DOE FreedomCAR and Vehicle Technologies Program
Advanced Power Electronics and Electrical Machines
Annual Review Report

Pollard Technology Center
Oak Ridge, Tennessee
May 3-5, 2005

Prepared by Oak Ridge National Laboratory

June 16, 2005

Table of Contents

DOE FreedomCAR and Vehicle Technologies Program Annual Review
Of Advanced Power Electronics and Electrical Machines
May 3–5, 2005: Attendees, RSVP Yes-Not Attended, Live Meeting, Walk-ins

NAME	COMPANY	Attendance
Adams, Donald J.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Anderson, Iver E.	Ames Laboratory	Tuesday-Wednesday-Thursday
Ayers, Curtis W.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Balachandran, Uthamalingam	Argonne National Laboratory	Thursday
Beatty, Brad L.	U.A. Air Force Research Laboratory	Tuesday-Wednesday-Thursday
Bharathan, Desikan	National Renewable Energy Laboratory	Tuesday-Wednesday-Thursday
Brown, Marilyn	Oak Ridge National Laboratory	Thursday
Callison, Gerald R.	Oak Ridge National Laboratory/ORISE	Tuesday
Campbell, Jeremy B.	Oak Ridge National Laboratory	Thursday
Campbell, Steven L.	Oak Ridge National Laboratory/ORISE	Tuesday-Wednesday-Thursday
Cha, Yung S.	Argonne National Laboratory	Tuesday-Wednesday
Chiasson, Prof.	University of Tennessee-Knoxville	Wednesday-Thursday
Chinthavali, Madhu	Oak Ridge National Laboratory/ORISE	Tuesday-Wednesday
Coomer, Chester L.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Day, Scott D.	Rockwell Automation	Tuesday-Wednesday-Thursday
Draine, Jan M.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Duong, Tien Q.	U.S. Department of Energy	Tuesday-Wednesday-Thursday
Fessler, Raymond R.	BIZTEK Consulting, Inc.	Tuesday-Wednesday-Thursday
Fiegenschuh, Karl F.	Ford Motor Company	Tuesday-Wednesday-Thursday
Fox, Edward C.	Oak Ridge National Laboratory	Tuesday
Gallego, Nidia C.	Oak Ridge National Laboratory	Tuesday
Gambrell, Kathleen P.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Garg, Vijay K.	Ford Motor Company	Tuesday-Wednesday-Thursday
Grostick, Ed T.	Oak Ridge National Laboratory	Tuesday-Wednesday
Hagey, Graham L.		Tuesday-Wednesday-Thursday
Hassani, Vahab	National Renewable Energy Laboratory	Tuesday-Wednesday-Thursday
Hsu, John S.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Jahns, Thomas M.	University of Wisconsin-Madison	Tuesday-Wednesday
Jallouk, Philip	Oak Ridge National Laboratory	Walk-in T-W(am)-TH(am)
Jih, Edward	Ford Motor Company	Live Meeting/Webcast
Jordan, Brett A.	United States Air Force	Tuesday-Wednesday-Thursday
Kang, Xiaosong	Eaton Corporation	Tuesday-Wednesday
Kaufman, David Y.	Argonne National Laboratory	Thursday
Kendrick, Lumas, Jr.	Sentech, Inc.	Tuesday-Wednesday-Thursday
Killough, Joseph	Knolls Atomic Power Laboratory, Inc.	Walk-in, Tuesday-Wednesday
King, Thomas J., Jr.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Kramer, Matt	Iowa State University	RSVP Yes-No Show
Lai, Jih-Sheng (Jason)	Virginia Tech	Tuesday-Wednesday-Thursday
Lanagan, Michael T.	Penn State University	Tuesday-Wednesday-Thursday
Lara-Curzio, Edgar	Oak Ridge National Laboratory	Wednesday
Lee, Anson	Chrysler	Live Meeting/Webcast
Liang, Fang	Ford Motor Company	Live Meeting/Webcast
Lin, Wayne C. (for Mary Rawlins)	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Lloyd, Michael W.	Energetics, Inc.	Tuesday-Wednesday-Thursday
Lutz, Jon F.	UQM Technologies, Inc.	Tueday-Wednesday
Marlino, Laura D.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
McCluskey, Francis Patrick	University of Maryland	Tuesday-Wednesday-Thursday

McCallum, Ralph W. (Bill)	Ames Laboratory/Iowa State University	Tuesday-Wednesday-Thursday
McKeever, John W.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Mehall, Mark S.	Ford Motor Company	Tuesday-Wednesday-Thursday
Miller, John M.	J-N-J Miller Design Services, PLC	Tuesday-Wednesday-Thursday
Montemarano, Jean	Naval Surface Warfare Center	Live Meeting/Webcast
Narumanchi, Sreekant V. J.	National Renewable Energy Laboratory	Tuesday-Wednesday-Thursday
Nelson, Samuel C., Jr.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Olszewski, Mitchell	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Olszewski, Pamela J.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Otaduy, Pedro J.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Ott, George W., Jr.	Oak Ridge National Laboratory	Wednesday
Ozpineci, Burak	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Peng, Fang Z.	Michigan State University	Tuesday-Wednesday-Thursday
Penney, Terry	National Renewable Energy Laboratory	T-W-TH, Replaced T. Hendricks
Richardson, Brian	Power Investments/Remy Int'l, Inc.	Tuesday-Wednesday-Thursday
Rogers, Susan A.	U.S. Department of Energy	Tuesday-Wednesday-Thursday
SantaBarbara, Louis	Knolls Atomic Power Laboratory, Inc.	Walk-in, Tuesday-Wednesday
Schiferl, Richard F.	Rockwell Automation	Tuesday-Wednesday
Scofield, James D.	USAF Research Laboratory	Tuesday-Wednesday-Thursday
Scudiere, Matthew B.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Seiber, Larry E.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Smith, Greg	General Motors – ATV	RSVP Yes-Live Meeting instead
Smith, Richard L.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Snead, Richard	Oak Ridge National Laboratory	RSVP Yes-No Show
Staunton, Robert H.	Oak Ridge National Laboratory	Tuesday-Wednesday
Stinton, David P.	Oak Ridge National Laboratory	Thursday
Su, Gui-Jia	Oak Ridge National Laboratory	Tuesday-Thursday
Sullivan, Rogelio	U.S. Department of Energy	Wednesday-Thursday
Taher, Mahmoud A.	Caterpillar, Inc.	RSVP Yes-No Show
Tang, Lixin	Oak Ridge National Laboratory/ORISE	Tuesday-Wednesday
Taylor, Samuel P.	National Energy Technology Laboratory	RSVP Yes-No Show
Thompson, Brian E.	University of Ottawa	Tuesday-Wednesday-Thursday
Tolbert, Leon M.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Tuttle, Bruce A.	Sandia National Laboratory	Thursday
Welchko, Brian A.	General Motors – ATV	Tuesday-Wednesday-Thursday
Weimer, Joseph A.	U.S. Air Force	RSVP Yes-No Show
Wereszczak, Andrew A.	Oak Ridge National Laboratory	Wednesday-Thursday
Wiles, Randy H.	Oak Ridge National Laboratory	Tuesday-Wednesday-Thursday
Wilson, David L.	Freescale Semiconductor	Tuesday-Wednesday-Thursday
Ziegler, Richard	Sentech, Inc.	Tuesday-Wednesday-Thursday
Zolot, Matt	National Renewable Energy Laboratory	Walk-in, Tuesday-Wednesday-TH

FreedomCAR and Vehicles Technologies Program Annual Review Live Meeting Report - May 3-5, 2005

Reservation Size	10
Maximum Simultaneous Connections	6

Activity Day	Name	Company	Role	Arrived	Duration (HH:MM:SS)
5/3/2005	Al Hefner - hefner@nist.gov	nist	Attendee	5/3/2005 8:43	5:28:39
5/3/2005	anson lee - al14@dcx.com	daimlerchrysler	Attendee	5/3/2005 13:13	0:39:02
5/3/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/3/2005 15:22	0:26:51
5/3/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/3/2005 14:33	0:18:25
5/3/2005	ashtiani - cna@dcx.com	DaimlerChrysler	Attendee	5/3/2005 9:47	0:38:18
5/3/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/3/2005 12:36	2:16:39
5/3/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/3/2005 8:44	2:34:53
5/3/2005	feng liang - fliang1@ford.com	Ford Motor company	Attendee	5/3/2005 13:00	0:00:34
5/3/2005	feng liang - fliang1@ford.com	Ford Motor company	Attendee	5/3/2005 13:12	1:52:28
5/3/2005	feng liang - fliang1@ford.com	Ford Motor company	Attendee	5/3/2005 9:58	1:57:45
5/3/2005	jean montemarano - montemaranoja@nswccd.navy.mil	NSWCCD	Attendee	5/3/2005 13:14	3:01:31
5/3/2005	jean montemarano - montemaranoja@nswccd.navy.mil	NSWCCD	Attendee	5/3/2005 8:55	2:23:09
5/3/2005	Kathy Gambrell - gambrellkp@ornl.gov	ornl	Presenter	5/3/2005 7:13	9:26:02
5/4/2005	Al Hefner - hefner@nist.gov	nist	Attendee	5/4/2005 9:29	5:26:40
5/4/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/4/2005 11:49	0:00:24
5/4/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/4/2005 14:14	0:32:37
5/4/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/4/2005 10:55	0:37:20
5/4/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/4/2005 9:39	0:41:39
5/4/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/4/2005 12:50	0:29:40
5/4/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/4/2005 9:05	2:37:08
5/4/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/4/2005 13:14	1:38:55
5/4/2005	feng liang - fliang1@ford.com	Ford Motor company	Attendee	5/4/2005 14:48	0:18:37
5/4/2005	feng liang - fliang1@ford.com	Ford Motor company	Attendee	5/4/2005 10:13	0:17:10
5/4/2005	jean montemarano - montemaranoja@nswccd.navy.mil	NSWCCD	Attendee	5/4/2005 9:26	2:14:06
5/4/2005	jean montemarano - montemaranoja@nswccd.navy.mil	NSWCCD	Attendee	5/4/2005 12:50	3:48:29
5/4/2005	Kathy Gambrell - gambrellkp@ornl.gov	ornl	Presenter	5/4/2005 7:35	9:03:05
5/5/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/5/2005 10:08	0:19:01
5/5/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/5/2005 10:52	0:19:01
5/5/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/5/2005 12:38	0:34:20
5/5/2005	Anson Lee - al14@dcx.com	daimlerchrysler	Attendee	5/5/2005 11:26	0:24:28
5/5/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/5/2005 9:03	2:34:44
5/5/2005	Edward Jih - cjih@ford.com	Ford Motor Company	Attendee	5/5/2005 12:47	1:27:49
5/5/2005	jean montemarano - montemaranoja@nswccd.navy.mil	NSWCCD	Attendee	5/5/2005 8:40	5:39:28
5/5/2005	Kathy Gambrell - gambrellkp@ornl.gov	ornl	Presenter	5/5/2005 7:19	6:56:32

Evaluation Form Results

DOE FreedomCAR and Vehicle Technologies Program Annual Review
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May 3-5, 2005

16 forms were collected during the 3-day period. The results are as follows.

How satisfied are you:

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
with the quality of the overall event?	8	7	1		
with the scope of information presented?	6	7	2	1	
with the usefulness of the information?	5	8	3		
with the quality of the presentations?	6	9	1		
with the overall review format's emphasis on research?	4	9	3		
that you had sufficient time to network and share ideas with the presenters?	8	7		1	
with the amount of time dedicated to questions and discussion?	10	4		1	
with the review's overall value in helping you improve your understanding of the FreecomCAR and Vehicle Technologies Program	6	8	2		
that you would attend another review in the future?	8	7	1		

Comments:

- Very informative. I have a much broader understanding of the issues affecting the FreedomCar Program.

- It would be helpful to have presentations loaded to USCAR prior to the review – we can involve our specialists more rapidly. CD rather than books would be great.
- Great facilities and people. Thanks to Kathy, Jan, and Pam and all the folks behind the scenes.
- Presentation pro forma was good. Liked presentations that spent 10% to 20% on project plan and 10% to 20% on metrics/gaps and remainder of time on deliverables/results/challenges.
- Drive analysis and correlation rather than empirical.
- Cost is a metric and we must address!
  - At least estimate material cost
  - Compare and contrast to other devices for MFG/ASSY cost

- Support activities need not report.
- Reviewers and DOE should meet to discuss (briefly) process improvement at the end.

- Well run program. Not technical or organizational issues. Time well spent. Kudos to staff at ORNL. Much better than past reviews.

- Much better organized than last year.

- Excellent presentations, questions, and format. Good scope of topics. Fine facilities and format. Excellent and helpful staff.

- Three days is a big commitment for my time. I prefer one day or two days. Internet access on site is a bit plus. All presentation materials are well prepared.

- Need more attendance of industry representatives.

- Some research appears not to be interfaced (tied-in) to industry involvement (e.g., ORNL motor R&D).
- Most research does not identify estimated completion data and success-failure criteria.
- The overall R&D effort and the Annual Review could benefit from a detailed systems overview relating FreedomCAR goal and the system/components trade-offs. What are vehicle powertrain system attributes?
- There is insufficient R&D emphasis on long-term (fuel cell vehicle) R&D (DOE role).
- Systems analysis is a major shortcoming of the program. As such, there is not logic or basis for the selected R&D. What are the priorities? What rationale determines the funding allocation?
- The R&D is primarily focused on ICE hybrids instead of future fuel cell vehicles. Benchmarking is looking at technology (Prius) which is "past-tense" and does not adequately represent state-of-the-art Benchmarking is playing "catch-up." Toyota 2006 hybrid technology will "leap-frog" the Prius and Prius data provides inadequate reference for FreedomCAR R&D.

- Great job.

- A team spirit prevailed at this review. Interchange was excellent. There were many useful contacts. It was good to see the progress made since the last review.
- The review was too long. Could we limit it to 2 days?
- The format was good – it forced the presenters to focus on our research purpose.

- Explanation of research plan will be very useful. Almost every one talked about DOE FreedomCAR goals and mentioned about cost, ESR, temperature, etc. Every one made the standard "motherhood" statement – saying they are addressing all the issues, but none explained how they will actually do it. Examples: How will they increase ripple current? No explanation was given.

- There appears to be duplication of work done in other universities and research centers at ORNL in advanced motor research.
  Corona inception testing – was done by Rockwell Automation in the 1990s.
  Salient pole PM motors optimization was investigated by UW Madison and U. of Glasgow SPEED in the 1980s.
  I suggest more literature searches in this area before "reinventing the wheel."
- I like the work on PM material thermal cycling test and life tests (Edgar @ ORNL). The question of PM material degradation over time in applications is an important topic.

- Need much more emphasis on hybrid vehicles systems research. The emphasis instead was on hybrid vehicle components, with pretty pictures or Prius parts. As a Prius owner myself, I found this entertaining, but if we are seriously wanting fuel-efficient vehicles, we need to expand the scope of

the research. Here are some examples:

Are there better ways to combust the fuel?
When to use series mode propulsion vs. parallel mode propulsion, and why?
Optimal control algorithms to couple electric motor to combustion motor.
Investigation of other gas saving systems, such as electric power steering.
Optimum transmission topologies (CVT, planetary gears, etc.).

- Excellent job by conference arrangers!
- There is a notable

  Lack of focus on the system level issues for automobiles.
  We need a “changing set of goals” as more and more information becomes available on all fronts.

- Very good event.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Summary of Reviewers' Ratings (grouped by research area)

Project	Presenter	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Component Development					
Component Chracterizations	Larry Sieber				
Average Tech Team		6.7	2.3	3.9	2.4
Average Other		7.3	3.3	2.3	3.3
Average Overall		6.9	2.6	3.4	2.7
Glass Ceramic Dielectrics for DC Bus Capacitors	Mike Lanagan				
Average Tech Team		6.1	1.1	1.0	1.3
Average Other		8.0	3.5	3.5	3.3
Average Overall		6.8	2.0	1.9	2.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	David Kaufman				
Average Tech Team		8.9	4.0	3.9	3.0
Average Other		7.7	3.3	3.7	3.3
Average Overall		8.5	3.8	3.8	3.1
Polymer Film and Nano-Dielectric Capacitors	Bruce Tuttle				
Average Tech Team		8.0	2.7	1.3	1.3
Average Other		8.0	3.8	3.6	3.6
Average Overall		8.0	3.1	2.1	2.1
Electric Machines					
Electric Motor Research & Development	John Hsu				
Average Tech Team		9.4	4.0	1.6	1.3
Average Other		8.8	4.0	3.6	3.3
Average Overall		9.2	4.0	2.3	2.0
Flux Weakening and CPSR Enhancement Techniques	John McKeever				
Average Tech Team		8.7	3.8	3.2	3.0
Average Other		9.3	3.5	3.9	3.3
Average Overall		9.0	3.8	3.3	3.1
Permanent Magnets					
Characterization of Capacitor Materials	Andy Wereszczak				
Average Tech Team		8.0	3.1	3.7	3.7
Average Other		7.3	3.7	3.7	3.3
Average All		7.8	3.3	3.7	3.6
Development of Improved Powder for Bonded Permanent Magnets	Iver Anderson				
Average Tech Team		8.7	4.0	3.3	3.0
Average Other		8.7	3.7	3.7	4.0
Average Overall		8.6	3.9	3.5	3.4
Low Cost, High-Energy-Product Permanent Magnets	Yung Cha				
Average Tech Team		6.0	1.2	2.0	1.2
Average Other		8.5	3.3	3.0	3.3
Average All		7.0	2.0	2.4	2.0
Characterization of PM Materials	Edgar Lara-Curzio				
Average of Tech Team		9.0	4.0	1.2	2.0
Average of Other Reviewers		NA	NA	NA	NA
Average All Reviewers		9.0	4.0	1.2	2.0

Project	Presenter	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Power Electronics					
AIPM Validation Testing	Sam Nelson				
Average Tech Team		8.6	3.7	3.1	3.0
Average Other		9.3	3.3	3.0	3.6
Average Overall		8.8	3.5	3.1	3.2
Benchmarking Competitive Technologies	Bob Staunton				
Average Tech Team		9.1	4.0	2.3	2.6
Average Other		8.5	3.0	3.0	2.8
Average Overall		9.0	3.7	2.5	2.6
Integrated DC/DC Converter for Multi-Voltage Bus System	Gui-Jia Su				
Average Tech Team		5.1	1.6	1.7	2.7
Average Other		8.8	3.5	3.4	3.3
Average Overall		6.5	2.3	2.3	2.9
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Gui-Jia Su				
Average Tech Team		5.9	2.0	2.9	2.7
Average Other		8.3	3.0	3.0	3.1
Average Overall		6.7	2.4	2.9	2.9
Wide Bandgap Materials	Burak Ozpineci				
Average Tech Team		9.6	4.0	4.0	3.9
Average Other		7.8	3.4	3.8	4.0
Average Overall		8.8	3.8	3.9	3.9
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Fang Peng				
Average Tech Team		8.1	2.9	4.0	3.3
Average Other		8.3	3.8	3.6	3.8
Average Overall		8.2	3.2	3.9	3.5
Thermal Control and Systems					
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Curt Ayers				
Average Tech Team		8.0	2.9	3.0	2.3
Average Other		7.6	3.2	2.6	2.6
Average Overall		7.8	3.0	2.8	2.4
Inverter Packaging	John Hsu				
Average Tech Team		8.0	3.7	3.0	2.3
Average Other		7.0	3.5	3.0	3.0
Average Overall		7.8	3.6	3.0	2.7
Low Thermal Resistance IGBT Structure	Vahab Hassani				
Average Tech Team		7.9	3.3	2.6	2.0
Average Other		7.3	3.8	3.8	2.8
Average Overall		7.8	3.5	3.0	2.4
Modeling High Heat Flux Heat Removal: Jet Impingement	Sreekant Narumanchi				
Average Tech Team		7.8	3.2	2.8	2.3
Average Other		7.3	3.5	3.0	3.0
Average Overall		7.4	3.3	2.7	2.4
Modeling High Heat Flux Heat Removal: Spray Cooling	Desikan Bharathan				
Average Tech Team		7.3	2.9	1.4	1.3
Average Other		7.0	3.0	2.8	2.4
Average Overall		7.2	3.0	1.8	1.6
Study on Prius Motor Temperature Rise and Ratings	John Hsu				
Average Tech Team		9.0	3.7	2.7	2.6
Average Other		9.0	3.8	3.8	3.8
Average All		9.0	3.7	3.1	3.0

Project	Presenter	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Other					
Power Electronics Crosscut Activities for EERE and OETD	Richard Smith				
Average Tech Team		3.1	2.3	2.7	2.1
Average Other		8.0	3.3	3.3	3.0
Average All		4.6	2.6	2.9	2.4

Rating Descriptions

Relevance to overall DOE objectives and mission (long-range, high-risk R&D for Advanced Power Electronics & Electric Machinery) to achieve FreedomCAR goals.

4 – Outstanding. *The project is sharply focused on one or more key technical barriers to the development of advanced power electronics and electric motors.*
3 – Good. *Most aspects of the project will contribute to significant progress in overcoming these barriers.*
2 – Fair. *Some aspects of the project may lead to progress in overcoming some barriers.*
1 – Poor. *The project is very unlikely to make significant contributions to overcoming the barriers*.

