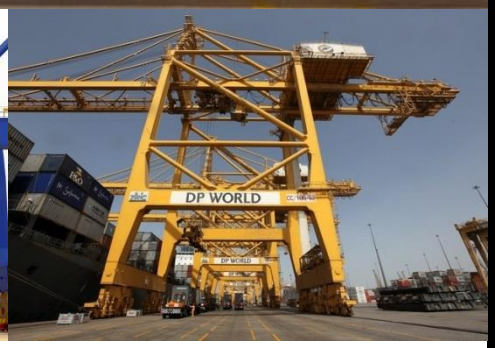
Cold-Plus® Performance Report



COLD-PLUS®

TESTING ANALYSIS AND REPORT OF FINDINGS

DP World, Refrigerated Warehouse; Dubai, UAE

January 17, 2017

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Cold-Plus® Testing Analysis and Report of Findings

DP World, Refrigerated Warehouse; Dubai, UAE

Data Collection: December 5, 2016 through December 27, 2016

Report date: January 17, 2017

Executive Summary

Under the direction and supervision of Professor Jenkins, Ph.D., PE, the following data was collected and analyzed from a cold storage warehouse supported by 5 Blitzer 6H-25.2 units located at the DP World Refrigerated Warehouse in Dubai, UAE. The data compares energy efficiency prior to, and after the injection of Cold-Plus®. Data was taken at one minute intervals for a period of 3 weeks and analyzed to measure the energy usage to keep the temperature constant in the room. For testing purposes, only three of the five Blitzer Units were running for the duration of the test. The other two units were taken out of service for the duration of this test. See Photo 1 showing the Blitzer Unit.

The data analysis concludes that there was a significant reduction of energy used per degree cooled in the system, with an energy reduction of 21.9% in the three units tested. This reduction in energy is a direct result of Cold-Plus®, which once injected caused a more efficient flow of the refrigerant and more efficient transfer of the cooling through the refrigeration system. This resulted in less compressor usage, particularly at peak periods, and supports the manufacturer's claim of significant energy savings and extension of life of the equipment after the injection of Cold-Plus®.

Analysis Review

Photo 1

The test protocol called for utilizing only 3 of the 5 compressors. These are defined as units 6, 7 and 9. The remaining two units remained off for the duration of the test. The protocol called for logging the following:

- Compressor amps
- Supply air (SA) temperature
- Supply air Relative Humidity percentage
- Return air (RA) Temperature
- Cold room temperature
- Temperature above cold curtain entrance
- Ambient air temperature.

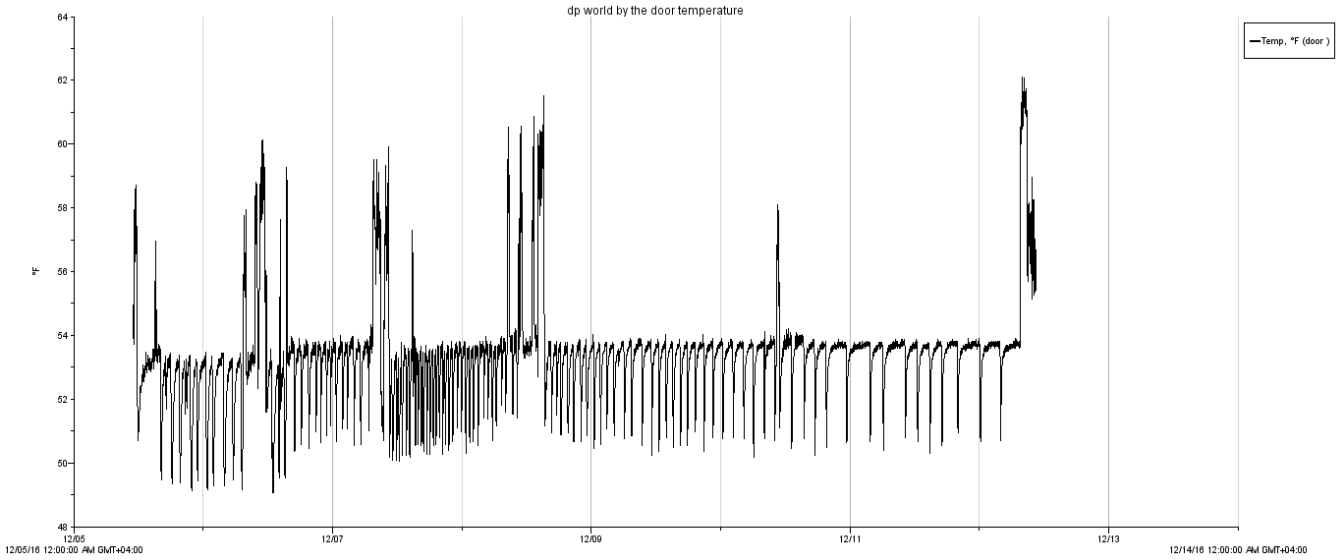
The test began December 5, 2016 and ended December 27, 2016. The methodology was:

