005 and October, 2006 Manufacturer's Meetings**
- **Why upgrade the CO₂ Dead Space Test System?**
 - **Improve accuracy in setting test conditions and performing data analysis**
 - **Reduce variability from test to test**
 - **Allow manufacturers to duplicate the test system using commercially available components for direct correlation**

New CO₂ Dead Space Test System Final Correlation Test Results

- **Project Timeline**

- Completed installation – June, 2006
- Completed shakedown testing – December 2006
- Completed efforts to equate new system with existing system – December, 2007
- Completed correlation testing – July, 2008
- Completed statistical modelling of test results – May, 2009

New CO₂ Dead Space Test System Final Correlation Test Results

- Existing and New Test Systems



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- **Features of New CO₂ Deadspace Test System**
 - **Sheffield Head headform and half-torso**
 - **Face width, 146 mm; face length, 122 mm**
 - **Places in cell #7 of the new NIOSH Bivariate fit test panel, representing a medium-sized faced**
 - **Data monitoring/recording system powered by custom LabVIEW software application**
 - **Data recording interval is 25 milliseconds or 4 times more frequent than existing test system**
 - **Mass flow controllers for breathing gas control**

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- **Features of New CO₂ Deadspace Test System**
 - Revised sedentary cam design provides breathing cycle component durations consistent with Leslie Silverman human subject sedentary breathing research
 - Solenoid valve state change data file stamping
 - Excel spreadsheet-based data analysis routine

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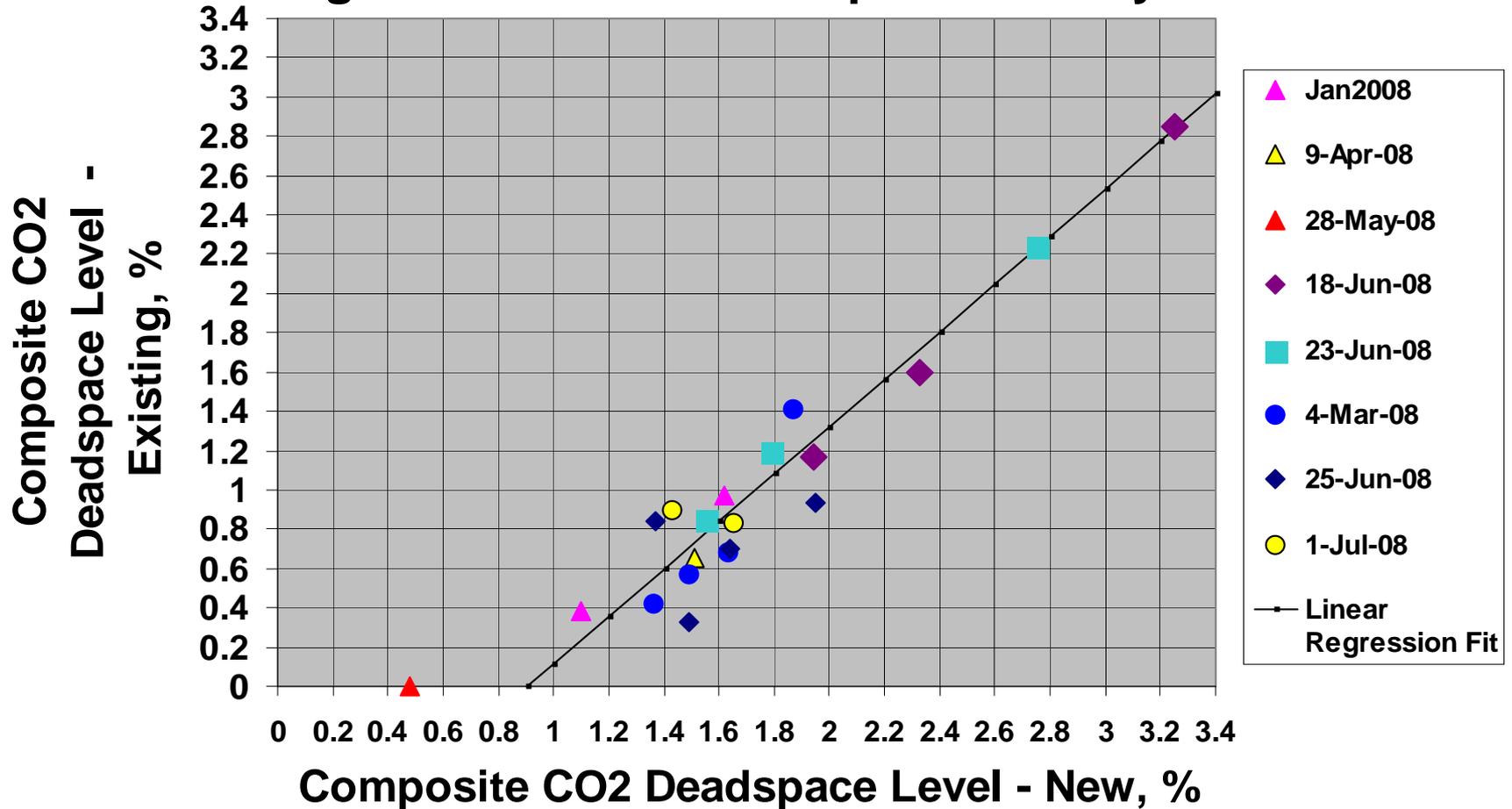
- **Performance of new CO₂ Deadspace Test System**
 - Control peak breathing gas CO₂ concentration at 5.00 ± 0.02%
 - Control sample gas extracted from the breathing zone for analysis at 450 ± 0.7 sccm
 - Consistent blank CO₂ levels generally ranging from 0.39% to 0.44%
 - Precise determination of the start and end of inhalation phase from solenoid valve actuation times corroborated with facepiece resistance