Approach to performing the research and development

4 – Outstanding. *It is difficult for the approach to be improved significantly.*
3 – Good. *The approach is generally well thought out and effective, but could be improved in a few areas.*
2 – Fair. *The approach has significant weaknesses.*
1 – Poor. *The approach is not responsive to the project objectives.*

Technical Accomplishments and Progress toward project and DOE goals (Advanced Power Electronics and Electrical Machinery)

4 – Outstanding. *The project has made excellent progress toward overcoming one or more key technical barriers to development of advanced power electronics and electric motors.*
3 – Good. *The project has shown significant progress toward overcoming barriers.*
2 – Fair. *The project has shown a modest amount of progress in overcoming barriers, the overall rate of progress has been slow.*
1 – Poor. *The project has demonstrated little or no progress toward overcoming the barriers.*

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Comments (grouped by title/presenter)

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
AIPM Validation/Testing					
Presenter: Nelson, Sam *Reviewer: Anson Lee*	Mandatory step in research.	Great Approach.	Good progress, test, and validation is near completion.		
Reviewer: Brian Welchko			Project has wrapped up.		
Reviewer: Edward Jih and Tech Team (OEM)					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith			Project has wrapped up.		
Reviewer: James Scofield	Compact, efficient inverters for traction drives a key component for EV and HEV.	Higher rating would require inclusion of reliability assessment, thermal cycling, and elevated T considerations.	Efficiency evaluation very good work. Validate pgm. goal metrics and highlight areas remaining for concentrated effort. Power/vol metric unlikely to be achieve without increased temp capability.		
Reviewer: Jason Lai	Unfortunately, it's not in-house development. Lots of details are missing.	Need to know more fundamentals and characteristics of inverter control and packaging, not just testing.	Experimental results have been obtained, although there are some more questions that need to be answered.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
AIPM Validation/Testing					
Presenter: Nelson, Sam					
Reviewer: John M. Miller	Very relevant and good description of test methodology.	Excellent tech approach	Project shows good agreement with FreedomCAR goals , or getting closer, so progress is very respectable.	Would be very insightful to see the impact of testing this same AIPM at 650V and at 800V provided power stage electronics were available. Then how would the resulting metrics compare with those measured here at 325Vdc and 402Vdc.	
Reviewer: K Fiegenschuh	Successful development of a power inverter that can meet the goals of the FreedomCAR program is a key enabler that supports the viability of future fuel cell and hybrid vehicles. Once prototype inverters have been developed, it is important that a competent and unbiased facility test all inverters to determine their ability to meet the program targets.	Project is wrapping up.	ORNL has done a good job of testing the power inverters developed through the APEEM program, working closely with the AIPM manufacturers to get the hardware, resolve hardware problems and thoroughly test the devices.		
Reviewer: M. Mehall			Nice reporting of actual results to goals.		
Reviewer: Pat McCluskey	Confirmation that SemiKron module meets targets of AIPM in PNGV is good, but, 1) Does it meet new targets of FreedomCAR? 2) Since it meets AIPM/PNGV will it now be accepted and integrated into automobile? 3) What are suggestions for moving it into the marketplace?	Good performance characterization, need more characterization of long-term reliability in automotive applications.	Good characterization of the critical parameters of the SemiKron inverter. Good confirmation of its meeting the targets of AIPM for PNGV.	Long-term reliability of SemiKron AIPM for automotive environment. Analysis of new development needed to meet new FreedomCAR goals.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
AIPM Validation/Testing					
Presenter: Nelson, Sam					
Reviewer: Vijay Garg					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Benchmarking of Competitive Technologies					
Presenter: Staunton, Robert *Reviewer: Anson Lee*	Highly relevant project.	Good approach - testing could be more centralized.	Good results.	Continue benchmarking other advanced systems.	
Reviewer: Brian Welchko	Benchmarking provides important feedback.	This is a very fractured approach with work being done an ANL, UT, and ORNL. The new personnel which have been added seem questionable as this does not seem to be an area of expertise for them.	I was hoping for better results. What has been presented is pretty basic for the money and effort which was spent.		The idea of benchmarking is to provide a complete picture of the competition and place the information in the public forum where we can all learn from it. Unfortunately, many questions I have were not answered.
Reviewer: Edward Jih and Tech Team (OEM)		Fragmented testing (because of testing facilities at different places which requires a well coordinated effort).	Comparing technology used in Prius converter/inverter to Z-source converter/inverter is an excellent idea (slide 14).		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Benchmarking provides important feedback.	This is a very fractured approach with work being done at ANL, UT, and ORNL. The new personnel who have been added seem questionable as this does not seem to be an area of expertise for them.	I was hoping for better results. What has been presented is pretty basic for the money and effort which was spent.		The idea of benchmarking is to provide a complete picture of the competition and place the information in the public forum where we can all learn from it. Unfortunately, many questions I have were not answered.
Reviewer: Jason Lai	I rather like to see Japanese tear apart GM or Ford vehicle, not the other way around.	It's good to find out what's been done but it's also important to know the first principle, then other people's design can be criticized or compared.	Need to be going into what's the design philosophy and characterize more on the electrical performance.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Benchmarking of Competitive Technologies					
Presenter: Staunton, Robert *Reviewer: John M. Miller*	BCT is relevant during the interim	The BCT approach presumes U.S. is in a 1-down position technically. We are in HEV technology, so DOE's role needs to be in getting U.S. industry into a 1-up position technically.	Good interim program, but not a long-term sustainable prospect.	I need to see a "technology-trajectory" result from such BCT work that points where the competition is headed in 3-5 yrs. out, or further. Then DOE/ORNL align projects in the 5-15 year-out period to anticipate future developments. Tine to wrap this one up.	
Reviewer: K Fiegenschuh	Benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice.	Approach appears to be questionable because it appears that benchmarking is done at several sites. This requires careful coordination and even more importantly, careful correlation of test equipment, facilities and procedures to ensure consistency of results.	Benchmarking is important to the FreedomCAR program, and I presume that important results came from this year's work, but this presentation did not show any test results. Presentation was superficial and presented no data to evaluate.		
Reviewer: M. Mehall	Critical to identifying the state of art and gaps.	Keep driving to collaborate with ANL vehicle level efforts.	I'd like to see benchmark metrics compared and extrapolated to forecast 2015 and gaps. Correlate Vehicle/System/Component benchmark metrics to ensure that they are sufficient and compatible indicators of technology improvements. Point measures rather than duty cycle measures may not suffice!		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Benchmarking of Competitive Technologies					
Presenter: Staunton, Robert					
Reviewer: Pat McCluskey	Benchmarking valuable but needs to lead to conclusions that direct further improvement and program direction, so that it is proactive and not reactive. A roadmap or technology matrix would be helpful.	Very good approach in that: 1) examines 3 different cars from 2 different manufacturers, 2) contains both test of performance, along with disassembly and technology evaluation. Needs to have a stated standardized test procedure for comparing the different models with established and agreed on comparison metrics.	Good progress on assessing technology. Comparison of Accord vs. Civic very interesting, especially details of power module. A statement of the types of information being evaluated should be presented.		
Reviewer: Vijay Garg		Fragmented testing (because of testing facilities at different places which requires a well coordinated effort).	Comparing technology used in Prius converter/inverter to Z-source converter/inverter is an excellent idea (slide 14).		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Characterization of PM Materials					
Presenter: Lara-Curzio, Edgar					
Reviewer: Brian Welchko	Testing of PM materials is important	This project is testing materials we have no interest in.	Results show that mechanical strength changes after thermal cycling but magnetic properties do not. The EETT knows that magnetic properties change after thermal cycling. Thus the desirable materials (for the EETT) are not being considered.		
Reviewer: Edward Jih and Tech Team (OEM)					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Testing of PM materials is important.	This project is testing materials we have no interest in.	Results show that mechanical strength changes after thermal cycling but magnetic properties do not. The EETT knows that magnetic properties change after thermal cycling. Thus the desirable materials (for the EETT) are not being considered.		
Reviewer: M. Mehall		Approach does not seem right to me.			

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Characterization of PM Materials					
Presenter: Lara-Curzio, Edgar					
Reviewer: Vijay Garg					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Component Characterization					
Presenter: Seiber, Larry *Reviewer: Anson Lee*	Good relevance to overall program.		Identified weakness of some components.		
Reviewer: Brian Welchko	The testing of developed components is important.	Thorough test plan with quality facilities and methods.	The tests have been done on non-important components.		This is putting the cart before the horse. Testing is great, but only recently have they received important material to test (AMES magnets). Testing on commercial products or products which are not aligned with FreedomCAR goals is not a worthwhile use of DOE resources.
Reviewer: Edward Jih and Tech Team (OEM)					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	The testing of developed components is important.	Thorough test plan with quality facilities and methods.	The tests have been done on non-important components.		This is putting the cart before the horse. Testing is great, but only recently have they received important material to test (AMES magnets). Testing on commercial products or products which are not aligned with FreedomCAR goals is not a worthwhile use of DOE resources.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Component Characterization					
Presenter: Seiber, Larry					
Reviewer: Jason Lai	Big effort with little significant results.	Need more input form application people and understanding of fundamental.	Some good test results, but too much effort in this. We should have theoretical projection to support the test results.		
Reviewer: John M. Miller	Component characterization is very important to DOE so that valid tester/goals are obtained.	This business with ESR cannot be correct	OK	How was ESR determined? What is definition used? How tested? AC-impedance is the proper test and ESR=Re{ZAC}	
Reviewer: K Fiegenschuh	Although in the broadest sense, benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice, this project seems to be less like "benchmarking" and more like component and subcomponent testing. Thus, the value from an OEM perspective is less than systems benchmarking would be.	The test plan is great. Lab & PI use good facilities and good methods. No issues with the approach.	Within the defined scope of the project, the accomplishments and progress have been good. However, there appears to be little relevance of this kind of component testing to the high level OEM needs for systems and subsystems that can help deliver high quality, low cost, competitive hybrid and fuel cell vehicles.		
Reviewer: M. Mehall	This seems like a support activity. We should be focused on benchmarking where we know there are big gaps. The PI should be soliciting your support as needed.	A very capable lab.	Support activities should not be reporting. PIs should fund the tests needed to support their needs.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Component Characterization					
Presenter: Seiber, Larry					
Reviewer: Pat McCluskey	It is very important to have a testing capability for assessing the performance and reliability of commercial and custom capacitors for the unique automotive environment.	It is important that the test results should be supported by theoretical analysis and that the interpretation of the results should lead to further improvements in technology or in the development of future DOE goals. Also should make sure that the test procedures are appropriate for assessing life in the automotive environment.	Excellent testing of the capacitor available. Good interaction w/commercial sources and government labs to get a supply of capacitors. Should get some sample and develop test capability for higher capacitance and higher voltage.		
Reviewer: Vijay Garg					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Development of Improved Powder for Bonded Permanent Magnets					
Presenter: Anderson, Iver *Reviewer: Anson Lee*	Highly relevant research	Good approach to improve magnets.	Good results shown.		
Reviewer: Brian Welchko	Very important. If successful, this could put PM machines production costs on par with induction machines.	Doing a good job.	Making progress. I wish it was faster because I want to use the end result.		
Reviewer: Edward Jih and Tech Team (OEM)				Continue this project.	1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Presenter did not spend enough time on substantial project material.
Reviewer: Greg Smith	Very important. If successful, this could put PM machine production costs on par with induction machines.	Doing a good job.	Making progress. I wish it was faster because I want to use the end result.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Development of Improved Powder for Bonded Permanent Magnets					
Presenter: Anderson, Iver					
Reviewer: James Scofield	Effort focused on optimized rare earth PM materials processing, coating, and alloy formation is outstanding. Focus on key process parameter for melt spin and gas atomized particle formative focus key to realizing desired BH product temperature performance, and alloy stability. Coating and commercialization of molded parts focus essential and being addressed.	Effort addressing all key areas/issues.	Energy product demagnetization, temp, and alloy formation processing tasks have all achieved commendable results which significantly advances the SOA.		
Reviewer: Jason Lai	A synergy for PM motor development	Continue improving alloy design			
Reviewer: John M. Miller	Gas atomization process could prove very valuable to metal spray deposition of PM bonded materials. But how viable is this process for commercialization?	Need clearer assessment of magnetizer requirements of sintered PMs	Excellent metallurgy		
Reviewer: K Fiegenschuh	Motor and magnet research is important to meeting the goals for FreedomCAR and are key enabling technologies for future hybrid and fuel cell vehicles.	Appears to have solid research plan with collaboration with industry, other national labs. However PI spent too much of the time available in the presentation on background material and project plans, so he had to rush through the detailed technical results. Recommend that less time be spent on background so that there is adequate time to review the technical accomplishments.	Thorough report and data presented, but as mentioned before, inadequate time in presentation for PI to discuss data in detail.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Development of Improved Powder for Bonded Permanent Magnets					
Presenter: Anderson, Iver *Reviewer: M. Mehall*	Big cost carrot! Keep driving.				1. Focus on big picture progress to gaps that we are aiming to close. Use technical progress to support how much we progress we are making on gaps (use metrics such as $, wt, formability, quality measure…where possible). Time does not permit recounting all tasks, so focus on desire outcomes and results of approach.
Reviewer: Pat McCluskey	Magnetic are the key to efficient electrical machines and the goals of improved performance. Energy product at higher temperature and lower manufacturing cost are critical to hybrid vehicle. This project addresses a number of promising ways to achieve these goals.	The techniques used to achieve the goals of improved energy product at higher temperature and lower manufacturing cost seem very promising. The experiments and materials development approaches are sound.	Outstanding progress has been made on several fronts as evidenced by an impressive publication and patent reward.		
Reviewer: Vijay Garg					1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Presenter did not spent enough time on substantial project material.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Electric Motor Research and Development					
Presenter: Hsu, John *Reviewer: Anson Lee*	Highly relevant research.	Seemed to be a "shot-gun" approach.	This research has been ongoing since 2000, not enough results or data were shown.		Dr. Hsu might need help on other projects so he could focus.
Reviewer: Brian Welchko	Electric machines research is extremely important if FreedomCAR goals are to be achieved.	This is a slush fund for whatever ORNL feels like working on. There is no clear objective. Correlation to FreedomCAR goals is sparse.	The Prius test report is minimally acceptable. The remaining listed accomplishments are only theoretical or fairly irrelevant.		Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: Edward Jih and Tech Team (OEM)	1. The PI is working on the application of this technology in Induction motors since 2000 (this is evident from his publications). Since 2004, he started working on the application of this technology in IPM motors. 2. The PI did not present data to support that this technology would lead to overcome barriers.	Prius (slide 26) test report is barely acceptable.	It seems that projects to develop this technology started in CY 2000 or earlier (see reference in Additional comments). However, the team has seen useful data such as efficiency and other performance parameters and their comparison in matrix form with competitive data set.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects. 3. John S. Hsu, "Hybrid-Secondary Uncluttered Induction (HSU-I) Machines", IEEE Transactions on Energy Conversion, June 2001, Vol 16, No 2, pp. 192-187.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Electric Motor Research and Development					
Presenter: Hsu, John *Reviewer: Greg Smith*	Electric machine research is extremely important if FreedomCAR goals are to be achieved.				Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: James Scofield	Motors, their cost, performance and efficiency are critical to a competitive EV or HEV. Magnetics and motor evaluations on target. Excellent inclusion of Corona effects and voltages.	Evaluation of PM and novel configurations are exactly the approach required to define an effective HEV paradigm.	Corona effects Hsu PM design		
Reviewer: Jason Lai	Try to have a breakthrough although results are still not clear.	Corona test needs to use square wave high dv/dt type pulses, motor design is interesting, but need to consider leaking, coupling efficiency.	Need to see actual prototype performance.		
Reviewer: John M. Miller	1. Brushless excitations - very relevant to need for high CPSR in HEV and FCHVs 2. Corona & higher voltage - essential to longer term R&D and what new operating voltages may evolve to 3. New CVT - need a power flow analysis to show how better/worse than today's eCVT of input split parity.	1. Good theoretical & modeling approach. 2. Very good experimental work. 3. Needs further development and refinement, but very promising for compact eCVT's.	Incredible amount of work and substantial contributions have been made in this work.	Continue/expand.	

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Electric Motor Research and Development					
Presenter: Hsu, John *Reviewer: K Fiegenschuh*	rating The need for breakthroughs in electric machines is a critical enabler for hybrid and fuel cell vehicles becoming affordable, viable and high volume. R&D into new electric machine design concepts is valuable.	There are a number of projects within this one project, but the presentation did not devote enough time/space to any one project to do anything more than provide a superficial overview of the technical accomplishments on each one during the prior year. These projects need to be divided into separate projects so each can get the time it deserves, so research results can be reported in sufficient detail to understand progress, and so reviewers can evaluate each appropriately.	There are many subprojects in this catch-all subject area. Few have any significant value. Some like the Corona discharge work or the motor-based CVT are intellectually interesting but seem to have little value to the FreedomCAR program or to future hybrid or fuel cell product applications. This project needs to be subdivided into separate, concrete research projects each of which should have specific deliverables that are tied to specific FreedomCAR goals and each needs to be evaluated on its individual merit. This project seems like a sandbox for ORNL researchers. I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research.		

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Electric Motor Research and Development					
Presenter: Hsu, John					
Reviewer: M. Mehall		What are the anticipated improvements in a directional measurable units (e.g. how much cost reduction?). Show results or analyses that indicate progress toward those benefits.	It appears that model correlates to results, but is this single point? Seems that we need to look at a range of operating points. . Like to see more recommendations and conclusions backed up by results. Motor Voltage and Corona conclusion seems open ended. If many other parameters interact with Corona, to affect high voltage design, then what learning from this work is usable to move the art of increased voltage systems for reduced losses? Where should we be focusing to execute high voltage motors? Review benefits and show gaps to targets for each subproject as lead in. Review presentations with collaborators prior to presentation in future.		
Reviewer: Pat McCluskey	Work on field enhancement and weakening is important. Corona study is especially interesting as it tells one of the upper limits on voltage.	Good benchmarking. Interesting Corona test set-up. Is Corona the only limit to the maximum voltage? If other issues like battery and IGBT are involved, what is the relative importance of Corona as a limitation?	Good benchmarking and Corona results. On track (schedule and budget).		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Electric Motor Research and Development					
Presenter: Hsu, John *Reviewer: Vijay Garg*	1. The PI is working on the application of this technology in Induction motors since 2000 (this is evident from his publications). Since 2004, he started working on the application of this technology in IPM motors. 2. The PI did not present data to support that this technology would lead to overcome barriers.	Prius (slide 26) test report is barely acceptable.	It seems that projects to develop this technology started in CY 2000 or earlier (see reference in Additional comments). However, the team has seen useful data such as efficiency and other performance parameters and their comparison in matrix form with competitive data set.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects. 3. John S. Hsu, "Hybrid-Secondary Uncluttered Induction (HSU-I) Machines", IEEE Transactions on Energy Conversion, June 2001, Vol 16, No 2, pp. 192-187.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Flux Weakening and CPSR Enhancement Techniques					
Presenter: McKeever, John *Reviewer: Anson Lee*	Highly relevant research	Approach seemed reasonable.	Good results for a small machine, need to scale up to validate concept for a large (>50 kW) motor.		
Reviewer: Brian Welchko	Control is always an important topic because it is where the OEMs can add value and differentiate their products.	Good use of appropriate subcontractors. However, the Z-source converter is a major focus of this effort and it is listed as its own contract.	Results to date seem limited, but should come through in the long run. Promised results are tangible and not just a useless model.		ORNL does not seem to be doing any of the work on this project. All reported work seems to have originated at UW-Madison. That is ok, but it is not prudent that UW-Madison is only receiving a very small (my guess less that 10%) of the project funding.
Reviewer: Edward Jih and Tech Team (OEM)		Efficiency is still a concern for Inset PM motor.		Continue to develop and build an Inset PM motor in line with FreedomCAR specifications to alleviate efficiency concerns.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Control is always an important topic because it is where the OEM's can add value and differentiate their products.	Good use of appropriate subcontractors. However, the Z-source converter is a major focus of this effort and it is listed as its own contract.			ORNL does not seem to be doing any of the work on this project. All reported work seems to have originated at UW-Madison. That is ok, but it is not prudent that UW-Madison is only receiving a very small (my guess < 10%) of the project funding.