- Utilize HOBO loggers to collect the information in three segments:
  - Obtain Baseline data for 7 days
  - Install Cold-Plus®
  - Operate the systems for approximately 7 days to allow the Cold-Plus® to complete installation
  - Obtain Post Injection data for an additional 7 days to log the results
- Utilize data from 24 hour periods when it is confirmed through the logging that the doors were not opened. Compare energy consumption on these days.

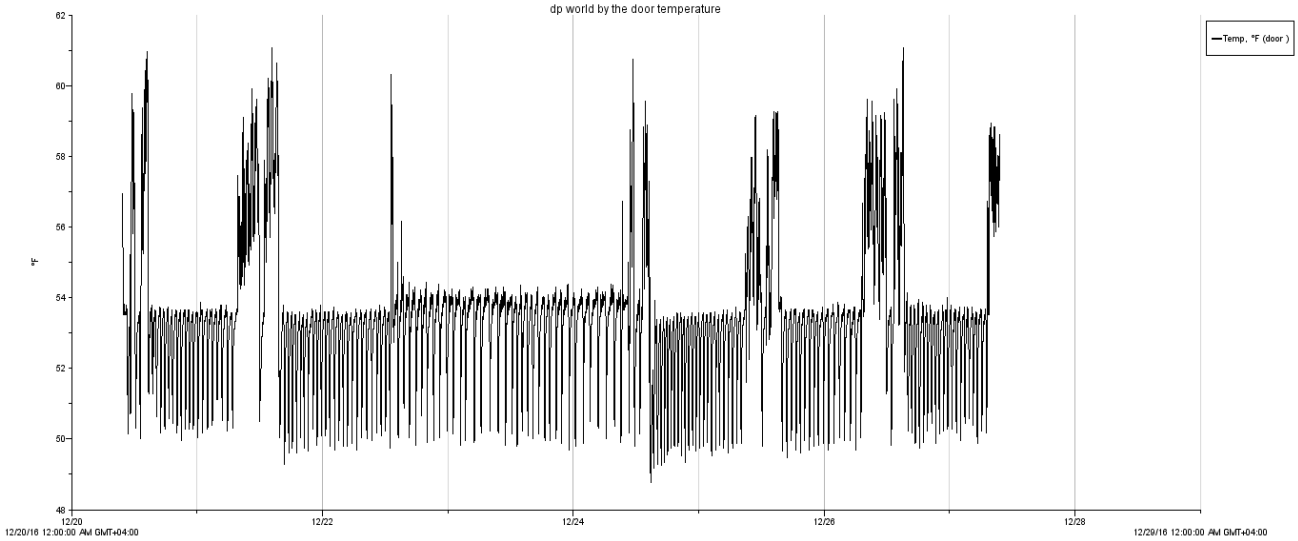
Data comparison is done determining the amps required to keep the room temperature constant while no door openings occurred. Comparing the values in the baseline with the last data period will give us the percent improvement in efficiency.

We used the temperature above the curtains to determine activity and heat introduction into the cold room.