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- **New vs. Existing Correlation Test Data Analysis**
 - Tested 20 respirators at both the existing and new test systems
 - A simple linear regression was subsequently fit to this data to predict CO₂ Deadspace Levels for the existing test system as a function of CO₂ Deadspace Levels measured at the new system
 - Using the R statistical software package, the optimal y-intercept and slope were calculated to be -1.097 and 1.209, respectively, and the linear regression took the form
 - $CO_{2\text{ (Existing)}} = -1.097 + 1.209 \times CO_{2\text{ (New)}}$

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Final Correlation Testing Existing vs. New CO₂ Deadspace Test Systems



New CO₂ Dead Space Test System Final Correlation Test Results

- **New vs. Existing Correlation Test Data Analysis**
 - Both the intercept and slope of the model were highly statistically significant ($p < 0.001$ for each coefficient)
 - Using this equation to predict the CO₂ level of the existing system (as a function of the new) gives an R² value of 0.909, meaning that approximately 91% of the variability in the new system's measurements can be explained by the variability in the measurements of the existing system

New CO₂ Dead Space Test System Final Correlation Test Results

- New vs. Existing Correlation Test Data Results**

CO ₂ Deadspace Level, %			P - Pass/F - Fail	
Existing	New	Existing Predicted	Existing	Existing Predicted
0.00	0.48	0.00	P	P
0.38	1.10	0.23	P	P
0.42	1.36	0.55	P	P
0.84	1.37	0.56	P	P
0.91	1.43	0.63	P	P
0.57	1.49	0.70	P	P
0.65	1.51	0.73	P	P
0.33	1.49	0.70	P	P
0.70	1.64	0.89	P	P
0.85	1.55	0.78	P	P
0.97	1.62	0.86	P	P
0.68	1.63	0.87	P	P
0.83	1.65	0.90	P	P
1.20	1.79	1.07	F	F
1.41	1.87	1.16	F	F
0.93	1.95	1.26	P	F
1.17	1.94	1.25	F	F
1.60	2.33	1.72	F	F
2.24	2.75	2.23	F	F
2.85	3.25	2.83	F	F

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- **New vs. Existing Correlation Test Data Results**
 - 19 of 20 respirators that passed or failed at the existing system, were correctly predicted to pass or fail, respectively, at the new system using the model

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- **Test Procedure for Determining New Test System CO₂ Deadspace Level**
 - **Respirators previously approved**
 - **Measure CO₂ Deadspace Level at new test system**
 - **Using linear regression model, determine existing test system equivalent CO₂ Deadspace Level**
 - **If existing test system equivalent CO₂ Deadspace Level is less than 1.0%, a passing grade is assigned to the respirator tested**

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- **Test Procedure for Determining New Test System CO₂ Deadspace Level**
 - **New respirators**
 - **Use new test system**

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Questions?