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Flux Weakening and CPSR Enhancement Techniques					
Presenter: McKeever, John					
Reviewer: James Scofield	Focus on cost, efficiency, and novel winding/stator designs an excellent focus for HEV, EV needs. Flux enhancement potential significant. More on Z-source.	Very good distribution of resources on key aspects which potentially can improve performance and reduce cost.	Early in effort, but progress appears to be commensurate.		
Reviewer: Jason Lai	Looks more like Honda mild ZV type motor.	Still need to be looking into other system architecture that can be more cost-effective, perhaps a current source converter would do the job: soft switching would be more efficient; although Z-source converter seems to be attractive .	Results to be seen.		
Reviewer: John M. Miller	1. Boost Conv/Z-Source - more relevant to FC vehicle. 2. Concentrated winding motor - very important and relevant to HEV long-term plans. 3. CPSR enhancement and voltage control - combines with both (1) and (2). Work is extremely relevant to HEV power split architectures.	Voltage Control - Inductance Control & Inverter Control - Reluctance Control - Very comprehensive approach.	Good & several reports written. Project should deliver performance comparisons of inset vs. v-magnets vs. u-magnet designs, especially broadness of efficiency contours in torque-speed plane.	Looking forward to the reports. Focus on wider CPSR AND broader efficiency islands.	
Reviewer: K Fiegenschuh	Good basic research into flux enhancement and weakening for electric motors. Technology could be a key enabling technology permitting lighter weight, more efficient and lower cost motors for future hybrid and fuel cell applications.	PI has assembled a good team of world-class researchers and collaborators to assist with the project. Would have liked to have seen more efficiency and performance data.	PI has shown work and results as well as comparisons to benchmark vehicles. Data provided in presentation indicates further efficiency improvements are needed.	Recommend building a larger machine and testing it for efficiency and performance characteristics.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Flux Weakening and CPSR Enhancement Techniques					
Presenter: McKeever, John					
Reviewer: M. Mehall			Continue to emphasize how technology is progressing to closing gaps with metrics.		
Reviewer: Pat McCluskey	Motor development enables reduced size, higher efficiency, improved reliability, higher CPSR, and lower costs - all key elements of DOE goals. Focuses on development for both ICE-hybrids (near term) and fuel cell hybrids (long term.	Good partnerships with academy/industry. Good breakdown of problem into study of boost converter, inductance control, increased saliency, and flux control.	Good work on motor design (6 kW as WEMPEC) and evaluation. Good work on describing the role of reluctance. Excellent use of models and simulation.		
Reviewer: Vijay Garg		Efficiency is still a concern for Inset PM motor.		Continue to develop and build an Inset PM motor in line with FreedomCAR specifications (55 kW peak) to alleviate efficiency concerns.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

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Glass Ceramic Dielectrics for DC Bus Capacitors					
Presenter: Lanagan, Mike					
Reviewer: Anson Lee	PSU performed testing for ANL, supporting ANL's research. This is not a separate research project.				
Reviewer: Brian Welchko					This seemed like it was a canned presentation for the center for dielectric studies (CDS). It seems that CDS is only doing a small amount of testing as part of a subcontract to ANL. In that context, all is well and should continue as ANL sees fit. CDS capacitor research sounds very good, but it is not aligned with FreedomCAR goals. Therefore, the DOE is not recommended to engage CDS directly.
Reviewer: Edward Jih and Tech Team (OEM)	OEM teams recommendation is to focus developing bulk capacitors for power electronic applications. Developing a center at PSU is not FreedomCAR goal.		Great overview of center's capability.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Professor Lanagan's consulting services are valuable to PIs of some national lab.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Glass Ceramic Dielectrics for DC Bus Capacitors					
Presenter: Lanagan, Mike					
Reviewer: Greg Smith					This seemed like it was a canned presentation for the center for dielectric studies (CDS). It seems that CDS is only doing a small amount of testing as part of a subcontract to ANL. In that context, all is well and should continue as ANL sees fit. CDS capacitor research sounds very good, but it is not aligned with FreedomCAR goals. Therefore, the DOE is not recommended to engage CDS directly.
Reviewer: James Scofield	Effort to develop graceful degradation mechanism for high energy density, high temp. caps highly relevant. Caps are still the weakest PE component, especially at elevated T operating conditions.	Well organized and focused project.	V. good initial demonstration of polymer-ceramic MLC for improved failure modes!		
Reviewer: Jason Lai	Seem to remain in material level. I believe there's a gap between material level and capacitor level. Package should also be addressed.	Has study on composite material. Need a scale-up result for >1000 µF, 500 V level demonstration.	Need to move forward to capacitor demonstration to stay at the material level.		
Reviewer: John M. Miller	Other than T operating, I'm not sure where these glass dielectrics fit in.	Good methodology.	Just don't see the progress I'd expect since earlier reviews.	Shut this project off.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Glass Ceramic Dielectrics for DC Bus Capacitors					
Presenter: Lanagan, Mike					
Reviewer: K Fiegenschuh	Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.	Presentation provides a interesting overview of work being done but question the need to review this project on a stand alone basis. It appears the work is being done under subcontract to ANL.	Results of this research ought to be reported under the ANL project that is the prime.		
Reviewer: M. Mehall	Need high temp bulk capacitance for high power apps. Capabilities of this center look good for support of testing.	Seems to be good metrics based approach.	Great overview of center's capability.		I struggled with reviewing this project because of the supporting role it plays.
Reviewer: Pat McCluskey	Glass-ceramic capacitors have traditionally been on e of the foremost ways to achieve high T, high energy density capacitors.	Coating of parylene to improve breakdown strength and provide a graceful failure with good energy density is a very promising addition to traditional glass ceramic development.	Elegant solution to the graceful failure problem in ceramics though the us of a polymer coating. Good experimental work on establishing the improved performance of these film coated glass ceramics.		
Reviewer: Vijay Garg	OEM teams recommendation is to focus developing bulk capacitors for power electronic applications. Developing a center at PSU is not FreedomCAR goal.		Great overview of center's capability		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Professor Lanagan's consulting services are valuable to PIs.

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HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop					
Presenter: Ayers, Curt					
Reviewer: Allen Hefner	New electronic cooling technologies are required to achieve goals of FreedomCAR program.	New electronic cooling system approach taking advantage of existing AC system with modifications seems like a plausible solution.	Good technical accomplishments considering early stage of project.		
Reviewer: Anson Lee	Good novel approach, very relevant to the task at hand.	I like the idea of using refrigerant to cool the electronics.	I would like to see both analytical and empirical data.		
Reviewer: Brian Welchko	This is still a separate cooling loop which requires its own pump. The only difference is that power is being dumped to the compressor instead of the radiator	The approach is fine.	Progress is fine.		It seems that this system will have a startup problem when the engine compartment is hot and the compressor is off.
Reviewer: Edward Jih and Tech Team (OEM)	The concept appears to be promising. However, the OEM team would like seeing preliminary data supporting the feasibility of concept.	More technical analysis is required to evaluate claims for refrigeration.	The project shows a modest progress since June 2004 review. However, no data or hardware demonstrating the progress was presented.		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Not clear that auto industry would accept such a method. This is still a separate cooling loop which requires its own pump. The only difference is that power is being dumped to the compressor instead of the radiator	The approach is fine.	Progress is fine.		It seems that this system will have a startup problem when the engine compartment is hot and the compressor is off.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop					
Presenter: Ayers, Curt *Reviewer: James Scofield*	The concept has direct relevance and technical merit. Details of controls for critical floating loop need to be carefully considered - i.e. leak detection, pressure regulation and monitoring, etc.	Improvement suggestions mainly are relating to providing milestone metrics and decision gate criteria details.	Data relating to heat removal (rates) or numerical data missing from presentation thus difficult to quantify or assess. Actual volume and weight impact need further detail and quantification.		
Reviewer: Jason Lai	This work has been done in industry. It was done for a high power ASD based HVAC system. Naturally, the refrigerant cooling can be used, but to have a separate/additional cooling capacity with "floating look' is hard to justify.	See above.	Not clear about the accomplishment, so far capacity and size penalty on cooing system against inverter size reduction should be given with solid number, real cm3 and kg number, not 1/3 or 1/2		See a major conflict point with the project goal of running power electronics and machining at 105° project goal.
Reviewer: John M. Miller	High potential to be viable automotive technology.	Excellent, well thought out system with capability for low cost. May need to include coolant level sensor.		Suggest that this project proceed.	
Reviewer: K Fiegenschuh	New techniques in electrical component cooling are critical to the FreedomCAR EE program. This research is in a promising area that could prove beneficial to the program if concerns about overall system efficiency can be sufficiently addressed.	Approach seems reasonable but the presentation lacked sufficient technical detail in approach or results to be able to effectively evaluate the research conducted. Need to see more information about the technical content of the project and plans for future data collection.	rating Concern about the modest progress with the project. We believe this project has been underway for over a year but we are not seeing any new results or data. Also concerns about the overall efficiency of the total system after adding a second cooling loop. Need to see an overall systems analysis of total cooling system to determine if the added loop (with added cost and possible efficiency losses) can be justified.	Future work ought to include analysis of total system – both efficiency and cost to determine if there is sufficient value in project concept to continue pursuing.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop					
Presenter: Ayers, Curt *Reviewer: M. Mehall*	Novel idea with potential.	Good approach, but need to see more analysis and results in presentation. Demonstrate, with sound theory, how systems will meet functional requirements at extremes of AC loop operation!.	Condenser outlet temperatures will reach 90°C(with low side <20°C) in Arizona! How will system be controlled at extremes and not have adverse affect on AC systems (e.g. cannot have compressor drain back into compressor discharge)?		
Reviewer: Pat McCluskey	Cooling techniques for the power electronics is a critical enabling technology for FreedomCAR.	Active cooling raises many reliability and efficiency questions: Reliability - What happens if there is a coolant leak? What happens if there is a blockage or failure in the A/C System? How will system operate at cold temps where refrigerant is typically not used? Is there a fail/safe if pump or cooling system fails? Efficiency - Spending a great deal of energy running active cooling systems to cool wasted energy from the power system-- Need to focus on passive cooling schemes and high efficiency/temperature devices.	Early in program, good progress so far. Should have shown results of operational test with and without A/C on.	Sensor/Diagnostic Health Management for coolant systems to ensure no build-up of debris, slow leaks, etc. FMEA of system to establish reliability concerns to focus engineering development efforts.	
Reviewer: Vijay Garg	The concept appears to be promising. However, the OEM team would like seeing preliminary data supporting the feasibility of concept.	More technical analysis is required to evaluate claims for refrigeration.	The project shows a modest progress since June 2004 review. However, no data or hardware demonstrating the progress was presented.		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

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High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics					
Presenter: Kaufman, David *Reviewer: Anson Lee*	High relevant research.	Excellent approach with fail-safe design.	Several set backs this year, need to produce a prototype.		
Reviewer: Brian Welchko	Capacitor technology is extremely important.	The idea of embedded caps is very desirable. There is a clear thought process and methodology towards achieving the targeted goals.	Worked through some setbacks and solved related issues. The PI freely acknowledged these difficulties! The preliminary results are very promising. He scaled up the voltage, demonstrated volumetric potential and identified commercial pathways to success.		Be very careful to maintain the focus on bulk capacitance and don't get sidetracked on the technology itself.
Reviewer: Edward Jih and Tech Team (OEM)	Focus on developing bulk capacitors is important to OEMs instead of technology only.	The approach used must assure that the developed technology is capable of assembling bulk capacitors.			A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Capacitor technology is extremely important.	The idea of embedded caps is very desirable. There is a clear thought process and methodology towards achieving the targeted goals.	Worked through some setbacks and solved related issues. The PI freely acknowledged these difficulties! The preliminary results are very promising. He scaled up the voltage, demonstrated volumetric potential and identified commercial pathways to success.		Be very careful to maintain the focus on bulk capacitance and don't get sidetracked on the technology itself. Need capacitor industry involvement.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics					
Presenter: Kaufman, David *Reviewer: Jason Lai*	The research only focuses on material study for capacitor. Individual cell property cannot represent the capacitor property. The project should move to the capacitor level to show actual performance such as ESR, GSZ, frequency response, ripple effect, packaged density.	See above. The collaborators are all low power users, not traditional inverter capacitor provider, such as AVX, Electronic Concept, etc.	Material property studied well, but not capacitor level.		
Reviewer: John M. Miller	Power Electronics and energy storage require high stability capacitors working to 600 V is good interim goal but should consider 800 V→1200 V for future sys.	Very good methodology.	Fault clearing and high Ev are worthy accomplishments, so is the achievement of ripple current capability.	I don't agree with DOE doing so much component work. For example AUX or United Chm ___? can do this.	
Reviewer: K Fiegenschuh	Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.	rating Work done so far has added to the knowledge base among US labs and industry partners. There is lots of promise in the research done and proposed. Particularly encouraging is summary of future plans to move from microfarad capacitors to those that are sized more appropriately for the power capacitor needs of APEEM.	Excellent progress so far, but need to reemphasize the importance that research move toward a greater emphasis on bulk capacitance.	Need more engineering work to prove out the ability to make a bulk capacitor using this technique. Also would like to see assurance that the design approach is realistic through, perhaps, independent evaluation/confirmation.	
Reviewer: M. Mehall	Bulk high temp capacitance is an enabler.	Scale up capacitance ASAP. Temperature capability of concept must be demonstrated.	Quite a struggle thus far, but keep pressing.		

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High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics					
Presenter: Kaufman, David *Reviewer: Pat McCluskey*	Development of high K, high Eb, high T capacitors is one of the most critical limitations to the successful development of underload electronics. This project is focused on a low-cost manufacturing technique for creating high K1 ceramic embedded capacitors.	The approach is very well structured. Good focus on reliability and graceful failure modes. The emphasis on film development and properties before addressing manufacturing and the embedding technology is an excellent approach for ensuring success, as is the good interaction with industry and manufacturing.	Very good demonstration of self-healing fault and of K1 and Eb of the new films. Needs more work on optimizing the top electrode structure for confining self healing w/high current density operation.		Excellent speaker. Well organized and very good overhead. Easy to follow.
Reviewer: Vijay Garg	Focus on developing bulk capacitors is important to OEMs instead of technology only.	The approach used must assure that the developed technology is capable for assembling bulk capacitors.			A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

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Integrated DC/DC Converter for Multi-Voltage Bus Systems					
Presenter: Su, Gui-Jia					
Reviewer: Anson Lee	Fair research value, a design exercise closer describes this project.	Commercially available technique.	Again, commercially available technology.		
Reviewer: Brian Welchko	This is not terribly important because our suppliers have a lot of expertise in this area.	This is a routine build a circuit and test it project. It is not really new research to solve known problems.	The circuit works.		Good engineering, but this is not research. We need to be focusing on solving problems. I recommend completing testing of the 2kW prototype and then stopping. The major focus (if continued) should be on controlling the 42V bus so that a 42V battery is not needed.
Reviewer: Edward Jih and Tech Team (OEM)	This is not a long-range high risk R&D project. It is simply an engineering project.				1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. No value in continuing this project.
Reviewer: Greg Smith	This is not terribly important because our suppliers have a lot of expertise in this area.	This is a routine build a circuit and test it project. It is not really new research to solve known problems.	The circuit works.		Good engineering, but this is not research. We need to be focusing on solving problems. I recommend completing testing of the 2kW prototype and then stopping. The major focus (if continued) should be on controlling the 42V bus so that a 42V battery is not needed.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Integrated DC/DC Converter for Multi-Voltage Bus Systems					
Presenter: Su, Gui-Jia *Reviewer: James Scofield*	Reduction in parts count and complexity positively impacts reliability and cost directly.	Very good project organization and approach. Simulate → Design→ Fabrication → Test → Simulate → Design. Early in project,, novel design topology.	Early in project, simulation predicts very encouraging possibilities.		
Reviewer: Jason Lai	Circuit development is targeting practical applications.	DSP control allows fast and intelligent transitioning control. Multiple voltages are handled and controlled by one converter. Half bridge may not be the way to go for cost reduction if passive component penalty becomes high.	Converter has been working - experimental results, meeting milestone.	Need to address efficiency and packaging.	
Reviewer: John M. Miller	On target, just what is needed as hybrid SUVs and P/U's are introduced? This DC/DC will supply the necessary 42V electronic power steering systems that will be needed.	Excellent controls work and use of DSP	On track	I think it's time for this project to transfer, or be picked up by, the OEM's. Too near term technology for DOE. Time to wrap it up.	
Reviewer: K Fiegenschuh	DC/DC Converters can be important to hybrid and fuel cell vehicles and help support the overall FreedomCAR goals. However there is some question about the value of an all-in-one 12/42/high voltage converter. This seems to be more of a packaging study than a research project. Individual vehicle manufacturers would need to determine the need and value of an all-in-one design.	rating It is unclear if there are any new technical breakthroughs planned in this research and if federal funding is warranted. It appears there is no significantly new technology being developed here; more like reengineering of existing technology.	PI has accomplished what he set out to accomplish and has done it competently; however, there is a concern that there was not enough technical stretch in the research objectives.	Ought to wrap up current project and, in the future, not proceed along this line of research within national labs.	I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research. The presentation states that there are no subcontractors and collaboration seems to have been superficial, yet this PI has two projects that total almost $1 million in FY05. How were these funds spent?

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Integrated DC/DC Converter for Multi-Voltage Bus Systems					
Presenter: Su, Gui-Jia					
Reviewer: M. Mehall	There don't appear to be any novel topology breakthroughs. Does not seem to be state of art effort.		Need to report out status on measurables: numbers of switches, performance impacts……		
Reviewer: Pat McCluskey	Going from 2 DC/DC converters to 1 would increase reliability and decrease cost. Not a critical technical barrier to HEV development, but a nice advantage for affordability and market acceptance.	Prototype design is promising. How does it address the fact that the HV keeps changing from 200V to 500V to 550V to 600V?	Good prototype fabrication and characterization. Not much in patents and publications.		
Reviewer: Vijay Garg					1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. No value in continuing this project.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles					
Presenter: Su, Gui-Jia *Reviewer: Anson Lee*	Fairly relevant project.	Approach seemed reasonable, but not too practical.	Good results were obtained based on this approach. Project completed.		
Reviewer: Brian Welchko	Auxiliary drives have not been a major focus of the EETT.	Well planned.	The idea works.		Project is complete. No carryover funding should be allotted for FY06.
Reviewer: Edward Jih and Tech Team (OEM)					1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Project is complete and no further funding to continue is recommended.
Reviewer: Greg Smith	Auxiliary drives have not been a major focus of the EETT.	Well planned.	The idea works.		Project is complete. No carryover funding should be allotted for FY06.
Reviewer: James Scofield	Integrated inverters project a good companion to integrated converter work being performed. May be key to positively impact cost and reliability for EV's which require PM HVAC compressors.	More emphasis should be on prototyping & thorough testing on a dual 3-phase machine/2-phase machine topology.	Very good simulation and design efforts to date. Validation now required especially for dual machine load.		

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles					
Presenter: Su, Gui-Jia					
Reviewer: Jason Lai	Integration helps cost reduction on interconnection.	Reduction on silicon will normally increase size of passive components. A trade off needs to be -----to justify.	System has been implemented and tested.		
Reviewer: John M. Miller	The 2-phase motor winding is non-industry standard, but relatively easy to implement, so there should be commercial interest.	Good, but some concern over an A/C compressor motor having a link to the vehicle traction motor. Could raise concerns over vehicle placement of the e-A/C compressor.	On track to completion	Project ends FY05	Should have industry partners (Tier 1 or Tier 2) at this point so it can transition to product development.
Reviewer: K Fiegenschuh	Innovative inverter designs can be useful in meeting FreedomCAR goals, but this seems to be more of an engineering exercise in determining whether motor driven accessories can replace belt driven accessories.	rating The PI seems to have competently analyzed the problem he chose to address, designed the experiment, done analysis and developed hardware to prove the concept. However, a thorough business analysis should have been done before any technical work was begun to determine if there were any cost, efficiency, functional or reliability advantages of a two phase motor design instead of the current practice of belt-driven components. Now that the project has been completed, the PI discusses contacting motor suppliers to get cost estimates. This should have been done first to see if there were any reason to have initiated the project in the first place.	The project was competently completed along the lines of the initial proposal.	The project has been completed. No further research is warranted.	I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research. The presentation states that there are no subcontractors and collaboration seems to have been superficial, yet this PI has two projects that total almost $1 million in FY05. How were these funds spent?
Reviewer: M. Mehall	Is this a truly novel architecture with great savings and no negative impacts?		What are the metrics and how are we performing to the goals?		

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles					
Presenter: Su, Gui-Jia					
Reviewer: Pat McCluskey	Integration of the HVAC into the hybrid drive has advantages in cost, weight and size but doesn't seem to e a key technical hurdle to the development of ICE/HEV or fuel cell HEV. It is somewhat peripheral albeit valuable.	The approach to integrating HVAC and hybrid drive seems sound.	Third year of program and progress is simulation study and design of task 1 and component selection for task 2. Should be further along in project and have more data on effectiveness of this solution. Publications are weak.		
Reviewer: Vijay Garg					1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Inverter Packaging					
Presenter: Hsu, John					
Reviewer: Allen Hefner	Improved package heat removal is essential to meet goals of FreedomCAR.	Some novel cooling heat removal methods are considered but many have reliability and practicality questions in vehicle applications.	Some important results are described but no applicable technologies have been identified.		
Reviewer: Anson Lee	Highly relevant project to reduce inverter size.	Approach to be a good approach.	Did not show any hardware or data; not much progress since last year.		
Reviewer: Brian Welchko	Good subject area	Focus on capacitor cooling is important.	Accomplishments and efforts seem scattered over many objectives.		Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: Edward Jih and Tech Team (OEM)	Goal to reduce Semikron inverter size to 33% without effecting its performance and life.	Slide 13 demonstrates the concept, which is good.	No conceptual hardware or data was presented to support the proof of concept.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Inverter Packaging					
Presenter: Hsu, John *Reviewer: Greg Smith*	Good subject area.	Focus on capacitor cooling is important.	Accomplishments and efforts seem scattered over many objectives.		Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: James Scofield	Jet impingement, spray, and other active fluidic solutions are complex costly, and potential reliability concerns. Focus should be greater on H.T. materials and greater emphasis on air and passive cooling schemes. Obviously, not possible in all cases and timelines.	Cu foam and multiple cooling approach evaluation very good to assess technology base. Should also consider novel heat spreaders coupled to existing cooling system/sinks.	Excellent evaluation of multiple approaches. Required to focus the selection process in evaluation of the best engineered system.		
Reviewer: Jason Lai	Some good work, but not easy to justify the significance. I am not sure if inverter size reduction goal can be achieved in this way.	Size reduction by better cooling does not guarantee loss reduction.	The package needs to include every thing including gate drive cht and interconnects.		Coolant temperature is not what stated 105°C target described in the project goal.
Reviewer: John M. Miller	Yes - shows promise of 150w/cm2 using Cu-foam in cascading die scheme. Cooling capacitors is very important contribution of this project.	Not clear on how vapor management system will be designed and fabricated to be space/volume efficient.	Excellent work and progress	Continue focus on passive components and volume reduction of complete concept.	