The following is the baseline for the door temperature:



You can see that there are days with activity and days without activity during the baseline logging. Comparing this to the graph for after treatment we see the following:



You can see the activity in the post treatment (D4) is more intensive. Statistically the difference to base is:

	Cold Room Temp, °F	Door Temp °F	Door Open	Minutes Open	Avg Open Temp °F
Base: 12/5-12/12	50.57	53.35	7.0%	702.00	57.67
D4: 12/20-12/27	50.56	52.81	16.9%	1696.00	56.65
	0.00	0.53	-9.8%	-994.00	1.01

There is no difference in the cold room temperature, which indicates that the compressor activity is cooling the additional heat load from the door opening activity. The increase in door open time is 142% of the base number. Because of the random door openings, we made the side by side comparison based only on the days where no door activity occurred. That would use a 24-hour period on 12/09/2016 as the baseline and 12/23/2016 as the after (D4) comparison. This will eliminate the door opening variation completely and focus on compressor activity.

Analyzing the individual compressor activity for those days we see the following comparison:

Unit 6

	AC Curr, Amps	SA Temp, °F	RA Temp, °F	ΔT	Comp On	Minutes On	AmpsWf
Base: 12/9	4.94	48.10	50.54	2.43	33.6%	484.00	2392.55
D4: 12/23	4.25	48.93	50.38	1.45	28.7%	413.00	1753.53
	0.69	-0.83	0.16	0.99	4.9%	71.00	639.02

Unit 7

	AC Curr, Amps	SA Temp, °F	RA Temp, °F	ΔT	Comp On	Minutes On	Amps Wf
Base: 12/9	0.18	52.69	52.27	-0.42	0.6%	8.00	1.42
D4: 12/23	0.00	0.04	0.36	0.32	0.0%	0.00	0.00
	0.18	52.65	51.91	-0.74	0.6%	8.00	1.42

Unit 9

	AC Curr, Amps	SA Temp, °F	RA Temp, °F	ΔT	Comp On	Minutes On	AmpsWF
Base: 12/9	1.31	52.22	52.58	0.36	7.4%	107.00	140.65
D4: 12/23	1.62	52.33	52.73	0.40	9.7%	139.00	225.61
	-0.31	-0.11	-0.15	-0.04	-2.2%	-32.00	-84.96

Weighted Amps Baseline – 12/9		**Weighted Amps Post Injection 12/23**
Unit 6	2,392.55 Amps	1,753.53 Amps
Unit 7	1.42 Amps	0.00 Amps
Unit 9	140.65 Amps	225.61 Amps
Total	**2,534.62 Amps**	**1,979.14 Amps**

Combining all three units, the total amperage was reduced from 2,534 Amps Wf in the baseline period to 1,979 Amps Wf in the post injection period. **This is a reduction of 555.48 Amps Wf or 21.9%** used by the system to keep the room cooled to the same temperature.

Conclusions

This study concludes that a significant reduction of energy usage was achieved by the injection of Cold-Plus® into the (3) Blitzer 6H-25.2 compressors. The compressors used less amperage while running and, more importantly, they ran for fewer minutes. **This will result in 21.9% less electrical consumption**. The 21.9% reduction in energy consumption should also lead to a **significantly increased life of the equipment as a result of the compressors running less intensely and for fewer minutes to maintain the desired temperature**.

Professor Peter E. Jenkins, Ph.D., PE
CV attached

Peter E. Jenkins, Ph.D., P.E.
Professor, Mechanical Engineering Dept.
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Denver, Colorado 80217

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Summary

Extensive experience serving in administrative and management positions in both industry and academic institutions. Served as an officer of the University of Colorado Denver and of an advanced technology and manufacturing company with experience in administration, strategic and financial planning. Experience as senior contract officer dealing with U.S. and foreign industrial and government agencies. Academic and industry experience includes serving as Dean, Department Chair, Associate Department Chair, Executive Vice President, Chief Operating Officer, and Director of Engineering.

Successful experience dealing with government and industry institutions and have had success working and obtaining support from both political and industrial agencies. Enjoy outreach programs and working with the industrial and state political systems to obtain program support. Have extensive experience working with industry and government agencies to develop partnerships for technology transfer and for developing R&D programs.