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Inverter Packaging					
Presenter: Hsu, John *Reviewer: K Fiegenschuh*	rating Improving packaging efficiency of power electronics and electrical machines on vehicles is important for design of vehicles that meet customer expectations and needs without compromise. Small inverter sizes support this goal.	Unique approach to direct cooling directly on the die is innovative and warrants continued investigation.	Presentation lacks detailed data and test results that support the claim that the inverter can be downsized considerably. PI reports expected results somewhat superficially but present no details that allow reviewers to make a considered assessment of the value or progress of the work. I would like to see a list of staff research associates who assisted the PI in this research effort. The report mentions several subcontractors and collaborators, but it is unclear what their roles are, and if there are any associates at ORNL supporting this effort.		
Reviewer: M. Mehall	Great plan for empirical proof of concept work in an important area.	Very broad scope, considering all the challenges associated with 2-phase cooling.	I await well organized and more thorough reporting of results from testing of the concept hardware.		It appears that the concept, results and report are complete by year end. What happens beyond 2005 since the duration is called out as 2008? Is there complementary modeling that could be validated in conjunction with this work?
Reviewer: Pat McCluskey	Integrated packaging is a critical area to achieving DOE goals and capacitors are one of the chief hurdles to high performance at temperature. Combining direct cooling with integrated packaging has great promise.	Cascade die mounting structure combined with direct cooling is a good approach. Need more fundamental understanding of acerbated testing of caps to design a capacitor cooling test that is more relevant to automotive reliability. Also if the floating loop is fixed to the standard A/C refrigerant, the value of the refrigerant study may be limited.	Good progress and accomplishments. Need to test ISR prototype.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Inverter Packaging					
Presenter: Hsu, John *Reviewer: Vijay Garg*	Goal to reduce Semikron inverter size to 33% without effecting its performance and life.	Slide 13 demonstrates the concept, which is good.	No conceptual hardware or data was presented to support the proof of concept.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

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Low Cost, High-Energy-Product Permanent Magnets					
Presenter: Cha, Yung *Reviewer: Anson Lee*	High energy magnets are not mandatory for FreedomCar	Reasonable approach.	Limited progress, would not benefit FreedomCAR.		
Reviewer: Brian Welchko	High energy strength magnets are not, but they are not necessary for hybrid or fuel cell vehicles. Actually, if the magnets are too strong, they create a lot of fault tolerance issues and as a result, increase overall system cost.	Punching magnet shapes does not seem like it will be very practical.	This project is moving at a glacial pace.		It is way past time to cancel this project. The net efficiency over a drive cycle actually decreases if the magnets are too strong.
Reviewer: Edward Jih and Tech Team (OEM)	No value in continuing this project.				1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Net efficiency over the drive cycle may be low with sintered magnets. 3. High strength magnets is neither requirement nor a solution for hybrid and fuel cell vehicles.
Reviewer: Greg Smith	High energy strength magnets are not, but they are not necessary for hybrid or fuel cell vehicles. Actually, if the magnets are too strong, lower system efficiency and they create a lot of fault tolerance issues and as a result, increase overall system cost.	Punching magnet shapes does not seem like it will be very practical.	This project is moving at a glacial pace.		Project has been ongoing for to long, should be stopped.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Low Cost, High-Energy-Product Permanent Magnets					
Presenter: Cha, Yung *Reviewer: James Scofield*	Apparent focus on cost of mfg issues.	Did not see characterization of any processed compacts → B-H? Thermal cycling, mechanicals? My first review, thus I realize it may be part of program.	Appear to have significantly improved compaction process yield through die/punch modification. Slide 4 claims B-H improvements, data?		
Reviewer: Jason Lai	Cost reduction is the key				
Reviewer: John M. Miller	Very good work in eliminating/minimizing air entrainment during compaction process. As well as solving the fracturing problem with modified punch/die set.	Good focus on root cause of problem	On schedule.		
Reviewer: K Fiegenschuh	Although magnet R&D is important to FreedomCAR goals and to help develop technologies vital to hybrid and fuel cell vehicles, it is unlikely that high strength magnets will provide any significant advantage over other technologies.	Technical approach and future plans are not specific enough. More details about future research plans would be appreciated. Slide discusses plans to evaluate better magnetic materials, but no details about which materials, why they are expected to be "better," what the specific targets are for magnetic materials properties that form the basis for choosing new materials, etc. This also appears to be more of a manufacturing development program than a R&D program.	This project is currently in its 6th year yet we are seeing no appreciable results that indicate that the technology can provide a viable alternative to other technologies. There does not seem to have been a lot of progress over the year. There is some doubt that high strength magnet motors provide any net efficiency improvement over a vehicle drive cycle. Question the value of continuing work on a technology that appears to have little value to future hybrid or fuel cell vehicle technologies.	Would recommend that DOE seriously reconsider the value in continuing this line of research. We do not appear to be getting significant results from over 6 years of research. Need to question if this research is in line with the goals of long-term, pre-competitive research that can lead to technologies that can be implemented to help develop hybrid and fuel cell vehicles.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Low Cost, High-Energy-Product Permanent Magnets					
Presenter: Cha, Yung					
Reviewer: Pat McCluskey	No sintered magnets have the best energy product but they have high temperature application concerns. This project focuses on how to improve the energy product which is valuable but would be interested also in high temperature performance, not just RT.	New die and punch design is a good way to remove trapped air problem. Should also examine different compacting and sintering parameters (pressure and temperature, etc.) to optimize energy product.	Very good progress has been made on die and punch design as proven by the manufacture of new compacts. Need test data confirming improved crack resistance and less trapped air. Also need data confirming new design improves energy product.		
Reviewer: Vijay Garg	No value in continuing this project. It has been six years since the inception of this project with no useful results.				1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Net efficiency over the drive cycle may be low with sintered magnets. 3. High strength magnets is neither requirement nor a solution for hybrid and fuel cell vehicles.

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Low Thermal Resistance IGBT Structure					
Presenter: Hassani, Vahab *Reviewer: Allen Hefner*	New approaches to improved heat removal from IGBT package is relevant to achieve goals of FreedomCAR Program.	Simulation of cooling capability and stress of new structure is important first step. However, some of the techniques such as o-rings etc., do not seem viable.	Simulation results are interesting, but these are essentially untested ideas. I am not convinced that this is a world-class effort that will accomplish what others have been unable to do, that is, produce a reliable direct cooling package for high power		
Reviewer: Anson Lee	Good relevant project	Technical approach looked reasonable.	Would like to see design concept validated.		
Reviewer: Brian Welchko	This is an important subject.	Creative, but the idea has a 0% chance of success.	This has been a total failure.		Vahab listened to the criticism from the EETT and truly tried to address the suggestions
Reviewer: Edward Jih and Tech Team (OEM)	Any progress in reducing the internal thermal resistance of power module is useful.	The application of O-rings presents a risk of coolant leakage. Need data to prove it otherwise.	The team recognizes the fact that the first design concept failed and delayed the progress.		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	This is an important subject.	No real understanding of application, what will and will not work.	Project not grounded in volume production realities.		Vahab listened to the criticism from the EETT and truly tried to address the suggestions.
Reviewer: James Scofield	Requires experimental validation of most promising modeled approaches.	Excellent work. See note in No. 1	Needs experimental validation in overall thermal management modeling effort.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Low Thermal Resistance IGBT Structure					
Presenter: Hassani, Vahab *Reviewer: Jason Lai*	Targeting the area needed, especially IGVT interface issue.		Need more experiment verification.		
Reviewer: John M. Miller	Very relevant. The use of o-ring & gaskets may appear cost sensitive but may be IC-process feasible and inexpensive.	Very innovative concept that needs further development and validation.	Need to do stress analysis of solderless concepts.	Continue the project - innovations along the way are likely and of high value.	
Reviewer: K Fiegenschuh	Reduction in thermal resistance of the mounting of the IGBT is consistent with addressing the need for improved thermal efficiency and reduced cost of cooling systems.	An interesting approach to thermal management that evaluated alternatives to thermal grease. PI has been thorough in evaluating a number of different techniques for attaching and insulating the IGBT. Each design approach was evaluated for thermal resistance and stress. When issues were identified with one approach, another idea was tried and tested.	Although several design approaches were evaluated, it appears that none so far are likely candidates for high volume automotive applications. The solder joints face stresses that are likely to cause mechanical failure. The O-ring/gasket approach needs further study because experience has shown that most O-ring applications tend to leak under the severe duty cycles autos experience. More work is needed to ensure durability and reliability under automotive operating conditions.		
Reviewer: M. Mehall		Continue to look ensure that solutions that will be robust to surface and thermal gradient variability in both sealing and heat transfer surfaces.	Good progress despite set backs.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Low Thermal Resistance IGBT Structure					
Presenter: Hassani, Vahab					
Reviewer: Pat McCluskey	Finding a way to run electronics at T < 125° C in high temp coolants is critical to DOE goals. Low thermal resistance IGBT structure is one of few technologies that promises Δ~20°C performance.	Low thermal resistance IGBT structure focuses on elimination of thermally resistive layers, especially thermal grease (?)---- which is weak point of system. However, concerns with solution include stress level for metallurgical attach and cost/reliability for pressure approach.	Has examined multiple approaches to low thermal resistance IGBT structure and has identified and mitigated reliability/stress issues associated with the designs.	Should examine jet impingement force vs. force needed to break pressure contact over temperature range and for automotive environment (which includes vibration and shock that can break pressure contact intermittently).	If you can reduce the 105°C limit to 85°C or so, a world of opportunities open up with new thermal interface materials and heat sinks at a much lower cost and higher reliability as long as the system must operate at T cooling of 105°C with a T junction of 125°C. The ΔT of 20°C drives to novel solutions, such as the IGBT/Jet Impingement structure here.
Reviewer: Vijay Garg		The application of O-rings presents a risk due to coolant leakage. No data was presented to prove it otherwise.	The team recognizes the fact that the first design concept failed and delayed the progress.		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Mechanical Characterization of Dielectric Polymers					
Presenter: Wereszczak, Andy					
Reviewer: Anson Lee	Good material characterization of various films, high relevant.		Great results, gave good indication to researchers which materials should not be used.		
Reviewer: Brian Welchko			Very good results.		Project focused on mechanical testing of films from SNL. SNL project has since changed focus. As a result, this project will be completed in FY05.
Reviewer: Edward Jih and Tech Team (OEM)					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith			Very good results.		Project focused on mechanical testing of films from SNL. SNL project has since changed focus. As a result, this project will be completed in FY05. Very useful work.
Reviewer: Jason Lai	Capacitor mechanical characteristics is important, but most commercial film capacitors are potted in a case, the actual mechanical property that power electronics people deal with is not capacitor itself, but the case and potting material.		Dielectric level has been tested, but not packaged capacitor.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Mechanical Characterization of Dielectric Polymers					
Presenter: Wereszczak, Andy *Reviewer: John M. Miller*	Good Fundamental material science. I'm most pleased with the work on introducing probalistic design sensitivity (PDS) analysis as means to predict Weibul characteristics.	I'd like to see PDS methodology extended.	This project should be tied closer to FreedomCAR efforts, esp. in the PDS and how to predict capacitor life (i.e., Weibul char. life).	Tie this into requirements on warranty and life requirements set by Tech Team.	
Reviewer: K Fiegenschuh	Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development. Materials development is critical to the ability to deliver capacitors that can meet FreedomCAR needs for hybrid and fuel cell vehicles.	PI is using good analytical and experimental design in his experiments and has come up with a novel way to test films.	Good progress and accomplishments. Good and detailed report of work done during the prior year with plenty of technical information and data that is informative. All 'round good work.		
Reviewer: M. Mehall	Bulk high temp, low cost capacitance is an enabler.	Developing and correlating analytical tools is a critical capability .	Nice demonstration of progress with results of correlation.		
Reviewer: Pat McCluskey	Mechanical testing and knowledge improvement of film mechanical properties is essential for moving the film capacitors from the laboratory into production.	Development and validation of new mechanical testing techniques is necessary for assessing and facilitating the development of new capacitor technologies and associated manufacturing processes.	The project has developed a number of techniques: strain based fracture analyses for winding, µFea direct from photo into ANSYS, Mylar backed film testing, which would be very useful in further capacitor development and subsequent defect-free manufacturing.	Correlating mechanical properties and defects of subsequent capacitor failure density and distributions.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Mechanical Characterization of Dielectric Polymers					
Presenter: Wereszczak, Andy					
Reviewer: Vijay Garg					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Jet Impingement					
Presenter: Narumanchi, Sreekant *Reviewer: Allen Hefner*	I have serious reservations about jet impingement cooling being practical for this application.	Although it is interesting to simulate jet impingement cooling, the important issue is if this technology can be made practical and reliable for the FreedomCAR applications.	There are some interesting results but this is far from a unique world-class effort.		
Reviewer: Anson Lee	Good relevance to our tasks at hand.	Reasonable model was developed.	Model accuracy seemed reasonable, need more validation with real operational data.		
Reviewer: Brian Welchko	Having flexible models would be useful.	You have to be kidding! This is a pointless literature survey.	Zero useful accomplishments		This research is not based on reality. There absolutely must be an experimental component which is actually done by the researchers. The researchers are comparing their work to experimental data which has been published by other researchers. In that case, we can just use the other researchers models and save the American taxpayers some money.
Reviewer: Edward Jih and Tech Team (OEM)	PI is developing a Jet impingement model for Semikron inverter recommended by the team.	Both semi-empirical tool & numerical simulations were used.	PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Jet Impingement					
Presenter: Narumanchi, Sreekant *Reviewer: Greg Smith*	Having flexible models would be useful.	No clear direction.	Zero useful accomplishments.		This research is not based in reality. There absolutely must be an experimental component which is actually done by the researchers. The researchers are comparing their work to experimental data which has been published by other researchers. In that case, we can just use the other researchers models and save the American taxpayers some money.
Reviewer: James Scofield	Good work focused on a specific task/issue. Good connection to IGBT thermal performance of jet impingement.	Comparison of jets, fluid type, and single vs. two-phase techniques concise and contributes to system analysis tool set.	Provides solid basis for system evaluation. Requires more experimental validation and comparison.		
Reviewer: Jason Lai					
Reviewer: John M. Miller	Good detailed investigation of jet impingement cooling. Excellent modeling work.	What is the power consumption of providing pressurized fluid flow and recovery required to remove 1 p.u. power dissipation?	Excellent progress	Why are we doing this? Concerns over erosion, corrosion, package stress are well founded.	
Reviewer: K Fiegenschuh	Finite element models for jet impingement cooling can be useful tools when evaluating and designing cooling systems for future hybrid and fuel cell vehicles.	PI has developed an analytical tool that will be useful for evaluating jet impingement cooling.	PI has delivered the jet impingement model as requested. Data was correlated with published literature. However, PI needs to gather additional data points and correlate these experimental data with the model, then compare to real world data.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Jet Impingement					
Presenter: Narumanchi, Sreekant *Reviewer: M. Mehall*	Analytical tools to aid design for jet impingement are needed.	Good approach to modeling backed up with what appears to be a thorough overview of relevant background.	Would like to see more validation testing over broader range of material and environment conditions.		
Reviewer: Pat McCluskey	Jet Impingement is one of the few technologies that can achieve the DOE goal of Δ T < 20° C. Good companion with IGBT structure for low resistance.	Modeling is excellent, requires validation testing to confirm results.	Outstanding job of modeling single jet impingement. Needs some experimental validation work and practical assessment of results. Also needs some more complex multiple jet impingement modeling than just closed-form equation.	Experimental validation of single/multiple jet results. More elaborate modeling of multiple jet.	
Reviewer: Vijay Garg	PI is developing a Jet impingement model for Semikron inverter recommended by the team.		PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).		PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Spray Cooling					
Presenter: Bharathan, Desikan *Reviewer: Allen Hefner*	I have serious reservations about spray cooling being practical for this application.	Although it is interesting to survey the literature and summarize existing theory and empirical data for spray cooling, the important issue is if this technology can be made practical and reliable for the FreedomCAR applications.	There seems to be no accomplishments other than summarizing and adding a look up interface for previous results of others.		
Reviewer: Anson Lee	Good relevant project	Using Excel as a modeling tool is inadequate at best.	Must show how this tool could model the inverter.		
Reviewer: Brian Welchko	In theory, the project is a good idea.	A simple literature survey is all that is being done.	This is pathetic. All of the effort was spent on a software interface for models the researchers claim need experimental verification. There are zero plans to perform any of the experimental verification that is necessary!		Cancel this project. It is an absolute waste of DOE money in its current form. There has been zero real progress in the last year.
Reviewer: Edward Jih and Tech Team (OEM)		Team expressed reservations in using the EXCEL model (which was presented) to model and analyze the thermal performance of Semikron inverter fitted with spray cooling technology.	Team recommended to develop models of Semikron inverter with spray cooling technology and required hardware.		A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	In theory, the project is a good idea.	A simple literature survey is all that is being done.	Experimental verification is require to verify model. Extremely disappointed that no verification of model planned.		Cancel this project. It is an absolute waste of DOE money in its current form. There has been zero real progress in the last year.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Spray Cooling					
Presenter: Bharathan, Desikan					
Reviewer: James Scofield	Good project to evaluate the merits of various working fluids and spray configurations. NREL model improves efficiency of evaluation. Improved empirical connection required to improve correlation.	Better connection to improved correlation → experimental validation. Connection to system in terms of reliability, cost, volume and weight.	Only progress appears NREL model evaluation. No system connectivity.		
Reviewer: Jason Lai	It helps analytical work. The program goal stays with 105°C cooling.	Software may be useful for study purpose "spray" to be further verified.			
Reviewer: John M. Miller	Complex closed system cooling loops for liquid circulation, vapor recovery and condensing. Can spray cooling be integrated into the AIPM w/o substantial pkg volume increase?	Jet impingement is necessary if heat flux is greater than 150w/cm2 are demanded but would an automotive OE actually put this into serial production?	Valid as an optimal thermal management ethnology at this time - interior tech., but where is it leading?	Need Tech Team to update/validate the thermal environment requirements for HEV and FCV.	
Reviewer: K Fiegenschuh	Cooling of electrical components is important to future hybrid and fuel cell vehicle design to improve system efficiency and packaging requirements. This is a good idea in theory but based on the presentation it is unclear where the research is going or if there is any value expected to come from it.	PI has tried to model a complex system with what appears to be a simple Excel-based model. The resulting model seems superficial. It is unclear if such a simplistic model can adequately model spray and jet cooling.	See comments under #2 above.		
Reviewer: M. Mehall	Difficult area to model, but benefits could be great.	This is a good first step to do empirically based model until detailed models are capable.	Need to understand root cause of limited correlation to justify further work on such models. Focus on first principles and shift to detailed models if correlation is not attained.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Modeling High Heat Flux Heat Removal: Spray Cooling					
Presenter: Bharathan, Desikan					
Reviewer: Pat McCluskey	Cooling is critical to achieving DOE goals. Spray cooling shows promise as a way of achieving ΔT°<20°C goal. However, the relevant problem is not demonstrating spray cooling but rather combining it with packaging to provide a working module that can be cost effective and reliable for automotive applications.	Model and software are valuable for performing sensitivity analysis of cooling nozzle, fluid, and target distance selection for optimum cooling.	Model and associated software are ready for use - need to achieve better correlation with test data for heat transfer coefficient of fluorocarbons.	Spray cooling is fairly well demonstrated by prior DOD work. The challenge here is adapting the technology to the cost/reliability/environmental characteristics of commercial automotive applications. New project that stresses cost effective, reliable, long-life design of a spray cooling system for automotive, similar to the jet impingement/IGBT system or the refrigerant loop/inverter packaging system.	
Reviewer: Vijay Garg		Team expressed reservations in using the EXEL model (which was presented) to model and analyze the thermal performance of Semikron inverter fitted with spray and jet impingement cooling technologies.	Team recommended to develop models of Semikron inverter with spray and jet impingement cooling technologies and required hardware.		Team recommended to develop models of Semikron inverter with spray and jet impingement cooling technologies and required hardware.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Polymer Film and Nano-Dielectric Capacitors					
Presenter: Tuttle, Bruce *Reviewer: Anson Lee*	Relevant project for FreedomCAR	Seemed to be "shot-gunning," too many materials are being tried.	Not much progress since last year.		
Reviewer: Brian Welchko	The subject area and goals seem admirable.	This is a complete shotgun approach.	The output of this project continues to be a disappointment. It is way beyond time that the resources be redistributed to projects which are making progress.		
Reviewer: Edward Jih and Tech Team (OEM)		Developing and evaluating so many materials for bulk capacitors will require resources and time. Team is concerned about the resources, which may spread thin.		Team would like to recommend selecting few promising materials and focusing on them.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	The subject area and goals seem admirable.	No focus. No capacitor industry involvement in work.	The output of this project continues to be a disappointment. It is way beyond time that the resources be redistributed to projects which are making progress.		
Reviewer: James Scofield	Modified PPS and ceramic piezoelectric film focus is a very good approach to incrementally improving cap ED and temp. performance. Criticality of cap's to PE reliability, volume and weigh cannot be understated.	Appears to be a slightly more modest element of risk for the film portion of the work. Availability and ability to fabricate appropriate poly0films may be an obstacle.	PLZT ceramic aerosol deposition composition control very appealing for indication of reduced temp. sintering. Packaging and metallization impact.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Polymer Film and Nano-Dielectric Capacitors					
Presenter: Tuttle, Bruce *Reviewer: Jason Lai*	Remain in materials level. Should push forward for a large-size capacitor that can be used in power electronics/motor drive inverter DC Bus.	Different materials have been evaluated comprehensively. Sample capacitors have been built for testing.	Has the capacitors made for evaluation. Has interactions with key manufacturers and capacitor suppliers. Has addressed FreedomCAR needs.		
Reviewer: John M. Miller	Film capacitors are the proper type for automotive. But this need for a new chemistry to go from 100°C to 150°C is disappointing.	Excellent process, collaboration, and industry interaction.	Still haven't achieved the 140°C target.	Why should this have a future?	
Reviewer: K Fiegenschuh	Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.	PI seems to be taking a shotgun approach to identifying and evaluating candidate materials. According to the presentation this project has been ongoing since 1999 yet there is no indication of what work actually was accomplished in the prior year.	Several slides are devoted to detailing what is planned for the remainder of the year; and milestone plans for FY05, but I wonder about the limited discussion of technical data or results presented. It is unclear if there were significant technical accomplishments during the prior year and the presentation did a poor job of reporting them; or if there were no significant results and that was the reason for a technically superficial presentation.		
Reviewer: M. Mehall	Need lower cost, high life, and high temp bulk capacitance.	Cover the waterfront initially, but narrow down and demonstrate winners & losers quickly. Identify where we need more study because there are big opportunities.	Good exploratory work but need a means to use results to communicate progress more effectively. Materials cost and capability are the critical metrics.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Polymer Film and Nano-Dielectric Capacitors					
Presenter: Tuttle, Bruce					
Reviewer: Pat McCluskey	High temperature, high energy density capacitors are an important enabling technology for hybrid vehicles. The study of improved polymer and ceramic capacitors is very worthwhile.	Chemical modification of polymers for higher temperatures and greater volumetric efficiency and nanoparticle compactions for higher breakdown strength and increased energy density both show promise.	Of the two areas, polymers and nano-ceramics, the molecularly modified polymers seem to have shown the most development and promise for hybrid applications and the achievement in the area have been impressive.		
Reviewer: Vijay Garg		Developing and evaluating so many materials for bulk capacitors will require resources and time. Team is concerned about the resources, which may spread thin.		Team would like to recommend to select few promising materials and focus on them.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

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Power Electronics Crosscut Activities for EERE and OETD					
Presenter: Smith, Richard *Reviewer: Anson Lee*	Some relevance to FreedomCAR.	Good approach.	Modest findings. Not sure how this really benefits FreedomCAR.		
Reviewer: Brian Welchko		Approach makes sense.			This is a good idea in theory to leverage the funds of other branches of the government.
Reviewer: Edward Jih and Tech Team (OEM)					
Reviewer: Greg Smith					This is a good idea in theory to leverage the funds of other branches of the government.
Reviewer: Jason Lai	Try to make good use of program money	To identify key players. It's difficult to know who's doing what, especially worldwide. Researchers attending international conferences would know more.	I think auto manufacturers need to be involved.		
Reviewer: John M. Miller	Very important area to DOE and to DOE-industry interactions.		Need the reports.	Yes, have an interagency workshop.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Power Electronics Crosscut Activities for EERE and OETD					
Presenter: Smith, Richard *Reviewer: K Fiegenschuh*	Cross cutting activates support is a necessary function of DOE and its collaboration with other government activities. I recognize its need but question the need to formally review and evaluate it as if it were a research and development project. I would recommend that in the future this continue to be reported as an information item, but that there not be a requirement to evaluate the presentation in the same context as the technical R&D projects reported during the remainder of the meeting	See comment above.	See comment above.	See comment above.	
Reviewer: M. Mehall	I hope we find a GEM.	Need to be aggressive.	Seems like a slow start considering FY04 start.		
Reviewer: Pat McCluskey	With limited resources today, it is important to leverage resources w/other agencies and corporations that have similar applications and interests. This provides a method for achieving that leverage which can accelerate and enhance the research.	Good plan to get a wide range of collaborations involved. Good assessment of the cross-cutting research area and applications.	Good identification of key players and collaborators and significant progress make toward future cross-cutting proposals.		
Reviewer: Vijay Garg					

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Study on Prius Motor Temperature Rise and Ratings					
Presenter: Hsu, John *Reviewer: Anson Lee*	Benchmarking best-in-class is highly relevant.	Good approach but test set-up needs to be more versatile to run higher speeds.	Model is only good for 1 motor speed, not valid for all speeds.		
Reviewer: Brian Welchko	Good Project	Results are as desired implies the approach was successful	Project is completed. This is a good engineering analysis but what have we learned from it? There does not seem to be any indication of how this information could be used to improve any future designs.		Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: Edward Jih and Tech Team (OEM)	The OEM team recommends benchmarking of technologies. Benchmarking data is important for future R&D reference purposes.	It is not clear that the analytical model developed in this project can be applied successfully to other IPM motor designs at operating conditions other than 900 RPM.	The benchmarking efforts and competitive product data collection represents a step in the right direction.	If possible, please perform thermal test of Prius motor at other motor speeds (i.e., 2000 & 4000 RPM). Then more test measurements can be used to validate the motor temperature simulation tool.	1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team would like seeing the list of other investigators helping Dr Hsu in these projects. Team observed Dr. Hsu's name on a number of big projects (in terms of dollars).

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Study on Prius Motor Temperature Rise and Ratings					
Presenter: Hsu, John *Reviewer: Greg Smith*	Good project.	Results are as desired implies the approach was successful.	Project is completed. This is a good engineering analysis but what have we learned from it? There does not seem to be any indication of how this information could be used to improve any future designs.		Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.
Reviewer: James Scofield	Critical to the FC ultimate design criteria as thermal management to maintain performance and reliability must begin with highly accurate heat load models.	Excellent application of theory → FE analysis→ empirical results. Consumer acceptance will require performance under all load conditions. Control of thermal loads are the key.	Data speaks for itself. FE analysis - experimental agreement indicate validity of process and model. Should continue to evaluate other motor types and core-winding materials.		
Reviewer: Jason Lai	Good study, but hopefully it's not to serve Toyota.	Both analytical and experiment are done!	Solid numbers are given.	Perhaps the same approach can be used for the entire drive package, including inverter.	
Reviewer: John M. Miller	This work is very relevant to hybrid and FC vehicle thermal projects. The Prius traction motor is thermally sized to match power split continuous circulating power but only transient power levels as demanded for drivability (engine augmentations).	Excellent laboratory mock-up for realistic thermal performance.	Project shows excellent guidelines for FCVT motor design goal of 30 kw continuous rating.	DOE should require vehicle thermal survey of hybrid sedan and light truck/SUV to validate continued use of legacy thermal environmental spec.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Study on Prius Motor Temperature Rise and Ratings					
Presenter: Hsu, John					
Reviewer: K Fiegenschuh	Benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice.	Experimental test set up only evaluated components under one test condition (sinusoidal waveform at 900 rpm). Need to do testing under more than the one condition especially if one of the intents of the research is to develop an analytical model that will be versatile enough to predict outcomes under varying operating conditions.	I question how representative the results are of real world conditions; would have preferred to see some form of duty cycle evaluated that represented real world operating conditions. Analytical model is only correlated to the one test condition so may have limited usefulness.		
Reviewer: M. Mehall	Benchmarking to establish state of art or application is necessary!	Demonstrate or confirm that single operating point measures are sufficient.	Please compare to prior baselines or state of art. Nice correlation of models.		
Reviewer: Pat McCluskey	Benchmarking current hybrid technology efficiency is crucial to understanding if program goals are reasonable, to select promising technologies and to rule out less successful or limited approaches. Power limitation and motor heating are important concerns.	Tools developed can be valuable for DOE prototypes. This includes both modeling and measurement tools. However, project does not address fundamental engineering design reasons for the power limitation level in Prius motor & how it might be redesigned (needed materials or technology) to improve the power limits.	Good examination of the limits of current technology. Showed current efficiency and power levels are below DOE goal.	Expansion of these measurements & models to power electronic temp in Prius as well as motor windings.	

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Study on Prius Motor Temperature Rise and Ratings					
Presenter: Hsu, John *Reviewer: Vijay Garg*	The OEM team recommends benchmarking of technologies. Benchmarking data is important for future R&D reference purposes.	It is not clear that the analytical model developed in this project can be applied successfully to other IPM motor designs at operating conditions other than 900 RPM.	The benchmarking efforts and competitive product data collection represents a step in the right direction.		1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims. 2. Team would like seeing the list of other investigators helping Dr Hsu in these projects. Team observed Dr. Hsu's name on a number of big projects (in terms of dollars).

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Wide Bandgap Materials					
Presenter: Ozpineci, Burak					
Reviewer: Allen Hefner	SiC power devices have the ability to increase the thermal budget and therefore could solve one of the most difficult issues for power devices in the vehicle environment, that is the cooling with low thermal budget.	Comprehensive approach including SiC device characterization, theory, inverter, application, and system impact studies.	The work presented is accurate and results are consistent with the finding for high voltage SiC device work being performed by others. This could become a world class effort with high probability of having a large impact on FreecomCAR goals.		
Reviewer: Anson Lee	Highly relevant research.	Outstanding approach.	Great progress in a relatively short period of time.		
Reviewer: Brian Welchko	Very important research area.	Good approach and shows flexibility to adjust to changes in the marketplace.	Very good results.		
Reviewer: Edward Jih and Tech Team (OEM)					A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like to see additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	Very important research area.	Good approach and shows flexibility to adjust to changes in the marketplace.	Very good results.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Wide Bandgap Materials					
Presenter: Ozpineci, Burak					
Reviewer: James Scofield	Investigation of SiC, and other WBG candidates, impact on component efficiency, power density, and thermal mgmt requirements relaxation is OUTSTANDING. Focus is on the critical aspects of PE performance, reliability, and cost.	Excellent balance of modeling, and especially empirical performance determination/validation of SiC utilization impact on components. Key focus on reliability and system impact.	Inverter comparison of Si and SiC device utilization results correlate well with our performance measurements in DC/DC converter applications.		
Reviewer: Jason Lai	SiC may seem attractive but it is too early to show any promise for FreedomCAR.	Devices and inverters are characterized extensively.	Good progress so far with hard data experimental results.		
Reviewer: John M. Miller	RPI and others have already made Si vs. SiC comparisons in power electronics converters. However, not in the context of APEEMD.	Very good coverage over temperature extremes and explanation of Rds (?) increase below +50°C.	Excellent industry partners collaborations, but need application with ------- OE's.		
Reviewer: K Fiegenschuh	SiC is the kind of leapfrog technology that can benefit from long range federal research funding. The need for high reliability, low cost component is critical to future applications for hybrid and fuel cell vehicles.	This project has been evolving as the needs of the program and as the commercial/technical marketplace have been changing. The flexibility of the PI and the research increase its value.	Research has made good progress. PI has listened and reacted positively to recommendations from reviewers. PI has shared results & data and has associated the project with valuable collaborators resulting in appreciable progress.		
Reviewer: M. Mehall			Good reporting of final results on Semikron.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Wide Bandgap Materials					
Presenter: Ozpineci, Burak *Reviewer: Pat McCluskey*	SiC is a very promising technology for achieving high efficiency power modules at 105°C without the cost/reliability/performance complications of active cooling technologies. The analysis of SiC Diode/MOSFET/VJVET devices is very useful. Program needs to have a goal of either improvement or adaptation to automotive needs - not just measurement.	Benchmarking and confirmation was well done. Experimental analysis was fine. Interesting conclusions drawn in SiC MOSFETS. Adaptation, modification, and improvement for the automotive environment was missing. What are the suggestions/recommendations for device selection/packaging and integration?	Good collaboration with industrial and academic partners. Excellent characterization work and conclusions on SiC MOSFET. Needs to focus now on device selection and incorporation into package or system.	More work on packaging and integration, especially its effect on SiC performance and reliability in final module.	
Reviewer: Vijay Garg		Good approach.			A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles					
Presenter: Peng, Fang *Reviewer: Anson Lee*	Highly relevant project.	Clever approach, but need to verify if new failure modes could be created.	Good progress so far, need more thorough testing for prove-out.		
Reviewer: Brian Welchko	The importance of this project has diminished as the deficiencies of the topology have become known.	Excellent	Excellent	An extension of the project looking to adapt the topology to hybrid applications should be funded at a low level, perhaps $50K.	This project is wrapped up.
Reviewer: Edward Jih and Tech Team (OEM)			No data was presented to prove reliability of the device.	Continue the project to optimize and develop technology for application in hybrid vehicles.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like to see additional improvements with regard to hardware demonstration and analytical data supporting the claims.
Reviewer: Greg Smith	The importance of this project has diminished as the deficiencies of the topology have become known.	Excellent.	Excellent	An extension of the project looking to adapt the topology to hybrid applications should be funded at a low level, perhaps 50k.	This project is wrapped up.
Reviewer: James Scofield	Significant potential to impact cost and reliability by eliminating converter switch bridge. Inclusion of buck functionality.	Highly novel topology with good mix of simulation, fabrication test, and design validation in 55kW inverter. Reliability assessment should be included as switches appear to be doing double duty.	Results to date appear to verify predicted performance.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles					
Presenter: Peng, Fang *Reviewer: Jason Lai*	A very innovative circuit topology that allows versatile application.	Controls are being developed to address all possible issues.	Experimental results are available for further understanding.		
Reviewer: John M. Miller	Power Electronic innovation well worth the investigation.	Good, novel application of C-C's to replace Si-devices. But can the Z-source meet the FreedomCAR specific power (gravimetric and volumetric) requirements?	Need to very that the Z-source satisfies all 5 HEV modes: 1)Batt-EV (fwd pwr flow) 2) Batt charge at idle (reverse pwr flow) 3) Boosting (augment engine) 4) Regen to energy storage via traction motor 5) Vehicle reverse mode (but this is more of a transmission reqm't than inverter requirement) Need temperature tests yet.	If the Z-source satisfies the 5 HEV modes, then perhaps the OEM's will pick up further development.	
Reviewer: K Fiegenschuh	Innovative new approach to design topology that may (or may not) prove beneficial in the long run to improved power electronics for future fuel cell and hybrid vehicles.	Commendable that DOE has funded new innovative design approaches to inverter design. Initial results seem promising analytically and now we need more testing with hardware (and further analysis based on experimental tests) to fully understand the design implications and determine if the initial promise/optimism was justified.	There has been good progress in a little over 11/2 years of work, but we still need to see the hardware tested for reliability and other design attributes and a technical assessment of the results.		
Reviewer: M. Mehall	Novel concept with potential.		Await reliability and efficiency due to ripple effects.		
Reviewer: Pat McCluskey	Z-Source inverter shows promise as a low cost, high efficiency device for hybrid electric vehicles.	Approach of design development and testing is well thought out and on schedule.	Prototype designed and developed and preliminary testing already completed. Project already shows some advantages of prototype Z-Source inverter.		

	Relevance Justification	Approach Justification	Technical Accomplishment and Progress Justification	Suggestions for Future Projects	Additional Comments
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles					
Presenter: Peng, Fang *Reviewer: Vijay Garg*			No data was presented to prove reliability of the device.	Continue the project to optimize and develop technology for application in hybrid vehicles.	A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

Appendix A

Reviewers' Ratings (all ratings, grouped by title)

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Form Ratings (grouped by title)