Education

Ph.D. Purdue University, W. Lafayette, IN, 1974
M.S. Southern Methodist University, Dallas, TX, 1969
B.S. University of Kansas, Lawrence, KS, 1965
I.E.M. Harvard University, Cambridge, MA, 1994
M.B.A. Pepperdine University, Malibu, CA, 1986

Military Experience

United States Marine Corps: 1958-1963

Academic Experience

United States Naval Academy, Annapolis, ME

- Visiting Professor, Mechanical Engineering Dept, July, 2007- August, 2008
- Director, ONR Fuels Research Group

United States Air Force Academy, Colorado Springs, CO

- Distinguished Visiting Professor, Engineering Mechanics Dept., July 2004-May, 2006
- Director, Energy Research Center
- Member of UAV Research Program

United States Military Academy, West Point, NY
- Distinguished Visiting Professor, Civil & Mechanical Engineering. Dept.,
- July, 2002-June, 2003

University of Colorado Denver
- Special Assistant to the Vice Chancellor for Academic Affairs, 2002- July, 2002

Dean, College of Engineering & Applied Science, 1992-2002
- Professor of Mechanical Engineering, 1992-present
- Director, International Technology Transfer Program, 1993- 2002
- Director, Energy R&D Program, l992-2002

University of Nebraska-Lincoln, Mechanical Engineering Department, Lincoln, NE
- **Professor and Dept. Chair, 1986-1992**
- Director, Center for Engine Technology, 1986-1992

Texas A&M University, Mechanical Engineering Department, College Station, Texas
- **Assoc. Dept. Head, l980-l984**
- Professor, 1982-1984
- Associate Professor, 1978-1982
- Assistant Professor, 1975-1978
- Director, Turbomachinery Laboratory, 1978-1984

Northern Arizona University, Flagstaff, AZ
- Assistant Professor, 1974-1975

Professional Experience

Engine Corporation of America, Fullerton, CA
- Executive Vice President and Director of Engineering, 1984-1986

Texas Instruments, Inc., Dallas, TX
- Senior Design Engineer, 1966-1970

L.T.V. Vought Aeronautics, Dallas, TX
- Design Engineer, l965-66

Registration

Professional Engineer, Texas (39287)

Patents

Received five patents

Scientific and Professional Memberships

Colorado Society of Professional Engineers
President, Metro Chapter, 1996-1997
Member, Board of Directors, 1996-1998

American Society of Mechanical Engineering (ASME), Fellow, 1964-present
Member, Energy Committee, 1987-1988
Member, National Nominating Committee, 1981-1984

Member-at-large, Energy Resources Group, 1981-1986
Chairman, Technical Division, 1980-1981
Program Chairman, ASME Winter Annual Meeting, 1979
Member, Executive Committee, 1978-1982
Vice-chairman, Fluid Mechanics Section, 1975
Member, Gas Turbine Division, l978-present

American Institute of Aeronautics and Astronautics (AIAA), 1974-present
Terrestrial Energy Systems Technical Committee, 1978-1979

Society of Automotive Engineering (SAE), 1978-present
Chairman, National NGV Conference, 1991
Advisor, Univ. of Nebraska Student Chapter, 1987-1992
SAE Research Committee, 1993-1999
SAE ABET Committee, 1993-1999

National Society of Professional Engineers (NSPE), 1975-present
Education Committee Chairman, 1991

American Society of Engineering Educators (ASEE), 1974-present
Member, Energy Division
Associate Chairman, Summer Annual Conference, 1989

American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), 1976-present
Education and Research Committee, 1976-1978

Boy Scouts of America, 1976-present
Scoutmaster, Woodbadge Instructor and Commissioner

Honors and Awards

2008 Received Letter of Commendation for teaching at the three military academies from the Deputy Secretary of Defense, Gordon England.
2007 Appointed Visiting Professor, U.S. Naval Academy, Annapolis, MD.
2007 Selected as a Distinguished Alumni, University of Kansas
2004 Selected as a Distinguished Visiting Professor at the US Air Force Academy.
2003 Received the US Army's "Commander's Award for Outstanding Public Service", from the United States Military Academy, West Point, NY, May, 2003.
2002 Completed "ASCE EXCEED" Teaching Program at the U.S. Military Academy
2002 Selected as a Distinguished Visiting Professor at the US Military Academy, West Point, NY
2000 Selected as one of 50 participants in the Leadership Denver by the Denver Metro Chamber of Commerce.
1996 Elected President, Metro Chapter, Professional Engineers of Colorado
1994 Selected to attend the IEM program at Harvard University
1992 Elected to Tau Beta Pi Engineering Honorary Society
1991 Elected to the New York Academy of Sciences
1990 Invited to White House in Washington, DC to brief President Bush's staff on alternative fuels and engine technology

1990 Recipient of the University Outstanding Teaching Award, University of Nebraska-Lincoln.
1989 Hosted President Bush and three Cabinet members at the Center for Engine Technology at UNL.
Made technical presentation and gave tour of test facilities
1987 SAE Senior Teetor Award Winner
1985, 1988-1999 - Who's Who in America
1984 *Fellow*, American Society of Mechanical Engineers
1984 Received the National NUCEA Conferences and Institute Faculty Service Award
1983-1984 Appointed as a member of the Propulsion Committee for the National Research Council of the National Academy of Engineering
1983 Texas A&M University Faculty Distinguished Achievement Award
Member Pi Tau Sigma, Tau Beta Pi, Sigma Pi Sigma Outstanding Academic Societies

List of Significant Publications

1. Luo, H., Jenkins, PE., and Ren, Z. (2010) "*Concurrent desalination and hydrogen generation using microbial electrolysis and desalination cells"*. Submitted

2. Wang, W., Jenkins, PE., and Ren, Z*. (2010) "*Heterogeneous Corrosion Behavior of Carbon Steel in Water Contaminated Biodiesel". Submitted*

3. "*An Experimental Study of Synthetic Fuel Blends injected into a Rolls-Royce Model 250-C20B Turboshaft Gas Turbine*", by M.Cerza and P.E.Jenkins, presented at the ASME Turbo-Expo Conference, Glasgow, Scotland, June 14-18, 2010.

4"*M-Cycle Power System*", by P.E. Jenkins and V. Maisotsenko, presented at the HEFAT2010, Antalya, Turkey, July 19-21, 2010.

5. "*Carbon Nano-material Modified Air Cathodes for Improving Electricity Production in Microbial Fuel Cells*", presented at the American Chemical Society Meeting, March 21-25, 2010.

6. "*UCD Sports Engineering Program*" by P.E. Jenkins, A. Plaseied, and M. Khodaee, presented at the 8th Conference of the International Sports Engineering Association, Vienna, Austria, July 12-16, 2010. Published in the Procedia Engineering, Vol. 2, Issue 2, June 2010, pp.2757-2762.

7."*It's Not About The Bike*", by A. Plaseied, M. Khodaee, P.E. Jenkins, et.al, presented at the 8th Conference of the International Sports Engineering Association, Vienna, Austria, July 12-16, 2010. Published in the Procedia Engineering, Vol. 2, Issue 2, June 2010.

8. " *An Experimental Study on the Effects of Fisher-Tropsch (FT) Blends with Diesel #2 and JP-5 on the Performance of a Rolls-Royce Model 250-C20B Gas Turbine Engine*", presented at the ASME Turbo-Expo Conference, Orlando, FL, June 8-12, 2009.

9. "*Turbine Fuel Testing with Boron Nano-Particles*", by P.E. Jenkins, presented at the Naval Research Lab (NRL) Alternative Fuel Workshop,Washington, D.C., July 19-20, 2007.

10. "*The Impact of Sulfur Free Diesel Fuel on Lubricity and Contamination*", by P.E. Jenkins

and M. Tal, presented at the British Institution for Mechanical Engineers (with Honors) – published in the Total Vehicle Technology Conference, Sussex, England, April 26-28, 2004.

11. "Reversed Brayton Cycle Gas Turbine", by P.E. Jenkins, presented at the 2nd International HEFA Conference, Victoria Falls, Zambia, Africa, June 23-26, 2003.