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
AIPM Validation/Testing	Nelson, Sam	ORNL	Anson Lee	6	9	4.0	4.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	Brian Welchko	9	8	3.0	3.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	3.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	Greg Smith	9	8	3.0	3.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	James Scofield	9	8	3.0	3.0	3.5
AIPM Validation/Testing	Nelson, Sam	ORNL	Jason Lai	9	10	3.0	2.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	John M. Miller	10	10	4.0	4.0	4.0
AIPM Validation/Testing	Nelson, Sam	ORNL	K Fiegenschuh	5	8	4.0	3.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	M. Mehall	5	8	4.0	3.0	3.0
AIPM Validation/Testing	Nelson, Sam	ORNL	Pat McCluskey	9	9	3.0	3.0	4.0
AIPM Validation/Testing	Nelson, Sam	ORNL	Vijay Garg	10	9	4.0	3.0	3.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Anson Lee	7	8	4.0	3.0	3.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Brian Welchko	8	10	4.0	2.0	2.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	2.0	3.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Greg Smith	8	10	4.0	2.0	2.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Jason Lai			3.0	3.0	3.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	John M. Miller	10	10	3.0	3.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	K Fiegenschuh	5	8	4.0	2.0	3.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	M. Mehall	6	8	4.0	3.0	2.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Pat McCluskey	7	7	3.0	3.0	2.0
Benchmarking of Competitive Technologies	Staunton, Robert	ORNL	Vijay Garg	10	10	4.0	2.0	3.0
Characterization of PM Materials	Lara-Curzio, Edgar	ORNL	Brian Welchko	7	10	4.0	1.0	2.0
Characterization of PM Materials	Lara-Curzio, Edgar	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	1.0	2.0
Characterization of PM Materials	Lara-Curzio, Edgar	ORNL	Greg Smith	7	10	4.0	1.0	2.0
Characterization of PM Materials	Lara-Curzio, Edgar	ORNL	M. Mehall	5	8	4.0	2.0	2.0
Characterization of PM Materials	Lara-Curzio, Edgar	ORNL	Vijay Garg	10	7	4.0	1.0	2.0
Component Characterization	Seiber, Larry	ORNL	Anson Lee	5	7	3.0	4.0	3.0
Component Characterization	Seiber, Larry	ORNL	Brian Welchko	7	10	2.0	4.0	2.0
Component Characterization	Seiber, Larry	ORNL	Edward Jih and Tech Team (OEM)	8	4	2.0	3.0	2.0
Component Characterization	Seiber, Larry	ORNL	Greg Smith	7	10	2.0	4.0	2.0
Component Characterization	Seiber, Larry	ORNL	Jason Lai	7	4	2.0	2.0	3.0
Component Characterization	Seiber, Larry	ORNL	John M. Miller	10	10	4.0	2.0	3.0
Component Characterization	Seiber, Larry	ORNL	K Fiegenschuh	5	4	2.0	4.0	3.0
Component Characterization	Seiber, Larry	ORNL	M. Mehall	7	8	3.0	4.0	3.0
Component Characterization	Seiber, Larry	ORNL	Pat McCluskey	9	8	4.0	3.0	4.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Component Characterization	Seiber, Larry	ORNL	Vijay Garg	10	4	2.0	4.0	2.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Anson Lee	2	6	4.0	3.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Brian Welchko	7	10	4.0	4.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Edward Jih and Tech Team (OEM)	8	10	4.0	3.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Greg Smith	7	10	4.0	4.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	James Scofield	7	8	4.0	4.0	4.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Jason Lai	3	7	4.0	4.0	4.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	John M. Miller	10	10	3.0	3.0	4.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	K Fiegenschuh	5	8	4.0	3.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	M. Mehall	5	8	4.0	3.0	3.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Pat McCluskey	8	9	4.0	4.0	4.0
Development of Improved Powder for Bonded Permanent Magnets	Anderson, Iver	AMES	Vijay Garg	10	9	4.0	3.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Electric Motor Research & Development	Hsu, John	ORNL	Pat McCluskey	4	8	4.0	3.0	3.0
Electric Motor Research and Development	Hsu, John	ORNL	Anson Lee	5	9	4.0	2.0	1.0
Electric Motor Research and Development	Hsu, John	ORNL	Brian Welchko	9	10	4.0	1.0	1.0
Electric Motor Research and Development	Hsu, John	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	1.0	1.0
Electric Motor Research and Development	Hsu, John	ORNL	Greg Smith	5	10	4.0	2.0	2.0
Electric Motor Research and Development	Hsu, John	ORNL	James Scofield	3	10	4.0	3.5	3.0
Electric Motor Research and Development	Hsu, John	ORNL	Jason Lai	7	7	4.0	4.0	3.0
Electric Motor Research and Development	Hsu, John	ORNL	John M. Miller	10	10	4.0	4.0	4.0
Electric Motor Research and Development	Hsu, John	ORNL	K Fiegenschuh	5	9	4.0	2.0	1.0
Electric Motor Research and Development	Hsu, John	ORNL	M. Mehall	5	9	4.0	2.0	2.0
Electric Motor Research and Development	Hsu, John	ORNL	Vijay Garg	10	9	4.0	1.0	1.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Anson Lee	5	9	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Brian Welchko	10	10	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Greg Smith	5	10	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	James Scofield	4	10	3.0	3.5	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Jason Lai			4.0	4.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	John M. Miller	10	10	4.0	4.0	4.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	K Fiegenschuh	5	9	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	M. Mehall	5	7	4.0	3.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Pat McCluskey	4	8	3.0	4.0	3.0
Flux Weakening and CPSR Enhancement Techniques	McKeever, John	ORNL	Vijay Garg	10	7	4.0	3.0	3.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Anson Lee	5	7	0.0	0.0	3.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Brian Welchko	7	10	1.0	1.0	1.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Edward Jih and Tech Team (OEM)	8	1	1.0	1.0	1.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Greg Smith	7	10	1.0	1.0	1.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	James Scofield	8	9	4.0	4.0	4.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Jason Lai	5	6	3.0	3.0	3.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	John M. Miller	10	8	3.0	3.0	2.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	K Fiegenschuh	5	8	2.0	1.0	1.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	M. Mehall	5	6	2.0	2.0	1.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Pat McCluskey	9	9	4.0	4.0	4.0
Glass Ceramic Dielectrics for DC Bus Capacitors	Lanagan, Mike	PSU	Vijay Garg	10	1	1.0	1.0	1.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Allen Hefner	8	8	4.0	3.0	3.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Anson Lee	8	5	3.0	3.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Brian Welchko	4	10	2.0	3.0	3.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Edward Jih and Tech Team (OEM)	8	9	4.0	3.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Greg Smith	6	10	2.0	3.0	3.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	James Scofield	7	8	3.0	3.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Jason Lai	5	4	2.0	2.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	John M. Miller	8	10	4.0	3.0	3.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	K Fiegenschuh	5	9	3.0	3.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	M. Mehall	6	8	3.0	3.0	2.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Pat McCluskey	7	8	3.0	2.0	3.0
HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop	Ayers, Curt	ORNL	Vijay Garg	10	5	3.0	3.0	2.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Anson Lee	5	7	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Brian Welchko	7	10	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Edward Jih and Tech Team (OEM)	8	10	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Greg Smith	7	10	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Jason Lai	5	6	3.0	3.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	John M. Miller	10	8	3.0	4.0	4.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	K Fiegenschuh	5	8	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	M. Mehall	5	8	4.0	3.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Pat McCluskey	9	9	4.0	4.0	3.0
High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics	Kaufman, David	ANL	Vijay Garg	10	9	4.0	4.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Anson Lee	8	6	2.0	2.0	2.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Brian Welchko	8	7	2.0	2.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Edward Jih and Tech Team (OEM)	8	1	1.0	1.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Greg Smith	8	7	2.0	2.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	James Scofield	7	8	3.0	3.5	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Jason Lai	9	8	4.0	4.0	4.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	John M. Miller	10	10	4.0	3.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	K Fiegenschuh	5	7	1.0	2.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	M. Mehall	5	6	2.0	2.0	2.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Pat McCluskey	5	9	3.0	3.0	3.0
Integrated DC/DC Converter for Multi-Voltage Bus Systems	Su, Gui-Jia	ORNL	Vijay Garg	10	2	1.0	1.0	3.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Anson Lee	6	9	2.0	2.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Brian Welchko	8	8	2.0	4.0	3.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Edward Jih and Tech Team (OEM)	8	4	2.0	2.0	2.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Greg Smith	8	8	2.0	4.0	3.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	James Scofield	7	8	3.0	3.0	3.5
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Jason Lai	9	7	4.0	3.0	4.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	John M. Miller	9	10	3.0	3.0	3.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	K Fiegenschuh	5	4	2.0	2.0	3.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	M. Mehall	5	6	2.0	3.0	2.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Pat McCluskey	3	8	2.0	3.0	2.0
Integrated Inverter for HEVs and Fuel Cell Powered Vehicles	Su, Gui-Jia	ORNL	Vijay Garg	10	2	2.0	3.0	3.0
Inverter Packaging	Hsu, John	ORNL	Allen Hefner	8	8	4.0	3.0	2.0
Inverter Packaging	Hsu, John	ORNL	Anson Lee	5	5	4.0	3.0	2.0
Inverter Packaging	Hsu, John	ORNL	Brian Welchko	5	8	3.0	3.0	2.0
Inverter Packaging	Hsu, John	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	3.0	2.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Inverter Packaging	Hsu, John	ORNL	Greg Smith	7	8	3.0	3.0	3.0
Inverter Packaging	Hsu, John	ORNL	James Scofield	6	9	3.0	3.0	4.0
Inverter Packaging	Hsu, John	ORNL	Jason Lai	3	3	3.0	3.0	3.0
Inverter Packaging	Hsu, John	ORNL	John M. Miller	8	9	3.0	3.0	4.0
Inverter Packaging	Hsu, John	ORNL	K Fiegenschuh	5	9	4.0	3.0	2.0
Inverter Packaging	Hsu, John	ORNL	M. Mehall	7	9	4.0	3.0	3.0
Inverter Packaging	Hsu, John	ORNL	Pat McCluskey	9	8	4.0	3.0	3.0
Inverter Packaging	Hsu, John	ORNL	Vijay Garg	10	7	4.0	3.0	2.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Anson Lee	2	6	2.0	2.0	2.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Brian Welchko	7	10	1.0	2.0	1.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Edward Jih and Tech Team (OEM)	8	1	1.0	2.0	1.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Greg Smith	7	10	1.0	2.0	1.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	James Scofield	7	8	3.0	2.0	3.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Jason Lai	3	7	4.0	4.0	4.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	John M. Miller	10	10	3.0	3.0	4.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	K Fiegenschuh	5	8	1.0	2.0	1.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Pat McCluskey	8	9	3.0	3.0	2.0
Low Cost, High-Energy-Product Permanent Magnets	Cha, Yung	ANL	Vijay Garg	10	1	1.0	2.0	1.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Allen Hefner	8	7	4.0	3.0	2.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Anson Lee	8	5	3.0	3.0	2.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Brian Welchko	7	8	3.0	2.0	1.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Edward Jih and Tech Team (OEM)	8	10	4.0	3.0	3.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Greg Smith	8	8	3.0	1.0	1.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	James Scofield	7	9	3.0	4.0	2.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Jason Lai	3	3	4.0	4.0	3.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	John M. Miller	8	10	4.0	4.0	4.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	K Fiegenschuh	5	9	3.0	3.0	2.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	M. Mehall	7	8	4.0	3.0	3.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Pat McCluskey	10	9	4.0	3.0	4.0
Low Thermal Resistance IGBT Structure	Hassani, Vahab	NREL	Vijay Garg	10	7	3.0	3.0	2.0
Mechanical Characterization of Capacitor Materials	Wereszczak, Andy	ORNL	Anson Lee	5	7	4.0	4.0	4.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Brian Welchko	6	10	3.0	4.0	4.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Edward Jih and Tech Team (OEM)	8	7	3.0	3.0	3.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Greg Smith	6	10	3.0	4.0	4.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Jason Lai	6	5	3.0	3.0	3.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	John M. Miller	9	8	4.0	4.0	3.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	K Fiegenschuh	5	8	3.0	4.0	4.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	M. Mehall	6	8	3.0	3.0	3.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Pat McCluskey	9	9	4.0	4.0	4.0
Mechanical Characterization of Dielectric Polymers	Wereszczak, Andy	ORNL	Vijay Garg	10	6	3.0	4.0	4.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Allen Hefner	8	5	3.0	2.0	2.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Anson Lee	8	5	3.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Brian Welchko	5	8	3.0	1.0	1.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Edward Jih and Tech Team (OEM)	8	10	4.0	4.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Greg Smith	5	8	3.0	1.0	1.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	James Scofield	5	9	3.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Jason Lai	1	3	3.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	John M. Miller	8	9	4.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	K Fiegenschuh	5	9	3.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	M. Mehall	5	8	3.0	3.0	2.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Pat McCluskey	7	8	4.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Jet Impingement	Narumanchi, Sreekant	NREL	Vijay Garg	10	7	3.0	3.0	2.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Allen Hefner	8	5	3.0	2.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Anson Lee	8	5	3.0	1.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Brian Welchko	5	8	3.0	1.0	1.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Edward Jih and Tech Team (OEM)	8	7	3.0	1.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Greg Smith	7	8	3.0	1.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	James Scofield	6	9	3.0	3.0	2.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Jason Lai	3	3	3.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	John M. Miller	8	10	4.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	K Fiegenschuh	5	8	3.0	1.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	M. Mehall	5	8	3.0	2.0	1.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Pat McCluskey	7	8	2.0	3.0	3.0
Modeling High Heat Flux Heat Removal: Spray Cooling	Bharathan, Desikan	NREL	Vijay Garg	10	7	3.0	1.0	1.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Anson Lee	5	7	3.0	2.0	2.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Brian Welchko	7	10	2.0	1.0	1.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Edward Jih and Tech Team (OEM)	8	7	3.0	1.0	1.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Greg Smith	7	10	2.0	1.0	1.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	ANL	James Scofield	8	9	4.0	3.5	3.5
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Jason Lai	5	6	3.0	4.0	4.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	John M. Miller	10	8	4.0	4.0	3.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	K Fiegenschuh	5	8	3.0	1.0	1.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	M. Mehall	3	8	3.0	2.0	2.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Pat McCluskey	9	9	4.0	3.0	4.0
Polymer Film and Nano-Dielectric Capacitors	Tuttle, Bruce	SNL	Vijay Garg	10	6	3.0	1.0	1.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Anson Lee	6	2	2.0	3.0	2.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Brian Welchko	7	3	2.0	3.0	2.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Edward Jih and Tech Team (OEM)	8	4	2.0	2.0	2.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Greg Smith	7	1	2.0	3.0	2.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Jason Lai	6	5	3.0	3.0	3.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	John M. Miller	9	10	3.0	3.0	3.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	K Fiegenschuh	5	5	3.0	3.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	M. Mehall	5	5	3.0	3.0	2.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Pat McCluskey	8	9	4.0	4.0	3.0
Power Electronics Crosscut Activities for EERE and OETD	Smith, Richard	ORNL	Vijay Garg	10	2	2.0	2.0	2.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Anson Lee	8	8	4.0	3.0	2.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Brian Welchko	4	10	3.0	4.0	3.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	2.0	3.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Greg Smith	4	10	3.0	4.0	3.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	James Scofield	5	9	4.0	4.0	4.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Jason Lai	6		4.0	4.0	4.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	John M. Miller	10	10	4.0	4.0	4.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	K Fiegenschuh	5	8	4.0	2.0	2.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	M. Mehall	5	8	4.0	2.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Pat McCluskey	7	8	3.0	3.0	3.0
Study on Prius Motor Temperature Rise and Ratings	Hsu, John	ORNL	Vijay Garg	10	9	4.0	2.0	2.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Allen Hefner	10	9	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Anson Lee	6	9	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Brian Welchko	7	10	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Edward Jih and Tech Team (OEM)	8	10	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Greg Smith	8	10	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	James Scofield	10	8	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Jason Lai	9	4	3.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	John M. Miller	8	9	3.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	K Fiegenschuh	5	8	4.0	4.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	M. Mehall	5	9	4.0	4.0	3.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Pat McCluskey	9	9	3.0	3.0	4.0
Wide Bandgap Materials	Ozpineci, Burak	ORNL	Vijay Garg	10	10	4.0	4.0	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Anson Lee	6	9	4.0	4.0	3.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Brian Welchko	8	8	2.0	4.0	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Edward Jih and Tech Team (OEM)	8	7	3.0	4.0	3.0

Title	Presenter	Laboratory/ Company	Reviewer	Ability to Rate (1-10) (10 being expert)	Important to FreedomCAR (1-10) (10 being strongly agree)	Relevance Rating (1-4) (4 being highest)	Approach Rating (1-4) (4 being highest)	Technical Accomplishment and Progress Rating (1-4) (4 being highest)
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Greg Smith	8	8	2.0	4.0	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	James Scofield	7	8	4.0	3.5	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Jason Lai	9	8	4.0	4.0	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	John M. Miller	10	9	4.0	3.0	3.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	K Fiegenschuh	5	9	3.0	4.0	3.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	M. Mehall	5	7	3.0	4.0	3.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Pat McCluskey	4	8	3.0	4.0	4.0
Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles	Peng, Fang	MSU	Vijay Garg	10	9	3.0	4.0	3.0

Appendix B

Reviewer Forms (listed by title – entire form)

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

Successful development of a power inverter that can meet the goals of the FreedomCAR program is a key enabler that supports the viability of future fuel cell and hybrid vehicles. Once prototype inverters have been developed, it is important that a competent and unbiased facility test all inverters to determine their ability to meet the program targets.

Approach Rating: 3

Approach Justification

Project is wrapping up.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

ORNL has done a good job of testing the power inverters developed through the APEEM program, working closely with the AIPM manufacturers to get the hardware, resolve hardware problems and thoroughly test the devices.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title
AIPM Validation/Testing

Presenter
Nelson, Sam

Laboratory/Company
ORNL

Reviewer
Greg Smith

Ability to Rate (1-10) (10 being expert)
9

Important to FreedomCAR (1-10) (10 being strongly agree)
8

Relevance Rating: 3

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification
Project has wrapped up.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter
Nelson, Sam

Laboratory/Company
ORNL

Reviewer
Anson Lee

Ability to Rate (1-10) (10 being expert)
6

Important to FreedomCAR (1-10) (10 being strongly agree)
9

Relevance Rating: 4

Relevance Justification
Mandatory step in research.

Approach Rating: 4

Approach Justification
Great Approach.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification
Good progress, test, and validation is near completion.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	9

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title
AIPM Validation/Testing

Presenter
Nelson, Sam

Laboratory/Company
ORNL

Reviewer
M. Mehall

Ability to Rate (1-10) (10 being expert)
5

Important to FreedomCAR (1-10) (10 being strongly agree)
8

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification
Nice reporting of actual results to goals.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	9	8

Relevance Rating: 3

Relevance Justification

Compact, efficient inverters for traction drives a key component for EV and HEV.

Approach Rating: 3

Approach Justification

Higher rating would require inclusion of reliability assessment, thermal cycling, and elevated T considerations.

Technical Accomplishment and Progress Rating: 3.5

Technical Accomplishment and Progress Justification

Efficiency evaluation very good work. Validate pgm. goal metrics and highlight areas remaining for concentrated effort. Power/vol metric unlikely to be achieve without increased temp capability.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	*Laboratory/Company*
Nelson, Sam	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	9	9

Relevance Rating: 3

Relevance Justification

Confirmation that SemiKron module meets targets of AIPM in PNGV is good, but, 1) Does it meet new targets of FreedomCAR? 2) Since it meets AIPM/PNGV will it now be accepted and integrated into automobile? 3) What are suggestions for moving it into the marketplace?

Approach Rating: 3

Approach Justification

Good performance characterization, need more characterization of long-term reliability in automotive applications.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Good characterization of the critical parameters of the SemiKron inverter. Good confirmation of its meeting the targets of AIPM for PNGV.

Suggestions for Future Projects

Long-term reliability of SemiKron AIPM for automotive environment. Analysis of new development needed to meet new FreedomCAR goals.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title
AIPM Validation/Testing

Presenter
Nelson, Sam

Laboratory/Company
ORNL

Reviewer
Brian Welchko

Ability to Rate (1-10) (10 being expert)
9

Important to FreedomCAR (1-10) (10 being strongly agree)
8

Relevance Rating: 3

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification
Project has wrapped up.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

Very relevant and good description of test methodology.

Approach Rating: 4

Approach Justification

Excellent tech approach

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Project shows good agreement with FreedomCAR goals , or getting closer, so progress is very respectable.

Suggestions for Future Projects

Would be very insightful to see the impact of testing this same AIPM at 650V and at 800V provided power stage electronics were available. Then how would the resulting metrics compare with those measured here at 325Vdc and 402Vdc.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

AIPM Validation/Testing

Presenter	***Laboratory/Company***
Nelson, Sam	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	9	10

Relevance Rating: 3

Relevance Justification

Unfortunately, it's not in-house development. Lots of details are missing.

Approach Rating: 2

Approach Justification

Need to know more fundamentals and characteristics of inverter control and packaging, not just testing.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Experimental results have been obtained, although there are some more questions that need to be answered.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	***Laboratory/Company***
Staunton, Robert	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 2

Approach Justification

Fragmented testing (because of testing facilities at different places which requires a well coordinated effort).

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Comparing technology used in Prius converter/inverter to Z-source converter/inverter is an excellent idea (slide 14).

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	***Laboratory/Company***
Staunton, Robert	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

Benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice.

Approach Rating: 2

Approach Justification

Approach appears to be questionable because it appears that benchmarking is done at several sites. This requires careful coordination and even more importantly, careful correlation of test equipment, facilities and procedures to ensure consistency of results.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Benchmarking is important to the FreedomCAR program, and I presume that important results came from this year's work, but this presentation did not show any test results. Presentation was superficial and presented no data to evaluate.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	***Laboratory/Company***
Staunton, Robert	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	7	8

Relevance Rating: 4

Relevance Justification

Highly relevant project.

Approach Rating: 3

Approach Justification

Good approach - testing could be more centralized.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good results.

Suggestions for Future Projects

Continue benchmarking other advanced systems.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	*Laboratory/Company*
Staunton, Robert	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 2

Approach Justification

Fragmented testing (because of testing facilities at different places which requires a well coordinated effort).

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Comparing technology used in Prius converter/inverter to Z-source converter/inverter is an excellent idea (slide 14).

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	*Laboratory/Company*
Staunton, Robert	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	6	8

Relevance Rating: 4

Relevance Justification

Critical to identifying the state of art and gaps.

Approach Rating: 3

Approach Justification

Keep driving to collaborate with ANL vehicle level efforts.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

I'd like to see benchmark metrics compared and extrapolated to forecast 2015 and gaps.

Correlate Vehicle/System/Component benchmark metrics to ensure that they are sufficient and compatible indicators of technology improvements. Point measures rather than duty cycle measures may not suffice!

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	***Laboratory/Company***
Staunton, Robert	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	7	7

Relevance Rating: 3

Relevance Justification

Benchmarking valuable but needs to lead to conclusions that direct further improvement and program direction, so that it is proactive and not reactive. A roadmap or technology matrix would be helpful.

Approach Rating: 3

Approach Justification

Very good approach in that: 1) examines 3 different cars from 2 different manufacturers, 2) contains both test of performance, along with disassembly and technology evaluation. Needs to have a stated standardized test procedure for comparing the different models with established and agreed on comparison metrics.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Good progress on assessing technology. Comparison of Accord vs. Civic very interesting, especially details of power module. A statement of the types of information being evaluated should be presented.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	*Laboratory/Company*
Staunton, Robert	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	8	10

Relevance Rating: 4

Relevance Justification

Benchmarking provides important feedback.

Approach Rating: 2

Approach Justification

This is a very fractured approach with work being done an ANL, UT, and ORNL. The new personnel which have been added seem questionable as this does not seem to be an area of expertise for them.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

I was hoping for better results. What has been presented is pretty basic for the money and effort which was spent.

Suggestions for Future Projects

Additional Comments

The idea of benchmarking is to provide a complete picture of the competition and place the information in the public forum where we can all learn from it. Unfortunately, many questions I have were not answered.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	*Laboratory/Company*
Staunton, Robert	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	8	10

Relevance Rating: 4

Relevance Justification

Benchmarking provides important feedback.

Approach Rating: 2

Approach Justification

This is a very fractured approach with work being done at ANL, UT, and ORNL. The new personnel who have been added seem questionable as this does not seem to be an area of expertise for them.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

I was hoping for better results. What has been presented is pretty basic for the money and effort which was spent.

Suggestions for Future Projects

Additional Comments

The idea of benchmarking is to provide a complete picture of the competition and place the information in the public forum where we can all learn from it. Unfortunately, many questions I have were not answered.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	*Laboratory/Company*
Staunton, Robert	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 3

Relevance Justification

BCT is relevant during the interim

Approach Rating: 3

Approach Justification

The BCT approach presumes U.S. is in a 1-down position technically. We are in HEV technology, so DOE's role needs to be in getting U.S. industry into a 1-up position technically.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good interim program, but not a long-term sustainable prospect.

Suggestions for Future Projects

I need to see a "technology-trajectory" result from such BCT work that points where the competition is headed in 3-5 yrs. out, or further. Then DOE/ORNL align projects in the 5-15 year-out period to anticipate future developments. Tine to wrap this one up.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Benchmarking of Competitive Technologies

Presenter	***Laboratory/Company***
Staunton, Robert	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai		

Relevance Rating: 3

Relevance Justification

I rather like to see Japanese tear apart GM or Ford vehicle, not the other way around.

Approach Rating: 3

Approach Justification

It's good to find out what's been done but it's also important to know the first principle, then other people's design can be criticized or compared.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need to be going into what's the design philosophy and characterize more on the electrical performance.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Characterization of PM Materials

Presenter	***Laboratory/Company***
Lara-Curzio, Edgar	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Characterization of PM Materials

Presenter	***Laboratory/Company***
Lara-Curzio, Edgar	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	7

Relevance Rating: 4

Relevance Justification

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Characterization of PM Materials

Presenter	***Laboratory/Company***
Lara-Curzio, Edgar	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	8

Relevance Rating: 4

Relevance Justification

Approach Rating: 2

Approach Justification

Approach does not seem right to me.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Characterization of PM Materials

Presenter	***Laboratory/Company***
Lara-Curzio, Edgar	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 4

Relevance Justification

Testing of PM materials is important

Approach Rating: 1

Approach Justification

This project is testing materials we have no interest in.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Results show that mechanical strength changes after thermal cycling but magnetic properties do not. The EETT knows that magnetic properties change after thermal cycling. Thus the desirable materials (for the EETT) are not being considered.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Characterization of PM Materials

Presenter	***Laboratory/Company***
Lara-Curzio, Edgar	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	7	10

Relevance Rating: 4

Relevance Justification

Testing of PM materials is important.

Approach Rating: 1

Approach Justification

This project is testing materials we have no interest in.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Results show that mechanical strength changes after thermal cycling but magnetic properties do not. The EETT knows that magnetic properties change after thermal cycling. Thus the desirable materials (for the EETT) are not being considered.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

Component characterization is very important to DOE so that valid tester/goals are obtained.

Approach Rating: 2

Approach Justification

This business with ESR cannot be correct

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

OK

Suggestions for Future Projects

How was ESR determined? What is definition used? How tested? AC-impedance is the proper test and ESR=Re{ZAC}

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	7	4

Relevance Rating: 2

Relevance Justification

Big effort with little significant results.