12. "*Conversion/Training of High Tech Labor Resources*", by D. Ferrigno and P.Jenkins, presented at the 2nd European Systems Engineering Conference", Munich, Germany, September 13-15, 2000.

13. *"A New Micro-Gas Turbine Engine*," by P.E. Jenkins, presented at the ASME Gas Turbine Conference, Munich, *German*, May 8-11, 2000..

14. *"Insulating Techniques and Radiation Characteristics of Materials in Advanced Engine Designs*," by P.E. Jenkins, for EPA, Ann Arbor, MI, June 3, 1997, 41 pages.

15. *"High Temperature Materials Study for Advanced Engine Designs*," by P.E. Jenkins, for EPA, March 25, 1997, Ann Arbor, MI, 47 pages

16 *"International Technology Transfer Programs*," by P.E. Jenkins, U.S. Dept. of Energy Conference on Environmental Opportunities in Mexico and the Border Countries, Washington, DC, June 20-21, 1994, pp. 131-146.

17. "*Derivation of a Tumble Number for Accidents Involving Pedestrians,"* by W.M. Szydlowski and P.E. Jenkins, SAE Technical Paper No. 933660, presented at the 1993 SAE International Congress & Exposition, Detroit, MI, March 1-5, 1993.

18. *"Performance Analysis of a Spark Ignited Engine with ETBE as a Blending Agent,"* by P.E. Jenkins, Y.S. Cho and B. Kim, SAE Technical Paper No. 901520, presented at the Future Transportation Technology Conference, San Diego, CA, August 14-16, 1989.

19. *"Performance Analysis of SI Engines with Ethyl Testiary Butyl Ethers (ETBE) as a Blending Component in Motor Gasoline and Comparison with other Blending Components,"* by C. Baur, B. Kim, P.E. Jenkins and Y.S. Cho. Proceedings for the 1990 Intersociety Energy Conversion Conference, Vol. 4, pp. 337-342, August 12-17, 1990, Reno, NV.

20. *"Performance Characteristics of a Multiple-Disk Centrifugal Pump,"* by R. Roddy, G. Morrison and P.E. Jenkins, Paper No. 1949-WT, published in the ASME Transaction, *Journal of Fluids Engineering*, March 1987, Vol. 109, pp. 51-57.

21. *"Flowfield and Performance Measurements in a Vaned Radial Diffuser,"* by J.C. Dutton, P. Piemsombon and P.E. Jenkins, Paper No. 84-WA/FM-7, published in ASME Transaction, *Journal of Fluids Engineering*, June 1986, Vol. 108, pp. 141-147.

22. *"Analysis of Component Power Losses in Centrifugal Pumps,"* by W.W. Peng and P.E. Jenkins, presented at the Symposium on the Performance Characteristics of Hydraulic Turbines and Pumps, ASME Winter Annual Meeting, Boston, MA, November 1983, ASME *Journal of Fluids*, 1988.

23. *"Heat Transfer and Film Cooling with Steam Injection through an Inclined Hole over a Flat Plate,"* by J. Han, H. Chan and P.E. Jenkins, ASME-AICHE National Heat Transfer Conference, 83-HT-9,

Seattle, WA, July 1983.

24. *"Film Cooling with Steam Injection through Three Staggered Rows of Inclined Holes over a Straight Airfoil,"* by G. Conklin, J. Han and P.E. Jenkins, ASME International Gas Turbine Conference, 83-GT-30, March 1983.

25. *"A Fluidized-bed Combustion Heat Transfer Model using Finite Elements,"* by P.E. Jenkins and T.W. Richardson, ASME 82-GT-169, 1982.

26. *"The Prediction of Film Cooling Effectiveness of Steam,"* by J. Han and P.E. Jenkins, ASME 82-GT-100, 1982.

27. *"Comparison of the HTTT Reheat Gas Turbine Combined Cycle with the HTTT Non-Reheat Gas Turbine Combined Cycle,"* by I.G. Rice and P.E. Jenkins, Paper No. 81-GT-69, published in the ASME Transaction, *Journal of Engineering for Power*, 1981, Vol. 194, pp. 129-142.

Research Projects

2010 - Efficient Energy Production, Desalination and Waste Treatment in Bioelectrochemical Systems, $250K funded (2 years).
- Low-Energy Desalination and Electricity Generation in Bioelectrical Systems, funded by ONR, $99,433 (2 years).

2010 - USNA-ONR Alternative Fuel Testing, funded by ONR, $44K (1 year).

2009 - MFC Fuel Cell Program, funded by ONR, $450K (3 years).

2009 -USNA-ONR - JP5/FT Engine Alternative Fuel Testing Program, Phase I&2, $49K (Program funded by ONR)

2008 - USNA Alternative Fuel Gas Turbine Testing Program, ONR, $209,800 (Funded)

2007 - USNA Synthetic Fuel Development and Testing Program, ONR, $179,900 (Funded).

2005-06- Cadet Energy Research Training Program, US Air Force, $5.3M (proposed)
- Heavy-Fuel Engine for Small UAV Initiative, US Air Force, $532K (Funded)
- IED Detection: Acoustic Imaging, DoD, $2.2M (Funded)
- Technology Impact Analysis, DoD IED Program, $350K (Funded)

2005 - Director, US Air Force Academy Energy Research Center, $48,731 (Funded)

2004 - US Air Force Academy, Colorado Springs, CO, IPA, $146,000 (Funded)

2004 - *Clean Diesel Training Program*, FEV Engine Technology Corp, Auburn Hills, MI, $10,000 (Funded).

2002 - US Military Academy, West Point, NY, $142,000 (Funded)

2000 - *Retraining Instruction for Telecommunications & Computer Scien*ce, Raytheon Company, $450,000 (Funded)

1999 - *Retraining Instruction for Telecommunications & Computer Science*, US WEST, $2,185,000 (Funded)
- *Lowry Engineering Program*, $125,000/yr, Colorado Commission on Higher Education

1998 - *Tetherless T3 and Beyond* Workshop, National Science Foundation, $50,000 (Principal Investigator)

1997 - *Applying Educational Technologies to Undergraduate Engineering Programs*, Colorado Commission on Higher Education, $169,000 (Principal Investigator).
- *Lowry Engineering Program*, CCHE, $259,000 (Renewed).

1996 - *Lowry Engineering Program*, Colorado Commission on Higher Education, $259,000 (Principal Investigator)
- *Distance Learning Course Development*, Colorado Commission on Higher Education, $169,000 (Principal Investigator)

1995 - *Electronic Delivery Program*, U.S. GSA, $159,000 .
- *Distance Learning Program*, Colorado Commission on Higher Education, $29,000.
1994 - *Project Colorado – Service to the Citizen*, U.S. Postal Service, $39,400.
1992-1993 - *International Technology Transfer Program*, University of Colorado, $30,000.
1990-1991 - *Alternative Fuel Research Program*, Nebraska Energy Office with several industries, $856,740.
1989-1990 - *Small Cogeneration System Development*, Tahoe/Cogentech Corp., $498,000 (Phase II).
- *Rotary Engine Development for RPV*, U.S. Navy/CSA Corp., $50,000 (Phase I).
1988-1989 - *Small Engine Development/Demonstration Program*, JKR Technology Co./Ssangyong Motor Co., $350,000 (Phase I).
- *Small Cogeneration System Development Program*, Tahoe/Cogentech Corp., $250,000 (Phase I).
- *Metal Vapor Turbine-Alternator Development Program*, Space Power, Inc.,/U.S. Department of Defense, $55,000 (Phase I).
1987-1988 - *Packaged Rotary Cogeneration Development Program*, Power Systems Corporation/John Deere Inc., $220,000/yr.
1987 - *Hydrogen Injection Studies in a Cummins Diesel Engine*, Dual-Dynamics Corporation, $15,000.
1986-1987 - *Diesel Roto-Compound Engine Demonstration Program*, Engine Corporation of America/General Motors, $39,000 (Phase I).