Approach Rating: 2

Approach Justification

Need more input form application people and understanding of fundamental.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Some good test results, but too much effort in this. We should have theoretical projection to support the test results.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	8

Relevance Rating: 4

Relevance Justification

It is very important to have a testing capability for assessing the performance and reliability of commercial and custom capacitors for the unique automotive environment.

Approach Rating: 3

Approach Justification

It is important that the test results should be supported by theoretical analysis and that the interpretation of the results should lead to further improvements in technology or in the development of future DOE goals. Also should make sure that the test procedures are appropriate for assessing life in the automotive environment.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent testing of the capacitor available. Good interaction w/commercial sources and government labs to get a supply of capacitors. Should get some sample and develop test capability for higher capacitance and higher voltage.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	4

Relevance Rating: 2

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	4

Relevance Rating: 2

Relevance Justification

Although in the broadest sense, benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice, this project seems to be less like "benchmarking" and more like component and subcomponent testing. Thus, the value from an OEM perspective is less than systems benchmarking would be.

Approach Rating: 4

Approach Justification

The test plan is great. Lab & PI use good facilities and good methods. No issues with the approach.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Within the defined scope of the project, the accomplishments and progress have been good. However, there appears to be little relevance of this kind of component testing to the high level OEM needs for systems and subsystems that can help deliver high quality, low cost, competitive hybrid and fuel cell vehicles.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	5	7

Relevance Rating: 3

Relevance Justification

Good relevance to overall program.

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Identified weakness of some components.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	4

Relevance Rating: 2

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	7	8

Relevance Rating: 3

Relevance Justification

This seems like a support activity. We should be focused on benchmarking where we know there are big gaps. The PI should be soliciting your support as needed.

Approach Rating: 4

Approach Justification

A very capable lab.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Support activities should not be reporting. PIs should fund the tests needed to support their needs.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 2

Relevance Justification

The testing of developed components is important.

Approach Rating: 4

Approach Justification

Thorough test plan with quality facilities and methods.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The tests have been done on non-important components.

Suggestions for Future Projects

Additional Comments

This is putting the cart before the horse. Testing is great, but only recently have they received important material to test (AMES magnets). Testing on commercial products or products which are not aligned with FreedomCAR goals is not a worthwhile use of DOE resources.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Component Characterization

Presenter	***Laboratory/Company***
Seiber, Larry	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	7	10

Relevance Rating: 2

Relevance Justification

The testing of developed components is important.

Approach Rating: 4

Approach Justification

Thorough test plan with quality facilities and methods.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The tests have been done on non-important components.

Suggestions for Future Projects

Additional Comments

This is putting the cart before the horse. Testing is great, but only recently have they received important material to test (AMES magnets). Testing on commercial products or products which are not aligned with FreedomCAR goals is not a worthwhile use of DOE resources.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	*Laboratory/Company*
Anderson, Iver	AMES

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Continue this project.

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Presenter did not spend enough time on substantial project material.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

Motor and magnet research is important to meeting the goals for FreedomCAR and are key enabling technologies for future hybrid and fuel cell vehicles.

Approach Rating: 3

Approach Justification

Appears to have solid research plan with collaboration with industry, other national labs. However PI spent too much of the time available in the presentation on background material and project plans, so he had to rush through the detailed technical results. Recommend that less time be spent on background so that there is adequate time to review the technical accomplishments.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Thorough report and data presented, but as mentioned before, inadequate time in presentation for PI to discuss data in detail.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	2	6

Relevance Rating: 4

Relevance Justification

Highly relevant research

Approach Rating: 3

Approach Justification

Good approach to improve magnets.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good results shown.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	9

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Presenter did not spent enough time on substantial project material.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	8

Relevance Rating: 4

Relevance Justification

Big cost carrot! Keep driving.

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. Focus on big picture progress to gaps that we are aiming to close. Use technical progress to support how much we progress we are making on gaps (use metrics such as $, wt, formability, quality measure…where possible). Time does not permit recounting all tasks, so focus on desire outcomes and results of approach.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	7	8

Relevance Rating: 4

Relevance Justification

Effort focused on optimized rare earth PM materials processing, coating, and alloy formation is outstanding. Focus on key process parameter for melt spin and gas atomized particle formative focus key to realizing desired BH product temperature performance, and alloy stability. Coating and commercialization of molded parts focus essential and being addressed.

Approach Rating: 4

Approach Justification

Effort addressing all key areas/issues.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Energy product demagnetization, temp, and alloy formation processing tasks have all achieved commendable results which significantly advances the SOA.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	*Laboratory/Company*
Anderson, Iver	AMES

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	8	9

Relevance Rating: 4

Relevance Justification

Magnetic are the key to efficient electrical machines and the goals of improved performance. Energy product at higher temperature and lower manufacturing cost are critical to hybrid vehicle. This project addresses a number of promising ways to achieve these goals.

Approach Rating: 4

Approach Justification

The techniques used to achieve the goals of improved energy product at higher temperature and lower manufacturing cost seem very promising. The experiments and materials development approaches are sound.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Outstanding progress has been made on several fronts as evidenced by an impressive publication and patent reward.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 4

Relevance Justification

Very important. If successful, this could put PM machines production costs on par with induction machines.

Approach Rating: 4

Approach Justification

Doing a good job.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Making progress. I wish it was faster because I want to use the end result.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	7	10

Relevance Rating: 4

Relevance Justification

Very important. If successful, this could put PM machine production costs on par with induction machines.

Approach Rating: 4

Approach Justification

Doing a good job.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Making progress. I wish it was faster because I want to use the end result.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	10	10

Relevance Rating: 3

Relevance Justification

Gas atomization process could prove very valuable to metal spray deposition of PM bonded materials. But how viable is this process for commercialization?

Approach Rating: 3

Approach Justification

Need clearer assessment of magnetizer requirements of sintered PMs

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent metallurgy

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Development of Improved Powder for Bonded Permanent Magnets

Presenter	***Laboratory/Company***
Anderson, Iver	AMES

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	3	7

Relevance Rating: 4

Relevance Justification

A synergy for PM motor development

Approach Rating: 4

Approach Justification

Continue improving alloy design

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research & Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	4	8

Relevance Rating: 4

Relevance Justification

Work on field enhancement and weakening is important. Corona study is especially interesting as it tells one of the upper limits on voltage.

Approach Rating: 3

Approach Justification

Good benchmarking. Interesting Corona test set-up. Is Corona the only limit to the maximum voltage? If other issues like battery and IGBT are involved, what is the relative importance of Corona as a limitation?

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good benchmarking and Corona results. On track (schedule and budget).

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

1. The PI is working on the application of this technology in Induction motors since 2000 (this is evident from his publications). Since 2004, he started working on the application of this technology in IPM motors.
2. The PI did not present data to support that this technology would lead to overcome barriers.

Approach Rating: 1

Approach Justification

Prius (slide 26) test report is barely acceptable.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

It seems that projects to develop this technology started in CY 2000 or earlier (see reference in Additional comments). However, the team has seen useful data such as efficiency and other performance parameters and their comparison in matrix form with competitive data set.

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

3. John S. Hsu, "Hybrid-Secondary Uncluttered Induction (HSU-I) Machines", IEEE Transactions on Energy Conversion, June 2001, Vol 16, No 2, pp. 192-187.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	9

Relevance Rating: 4

Relevance Justification

rating The need for breakthroughs in electric machines is a critical enabler for hybrid and fuel cell vehicles becoming affordable, viable and high volume. R&D into new electric machine design concepts is valuable.

Approach Rating: 2

Approach Justification

There are a number of projects within this one project, but the presentation did not devote enough time/space to any one project to do anything more than provide a superficial overview of the technical accomplishments on each one during the prior year. These projects need to be divided into separate projects so each can get the time it deserves, so research results can be reported in sufficient detail to understand progress, and so reviewers can evaluate each appropriately.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

There are many subprojects in this catch-all subject area. Few have any significant value. Some like the Corona discharge work or the motor-based CVT are intellectually interesting but seem to have little value to the FreedomCAR program or to future hybrid or fuel cell product applications.

This project needs to be subdivided into separate, concrete research projects each of which should have specific deliverables that are tied to specific FreedomCAR goals and each needs to be evaluated on its individual merit. This project seems like a sandbox for ORNL researchers.

I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	5	9

Relevance Rating: 4

Relevance Justification

Highly relevant research.

Approach Rating: 2

Approach Justification

Seemed to be a "shot-gun" approach.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This research has been ongoing since 2000, not enough results or data were shown.

Suggestions for Future Projects

Additional Comments

Dr. Hsu might need help on other projects so he could focus.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	9

Relevance Rating: 4

Relevance Justification

1. The PI is working on the application of this technology in Induction motors since 2000 (this is evident from his publications). Since 2004, he started working on the application of this technology in IPM motors.
2. The PI did not present data to support that this technology would lead to overcome barriers.

Approach Rating: 1

Approach Justification

Prius (slide 26) test report is barely acceptable.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

It seems that projects to develop this technology started in CY 2000 or earlier (see reference in Additional comments). However, the team has seen useful data such as efficiency and other performance parameters and their comparison in matrix form with competitive data set.

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

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FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	5	9

Relevance Rating: 4

Relevance Justification

Approach Rating: 2

Approach Justification

What are the anticipated improvements in a directional measurable units (e.g. how much cost reduction?). Show results or analyses that indicate progress toward those benefits.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

It appears that model correlates to results, but is this single point? Seems that we need to look at a range of operating points. . Like to see more recommendations and conclusions backed up by results.

Motor Voltage and Corona conclusion seems open ended. If many other parameters interact with Corona, to affect high voltage design, then what learning from this work is usable to move the art of increased voltage systems for reduced losses? Where should we be focusing to execute high voltage motors?

Review benefits and show gaps to targets for each subproject as lead in. Review presentations with collaborators prior to presentation in future.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	9	10

Relevance Rating: 4

Relevance Justification

Electric machines research is extremely important if FreedomCAR goals are to be achieved.

Approach Rating: 1

Approach Justification

This is a slush fund for whatever ORNL feels like working on. There is no clear objective. Correlation to FreedomCAR goals is sparse.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

The Prius test report is minimally acceptable. The remaining listed accomplishments are only theoretical or fairly irrelevant.

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	5	10

Relevance Rating: 4

Relevance Justification

Electric machine research is extremely important if FreedomCAR goals are to be achieved.

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

1. Brushless excitations - very relevant to need for high CPSR in HEV and FCHVs 2. Corona & higher voltage - essential to longer term R&D and what new operating voltages may evolve to 3. New CVT - need a power flow analysis to show how better/worse than today's eCVT of input split parity.

Approach Rating: 4

Approach Justification

1. Good theoretical & modeling approach. 2. Very good experimental work. 3. Needs further development and refinement, but very promising for compact eCVT's.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Incredible amount of work and substantial contributions have been made in this work.

Suggestions for Future Projects

Continue/expand.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	3	10

Relevance Rating: 4

Relevance Justification

Motors, their cost, performance and efficiency are critical to a competitive EV or HEV. Magnetics and motor evaluations on target. Excellent inclusion of Corona effects and voltages.

Approach Rating: 3.5

Approach Justification

Evaluation of PM and novel configurations are exactly the approach required to define an effective HEV paradigm.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Corona effects Hsu PM design

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Electric Motor Research and Development

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Jason Lai	7	7

Relevance Rating: 4

Relevance Justification

Try to have a breakthrough although results are still not clear.

Approach Rating: 4

Approach Justification

Corona test needs to use square wave high dv/dt type pulses, motor design is interesting, but need to consider leaking, coupling efficiency.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need to see actual prototype performance.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Efficiency is still a concern for Inset PM motor.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Continue to develop and build an Inset PM motor in line with FreedomCAR specifications to alleviate efficiency concerns.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	9

Relevance Rating: 4

Relevance Justification

Good basic research into flux enhancement and weakening for electric motors. Technology could be a key enabling technology permitting lighter weight, more efficient and lower cost motors for future hybrid and fuel cell applications.

Approach Rating: 3

Approach Justification

PI has assembled a good team of world-class researchers and collaborators to assist with the project. Would have liked to have seen more efficiency and performance data.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

PI has shown work and results as well as comparisons to benchmark vehicles. Data provided in presentation indicates further efficiency improvements are needed.

Suggestions for Future Projects

Recommend building a larger machine and testing it for efficiency and performance characteristics.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	5	9

Relevance Rating: 4

Relevance Justification

Highly relevant research

Approach Rating: 3

Approach Justification

Approach seemed reasonable.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good results for a small machine, need to scale up to validate concept for a large (>50 kW) motor.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	7

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Efficiency is still a concern for Inset PM motor.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Continue to develop and build an Inset PM motor in line with FreedomCAR specifications (55 kW peak) to alleviate efficiency concerns.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	4	8

Relevance Rating: 3

Relevance Justification

Motor development enables reduced size, higher efficiency, improved reliability, higher CPSR, and lower costs - all key elements of DOE goals. Focuses on development for both ICE-hybrids (near term) and fuel cell hybrids (long term.

Approach Rating: 4

Approach Justification

Good partnerships with academy/industry. Good breakdown of problem into study of boost converter, inductance control, increased saliency, and flux control.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good work on motor design (6 kW as WEMPEC) and evaluation. Good work on describing the role of reluctance. Excellent use of models and simulation.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	5	7

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Continue to emphasize how technology is progressing to closing gaps with metrics.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	10	10

Relevance Rating: 4

Relevance Justification

Control is always an important topic because it is where the OEMs can add value and differentiate their products.

Approach Rating: 3

Approach Justification

Good use of appropriate subcontractors. However, the Z-source converter is a major focus of this effort and it is listed as its own contract.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Results to date seem limited, but should come through in the long run. Promised results are tangible and not just a useless model.

Suggestions for Future Projects

Additional Comments

ORNL does not seem to be doing any of the work on this project. All reported work seems to have originated at UW-Madison. That is ok, but it is not prudent that UW-Madison is only receiving a very small (my guess less that 10%) of the project funding.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	5	10

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Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

ORNL does not seem to be doing any of the work on this project. All reported work seems to have originated at UW-Madison. That is ok, but it is not prudent that UW-Madison is only receiving a very small (my guess < 10%) of the project funding.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

1. Boost Conv/Z-Source - more relevant to FC vehicle. 2. Concentrated winding motor - very important and relevant to HEV long-term plans. 3. CPSR enhancement and voltage control - combines with both (1) and (2). Work is extremely relevant to HEV power split architectures.

Approach Rating: 4

Approach Justification

Voltage Control - Inductance Control & Inverter Control - Reluctance Control - Very comprehensive approach.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Good & several reports written. Project should deliver performance comparisons of inset vs. v-magnets vs. u-magnet designs, especially broadness of efficiency contours in torque-speed plane.

Suggestions for Future Projects

Looking forward to the reports. Focus on wider CPSR AND broader efficiency islands.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Flux Weakening and CPSR Enhancement Techniques

Presenter	*Laboratory/Company*
McKeever, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	4	10

Relevance Rating: 3

Relevance Justification

Focus on cost, efficiency, and novel winding/stator designs an excellent focus for HEV, EV needs. Flux enhancement potential significant. More on Z-source.

Approach Rating: 3.5

Approach Justification

Very good distribution of resources on key aspects which potentially can improve performance and reduce cost.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Early in effort, but progress appears to be commensurate.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai		

Relevance Rating: 4

Relevance Justification

Looks more like Honda mild ZV type motor.

Approach Rating: 4

Approach Justification

Still need to be looking into other system architecture that can be more cost-effective, perhaps a current source converter would do the job: soft switching would be more efficient; although Z-source converter seems to be attractive .

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Results to be seen.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	8

Relevance Rating: 3

Relevance Justification

Other than T operating, I'm not sure where these glass dielectrics fit in.

Approach Rating: 3

Approach Justification

Good methodology.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Just don't see the progress I'd expect since earlier reviews.

Suggestions for Future Projects

Shut this project off.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	1

Relevance Rating: 1

Relevance Justification

OEM teams recommendation is to focus developing bulk capacitors for power electronic applications.

Developing a center at PSU is not FreedomCAR goal.

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Great overview of center's capability.

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Professor Lanagan's consulting services are valuable to PIs of some national lab.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	***Laboratory/Company***
Lanagan, Mike	PSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 2

Relevance Justification

Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.

Approach Rating: 1

Approach Justification

Presentation provides a interesting overview of work being done but question the need to review this project on a stand alone basis. It appears the work is being done under subcontract to ANL.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Results of this research ought to be reported under the ANL project that is the prime.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	5	7

Relevance Rating: 0

Relevance Justification

PSU performed testing for ANL, supporting ANL's research. This is not a separate research project.

Approach Rating: 0

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	1

Relevance Rating: 1

Relevance Justification

OEM teams recommendation is to focus developing bulk capacitors for power electronic applications.

Developing a center at PSU is not FreedomCAR goal.

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Great overview of center's capability

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Professor Lanagan's consulting services are valuable to PIs.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	***Laboratory/Company***
Lanagan, Mike	PSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	9

Relevance Rating: 4

Relevance Justification

Glass-ceramic capacitors have traditionally been on e of the foremost ways to achieve high T, high energy density capacitors.

Approach Rating: 4

Approach Justification

Coating of parylene to improve breakdown strength and provide a graceful failure with good energy density is a very promising addition to traditional glass ceramic development.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Elegant solution to the graceful failure problem in ceramics though the us of a polymer coating. Good experimental work on establishing the improved performance of these film coated glass ceramics.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	***Laboratory/Company***
Lanagan, Mike	PSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	5	6

Relevance Rating: 3

Relevance Justification

Seem to remain in material level. I believe there's a gap between material level and capacitor level. Package should also be addressed.

Approach Rating: 3

Approach Justification

Has study on composite material. Need a scale-up result for >1000 µF, 500 V level demonstration.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need to move forward to capacitor demonstration to stay at the material level.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	8	9

Relevance Rating: 4

Relevance Justification

Effort to develop graceful degradation mechanism for high energy density, high temp. caps highly relevant. Caps are still the weakest PE component, especially at elevated T operating conditions.

Approach Rating: 4

Approach Justification

Well organized and focused project.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

V. good initial demonstration of polymer-ceramic MLC for improved failure modes!

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	5	6

Relevance Rating: 2

Relevance Justification

Need high temp bulk capacitance for high power apps. Capabilities of this center look good for support of testing.

Approach Rating: 2

Approach Justification

Seems to be good metrics based approach.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Great overview of center's capability.

Suggestions for Future Projects

Additional Comments

I struggled with reviewing this project because of the supporting role it plays.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	***Laboratory/Company***
Lanagan, Mike	PSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 1

Relevance Justification

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

This seemed like it was a canned presentation for the center for dielectric studies (CDS). It seems that CDS is only doing a small amount of testing as part of a subcontract to ANL. In that context, all is well and should continue as ANL sees fit.

CDS capacitor research sounds very good, but it is not aligned with FreedomCAR goals. Therefore, the DOE is not recommended to engage CDS directly.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Glass Ceramic Dielectrics for DC Bus Capacitors

Presenter	*Laboratory/Company*
Lanagan, Mike	PSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	7	10

Relevance Rating: 1

Relevance Justification

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

This seemed like it was a canned presentation for the center for dielectric studies (CDS). It seems that CDS is only doing a small amount of testing as part of a subcontract to ANL. In that context, all is well and should continue as ANL sees fit.

CDS capacitor research sounds very good, but it is not aligned with FreedomCAR goals. Therefore, the DOE is not recommended to engage CDS directly.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	9

Relevance Rating: 4

Relevance Justification

The concept appears to be promising. However, the OEM team would like seeing preliminary data supporting the feasibility of concept.

Approach Rating: 3

Approach Justification

More technical analysis is required to evaluate claims for refrigeration.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The project shows a modest progress since June 2004 review. However, no data or hardware demonstrating the progress was presented.

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	9

Relevance Rating: 3

Relevance Justification

New techniques in electrical component cooling are critical to the FreedomCAR EE program. This research is in a promising area that could prove beneficial to the program if concerns about overall system efficiency can be sufficiently addressed.

Approach Rating: 3

Approach Justification

Approach seems reasonable but the presentation lacked sufficient technical detail in approach or results to be able to effectively evaluate the research conducted. Need to see more information about the technical content of the project and plans for future data collection.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

rating Concern about the modest progress with the project. We believe this project has been underway for over a year but we are not seeing any new results or data. Also concerns about the overall efficiency of the total system after adding a second cooling loop. Need to see an overall systems analysis of total cooling system to determine if the added loop (with added cost and possible efficiency losses) can be justified.

Suggestions for Future Projects

Future work ought to include analysis of total system – both efficiency and cost to determine if there is sufficient value in project concept to continue pursuing.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	8	5

Relevance Rating: 3

Relevance Justification

Good novel approach, very relevant to the task at hand.

Approach Rating: 3

Approach Justification

I like the idea of using refrigerant to cool the electronics.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

I would like to see both analytical and empirical data.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	5

Relevance Rating: 3

Relevance Justification

The concept appears to be promising. However, the OEM team would like seeing preliminary data supporting the feasibility of concept.

Approach Rating: 3

Approach Justification

More technical analysis is required to evaluate claims for refrigeration.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The project shows a modest progress since June 2004 review. However, no data or hardware demonstrating the progress was presented.

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	7	8

Relevance Rating: 3

Relevance Justification

Cooling techniques for the power electronics is a critical enabling technology for FreedomCAR.

Approach Rating: 2

Approach Justification

Active cooling raises many reliability and efficiency questions: Reliability - What happens if there is a coolant leak? What happens if there is a blockage or failure in the A/C System? How will system operate at cold temps where refrigerant is typically not used? Is there a fail/safe if pump or cooling system fails? Efficiency - Spending a great deal of energy running active cooling systems to cool wasted energy from the power system-- Need to focus on passive cooling schemes and high efficiency/temperature devices.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Early in program, good progress so far. Should have shown results of operational test with and without A/C on.

Suggestions for Future Projects

Sensor/Diagnostic Health Management for coolant systems to ensure no build-up of debris, slow leaks, etc.
FMEA of system to establish reliability concerns to focus engineering development efforts.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	8	10

Relevance Rating: 4

Relevance Justification

High potential to be viable automotive technology.

Approach Rating: 3

Approach Justification

Excellent, well thought out system with capability for low cost. May need to include coolant level sensor.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Suggest that this project proceed.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Jason Lai	5	4

Relevance Rating: 2

Relevance Justification

This work has been done in industry. It was done for a high power ASD based HVAC system. Naturally, the refrigerant cooling can be used, but to have a separate/additional cooling capacity with "floating look' is hard to justify.

Approach Rating: 2

Approach Justification

See above.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Not clear about the accomplishment, so far capacity and size penalty on cooing system against inverter size reduction should be given with solid number, real cm3 and kg number, not 1/3 or 1/2

Suggestions for Future Projects

Additional Comments

See a major conflict point with the project goal of running power electronics and machining at 105° project goal.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	6	8

Relevance Rating: 3

Relevance Justification

Novel idea with potential.

Approach Rating: 3

Approach Justification

Good approach, but need to see more analysis and results in presentation. Demonstrate, with sound theory, how systems will meet functional requirements at extremes of AC loop operation!.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Condenser outlet temperatures will reach 90°C(with low side <20°C) in Arizona! How will system be controlled at extremes and not have adverse affect on AC systems (e.g. cannot have compressor drain back into compressor discharge)?

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Allen Hefner	8	8

Relevance Rating: 4

Relevance Justification

New electronic cooling technologies are required to achieve goals of FreedomCAR program.

Approach Rating: 3

Approach Justification

New electronic cooling system approach taking advantage of existing AC system with modifications seems like a plausible solution.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good technical accomplishments considering early stage of project.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	4	10

Relevance Rating: 2

Relevance Justification

This is still a separate cooling loop which requires its own pump. The only difference is that power is being dumped to the compressor instead of the radiator

Approach Rating: 3

Approach Justification

The approach is fine.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Progress is fine.

Suggestions for Future Projects

Additional Comments

It seems that this system will have a startup problem when the engine compartment is hot and the compressor is off.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	6	10

Relevance Rating: 2

Relevance Justification

Not clear that auto industry would accept such a method. This is still a separate cooling loop which requires its own pump. The only difference is that power is being dumped to the compressor instead of the radiator

Approach Rating: 3

Approach Justification

The approach is fine.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Progress is fine.

Suggestions for Future Projects

Additional Comments

It seems that this system will have a startup problem when the engine compartment is hot and the compressor is off.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

HEV Traction Drive - Integrated Cooling System with ORNL Floated Loop

Presenter	*Laboratory/Company*
Ayers, Curt	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	7	8

Relevance Rating: 3

Relevance Justification

The concept has direct relevance and technical merit. Details of controls for critical floating loop need to be carefully considered - i.e. leak detection, pressure regulation and monitoring, etc.

Approach Rating: 3

Approach Justification

Improvement suggestions mainly are relating to providing milestone metrics and decision gate criteria details.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Data relating to heat removal (rates) or numerical data missing from presentation thus difficult to quantify or assess. Actual volume and weight impact need further detail and quantification.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	*Laboratory/Company*
Kaufman, David	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	8

Relevance Rating: 3

Relevance Justification

Power Electronics and energy storage require high stability capacitors working to 600 V is good interim goal but should consider 800 V→1200 V for future sys.

Approach Rating: 4

Approach Justification

Very good methodology.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Fault clearing and high Ev are worthy accomplishments, so is the achievement of ripple current capability.

Suggestions for Future Projects

I don't agree with DOE doing so much component work. For example AUX or United Chm ___? can do this.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Focus on developing bulk capacitors is important to OEMs instead of technology only.

Approach Rating: 4

Approach Justification

The approach used must assure that the developed technology is capable of assembling bulk capacitors.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.

Approach Rating: 4

Approach Justification

rating Work done so far has added to the knowledge base among US labs and industry partners. There is lots of promise in the research done and proposed. Particularly encouraging is summary of future plans to move from microfarad capacitors to those that are sized more appropriately for the power capacitor needs of APEEM.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Excellent progress so far, but need to reemphasize the importance that research move toward a greater emphasis on bulk capacitance.

Suggestions for Future Projects

Need more engineering work to prove out the ability to make a bulk capacitor using this technique. Also would like to see assurance that the design approach is realistic through, perhaps, independent evaluation/confirmation.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	9

Relevance Rating: 4

Relevance Justification

Focus on developing bulk capacitors is important to OEMs instead of technology only.

Approach Rating: 4

Approach Justification

The approach used must assure that the developed technology is capable for assembling bulk capacitors.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	*Laboratory/Company*
Kaufman, David	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	7	10

Relevance Rating: 4

Relevance Justification

Capacitor technology is extremely important.

Approach Rating: 4

Approach Justification

The idea of embedded caps is very desirable. There is a clear thought process and methodology towards achieving the targeted goals.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Worked through some setbacks and solved related issues. The PI freely acknowledged these difficulties! The preliminary results are very promising. He scaled up the voltage, demonstrated volumetric potential and identified commercial pathways to success.

Suggestions for Future Projects

Additional Comments

Be very careful to maintain the focus on bulk capacitance and don't get sidetracked on the technology itself. Need capacitor industry involvement.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	5	7

Relevance Rating: 4

Relevance Justification

High relevant research.

Approach Rating: 4

Approach Justification

Excellent approach with fail-safe design.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Several set backs this year, need to produce a prototype.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	5	6

Relevance Rating: 3

Relevance Justification

The research only focuses on material study for capacitor. Individual cell property cannot represent the capacitor property. The project should move to the capacitor level to show actual performance such as ESR, GSZ, frequency response, ripple effect, packaged density.

Approach Rating: 3

Approach Justification

See above. The collaborators are all low power users, not traditional inverter capacitor provider, such as AVX, Electronic Concept, etc.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Material property studied well, but not capacitor level.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	9

Relevance Rating: 4

Relevance Justification

Development of high K, high Eb, high T capacitors is one of the most critical limitations to the successful development of underload electronics. This project is focused on a low-cost manufacturing technique for creating high K1 ceramic embedded capacitors.

Approach Rating: 4

Approach Justification

The approach is very well structured. Good focus on reliability and graceful failure modes. The emphasis on film development and properties before addressing manufacturing and the embedding technology is an excellent approach for ensuring success, as is the good interaction with industry and manufacturing.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Very good demonstration of self-healing fault and of K1 and Eb of the new films. Needs more work on optimizing the top electrode structure for confining self healing w/high current density operation.

Suggestions for Future Projects

Additional Comments

Excellent speaker. Well organized and very good overhead. Easy to follow.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	***Laboratory/Company***
Kaufman, David	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	8

Relevance Rating: 4

Relevance Justification

Bulk high temp capacitance is an enabler.

Approach Rating: 3

Approach Justification

Scale up capacitance ASAP. Temperature capability of concept must be demonstrated.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Quite a struggle thus far, but keep pressing.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

High Dielectric Constant Film-on-Foil Embedded Capacitors for Power Electronics

Presenter	*Laboratory/Company*
Kaufman, David	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	7	10

Relevance Rating: 4

Relevance Justification

Capacitor technology is extremely important.

Approach Rating: 4

Approach Justification

The idea of embedded caps is very desirable. There is a clear thought process and methodology towards achieving the targeted goals.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Worked through some setbacks and solved related issues. The PI freely acknowledged these difficulties! The preliminary results are very promising. He scaled up the voltage, demonstrated volumetric potential and identified commercial pathways to success.

Suggestions for Future Projects

Additional Comments

Be very careful to maintain the focus on bulk capacitance and don't get sidetracked on the technology itself.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	1

Relevance Rating: 1

Relevance Justification

This is not a long-range high risk R&D project. It is simply an engineering project.

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
2. No value in continuing this project.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	7

Relevance Rating: 1

Relevance Justification

DC/DC Converters can be important to hybrid and fuel cell vehicles and help support the overall FreedomCAR goals. However there is some question about the value of an all-in-one 12/42/high voltage converter. This seems to be more of a packaging study than a research project. Individual vehicle manufacturers would need to determine the need and value of an all-in-one design.

Approach Rating: 2

Approach Justification

rating It is unclear if there are any new technical breakthroughs planned in this research and if federal funding is warranted. It appears there is no significantly new technology being developed here; more like reengineering of existing technology.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

PI has accomplished what he set out to accomplish and has done it competently; however, there is a concern that there was not enough technical stretch in the research objectives.

Suggestions for Future Projects

Ought to wrap up current project and, in the future, not proceed along this line of research within national labs.

Additional Comments

I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research. The presentation states that there are no subcontractors and collaboration seems to have been superficial, yet this PI has two projects that total almost $1 million in FY05. How were these funds spent?

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	8	6

Relevance Rating: 2

Relevance Justification

Fair research value, a design exercise closer describes this project.

Approach Rating: 2

Approach Justification

Commercially available technique.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Again, commercially available technology.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	2

Relevance Rating: 1

Relevance Justification

Approach Rating: 1

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. No value in continuing this project.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	6

Relevance Rating: 2

Relevance Justification

There don't appear to be any novel topology breakthroughs. Does not seem to be state of art effort.

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Need to report out status on measurables: numbers of switches, performance impacts……

Suggestions for Future Projects

Additional Comments

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Integrated DC/DC Converter for Multi-Voltage Bus Systems

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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	7	8

Relevance Rating: 3

Relevance Justification

Reduction in parts count and complexity positively impacts reliability and cost directly.

Approach Rating: 3.5

Approach Justification

Very good project organization and approach. Simulate → Design→ Fabrication → Test → Simulate → Design. Early in project,, novel design topology.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Early in project, simulation predicts very encouraging possibilities.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	5	9

Relevance Rating: 3

Relevance Justification

Going from 2 DC/DC converters to 1 would increase reliability and decrease cost. Not a critical technical barrier to HEV development, but a nice advantage for affordability and market acceptance.

Approach Rating: 3

Approach Justification

Prototype design is promising. How does it address the fact that the HV keeps changing from 200V to 500V to 550V to 600V?

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good prototype fabrication and characterization. Not much in patents and publications.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	8	7

Relevance Rating: 2

Relevance Justification

This is not terribly important because our suppliers have a lot of expertise in this area.

Approach Rating: 2

Approach Justification

This is a routine build a circuit and test it project. It is not really new research to solve known problems.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The circuit works.

Suggestions for Future Projects

Additional Comments

Good engineering, but this is not research. We need to be focusing on solving problems. I recommend completing testing of the 2kW prototype and then stopping. The major focus (if continued) should be on controlling the 42V bus so that a 42V battery is not needed.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	8	7

Relevance Rating: 2

Relevance Justification

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This is a routine build a circuit and test it project. It is not really new research to solve known problems.

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Technical Accomplishment and Progress Justification

The circuit works.

Suggestions for Future Projects

Additional Comments

Good engineering, but this is not research. We need to be focusing on solving problems. I recommend completing testing of the 2kW prototype and then stopping. The major focus (if continued) should be on controlling the 42V bus so that a 42V battery is not needed.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

On target, just what is needed as hybrid SUVs and P/U's are introduced? This DC/DC will supply the necessary 42V electronic power steering systems that will be needed.

Approach Rating: 3

Approach Justification

Excellent controls work and use of DSP

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

On track

Suggestions for Future Projects

I think it's time for this project to transfer, or be picked up by, the OEM's. Too near term technology for DOE. Time to wrap it up.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated DC/DC Converter for Multi-Voltage Bus Systems

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	9	8

Relevance Rating: 4

Relevance Justification

Circuit development is targeting practical applications.

Approach Rating: 4

Approach Justification

DSP control allows fast and intelligent transitioning control. Multiple voltages are handled and controlled by one converter. Half bridge may not be the way to go for cost reduction if passive component penalty becomes high.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Converter has been working - experimental results, meeting milestone.

Suggestions for Future Projects

Need to address efficiency and packaging.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	4

Relevance Rating: 2

Relevance Justification

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Project is complete and no further funding to continue is recommended.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	4

Relevance Rating: 2

Relevance Justification

Innovative inverter designs can be useful in meeting FreedomCAR goals, but this seems to be more of an engineering exercise in determining whether motor driven accessories can replace belt driven accessories.

Approach Rating: 2

Approach Justification

rating The PI seems to have competently analyzed the problem he chose to address, designed the experiment, done analysis and developed hardware to prove the concept. However, a thorough business analysis should have been done before any technical work was begun to determine if there were any cost, efficiency, functional or reliability advantages of a two phase motor design instead of the current practice of belt-driven components. Now that the project has been completed, the PI discusses contacting motor suppliers to get cost estimates. This should have been done first to see if there were any reason to have initiated the project in the first place.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The project was competently completed along the lines of the initial proposal.

Suggestions for Future Projects

The project has been completed. No further research is warranted.

Additional Comments

I would like to see a list of staff research associates who assisted the PI in this research effort. I would also like to see a list of outside collaborators who have participated in this research. The presentation states that there are no subcontractors and collaboration seems to have been superficial, yet this PI has two projects that total almost $1 million in FY05. How were these funds spent?

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer

Anson Lee

Ability to Rate (1-10) (10 being expert)	*Important to FreedomCAR (1-10) (10 being strongly agree)*
6	9

Relevance Rating: 2

Relevance Justification

Fairly relevant project.

Approach Rating: 2

Approach Justification

Approach seemed reasonable, but not too practical.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good results were obtained based on this approach. Project completed.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	2

Relevance Rating: 2

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	6

Relevance Rating: 2

Relevance Justification

Is this a truly novel architecture with great savings and no negative impacts?

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

What are the metrics and how are we performing to the goals?

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	3	8

Relevance Rating: 2

Relevance Justification

Integration of the HVAC into the hybrid drive has advantages in cost, weight and size but doesn't seem to e a key technical hurdle to the development of ICE/HEV or fuel cell HEV. It is somewhat peripheral albeit valuable.

Approach Rating: 3

Approach Justification

The approach to integrating HVAC and hybrid drive seems sound.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Third year of program and progress is simulation study and design of task 1 and component selection for task 2. Should be further along in project and have more data on effectiveness of this solution. Publications are weak.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	8	8

Relevance Rating: 2

Relevance Justification

Auxiliary drives have not been a major focus of the EETT.

Approach Rating: 4

Approach Justification

Well planned.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The idea works.

Suggestions for Future Projects

Additional Comments

Project is complete. No carryover funding should be allotted for FY06.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	8	8

Relevance Rating: 2

Relevance Justification

Auxiliary drives have not been a major focus of the EETT.

Approach Rating: 4

Approach Justification

Well planned.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The idea works.

Suggestions for Future Projects

Additional Comments

Project is complete. No carryover funding should be allotted for FY06.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	9	10

Relevance Rating: 3

Relevance Justification

The 2-phase motor winding is non-industry standard, but relatively easy to implement, so there should be commercial interest.

Approach Rating: 3

Approach Justification

Good, but some concern over an A/C compressor motor having a link to the vehicle traction motor. Could raise concerns over vehicle placement of the e-A/C compressor.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

On track to completion

Suggestions for Future Projects

Project ends FY05

Additional Comments

Should have industry partners (Tier 1 or Tier 2) at this point so it can transition to product development.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Su, Gui-Jia	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	9	7

Relevance Rating: 4

Relevance Justification

Integration helps cost reduction on interconnection.

Approach Rating: 3

Approach Justification

Reduction on silicon will normally increase size of passive components. A trade off needs to be -----to justify.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

System has been implemented and tested.

Suggestions for Future Projects

Additional Comments

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Integrated Inverter for HEVs and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Su, Gui-Jia	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	7	8

Relevance Rating: 3

Relevance Justification

Integrated inverters project a good companion to integrated converter work being performed. May be key to positively impact cost and reliability for EV's which require PM HVAC compressors.

Approach Rating: 3

Approach Justification

More emphasis should be on prototyping & thorough testing on a dual 3-phase machine/2-phase machine topology.

Technical Accomplishment and Progress Rating: 3.5

Technical Accomplishment and Progress Justification

Very good simulation and design efforts to date. Validation now required especially for dual machine load.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Goal to reduce Semikron inverter size to 33% without effecting its performance and life.

Approach Rating: 3

Approach Justification

Slide 13 demonstrates the concept, which is good.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

No conceptual hardware or data was presented to support the proof of concept.

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Team observed Dr. Hsu's name on several of big projects (in terms of dollars). Team would like seeing the list of other investigators contributing to these projects.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	9

Relevance Rating: 4

Relevance Justification

rating Improving packaging efficiency of power electronics and electrical machines on vehicles is important for design of vehicles that meet customer expectations and needs without compromise. Small inverter sizes support this goal.

Approach Rating: 3

Approach Justification

Unique approach to direct cooling directly on the die is innovative and warrants continued investigation.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Presentation lacks detailed data and test results that support the claim that the inverter can be downsized considerably. PI reports expected results somewhat superficially but present no details that allow reviewers to make a considered assessment of the value or progress of the work.

I would like to see a list of staff research associates who assisted the PI in this research effort. The report mentions several subcontractors and collaborators, but it is unclear what their roles are, and if there are any associates at ORNL supporting this effort.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	7	8

Relevance Rating: 3

Relevance Justification

Good subject area.

Approach Rating: 3

Approach Justification

Focus on capacitor cooling is important.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Accomplishments and efforts seem scattered over many objectives.

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Presenter	***Laboratory/Company***
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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	5	5

Relevance Rating: 4

Relevance Justification

Highly relevant project to reduce inverter size.

Approach Rating: 3

Approach Justification

Approach to be a good approach.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Did not show any hardware or data; not much progress since last year.

Suggestions for Future Projects

Additional Comments

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Goal to reduce Semikron inverter size to 33% without effecting its performance and life.

Approach Rating: 3

Approach Justification

Slide 13 demonstrates the concept, which is good.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

No conceptual hardware or data was presented to support the proof of concept.

Suggestions for Future Projects

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Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	8

Relevance Rating: 4

Relevance Justification

Integrated packaging is a critical area to achieving DOE goals and capacitors are one of the chief hurdles to high performance at temperature. Combining direct cooling with integrated packaging has great promise.

Approach Rating: 3

Approach Justification

Cascade die mounting structure combined with direct cooling is a good approach. Need more fundamental understanding of acerbated testing of caps to design a capacitor cooling test that is more relevant to automotive reliability. Also if the floating loop is fixed to the standard A/C refrigerant, the value of the refrigerant study may be limited.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good progress and accomplishments. Need to test ISR prototype.

Suggestions for Future Projects

Additional Comments

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Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	8	9

Relevance Rating: 3

Relevance Justification

Yes - shows promise of 150w/cm2 using Cu-foam in cascading die scheme. Cooling capacitors is very important contribution of this project.

Approach Rating: 3

Approach Justification

Not clear on how vapor management system will be designed and fabricated to be space/volume efficient.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent work and progress

Suggestions for Future Projects

Continue focus on passive components and volume reduction of complete concept.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	3	3

Relevance Rating: 3

Relevance Justification

Some good work, but not easy to justify the significance. I am not sure if inverter size reduction goal can be achieved in this way.

Approach Rating: 3

Approach Justification

Size reduction by better cooling does not guarantee loss reduction.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The package needs to include every thing including gate drive cht and interconnects.

Suggestions for Future Projects

Additional Comments

Coolant temperature is not what stated 105°C target described in the project goal.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	7	9

Relevance Rating: 4

Relevance Justification

Great plan for empirical proof of concept work in an important area.

Approach Rating: 3

Approach Justification

Very broad scope, considering all the challenges associated with 2-phase cooling.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

I await well organized and more thorough reporting of results from testing of the concept hardware.

Suggestions for Future Projects

Additional Comments

It appears that the concept, results and report are complete by year end. What happens beyond 2005 since the duration is called out as 2008?

Is there complementary modeling that could be validated in conjunction with this work?

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Inverter Packaging

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Allen Hefner	8	8

Relevance Rating: 4

Relevance Justification

Improved package heat removal is essential to meet goals of FreedomCAR.

Approach Rating: 3

Approach Justification

Some novel cooling heat removal methods are considered but many have reliability and practicality questions in vehicle applications.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Some important results are described but no applicable technologies have been identified.

Suggestions for Future Projects

Additional Comments

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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	5	8

Relevance Rating: 3

Relevance Justification

Good subject area

Approach Rating: 3

Approach Justification

Focus on capacitor cooling is important.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Accomplishments and efforts seem scattered over many objectives.

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Inverter Packaging

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	6	9

Relevance Rating: 3

Relevance Justification

Jet impingement, spray, and other active fluidic solutions are complex costly, and potential reliability concerns. Focus should be greater on H.T. materials and greater emphasis on air and passive cooling schemes. Obviously, not possible in all cases and timelines.

Approach Rating: 3

Approach Justification

Cu foam and multiple cooling approach evaluation very good to assess technology base. Should also consider novel heat spreaders coupled to existing cooling system/sinks.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent evaluation of multiple approaches. Required to focus the selection process in evaluation of the best engineered system.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	1

Relevance Rating: 1

Relevance Justification

No value in continuing this project.

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Net efficiency over the drive cycle may be low with sintered magnets.

3. High strength magnets is neither requirement nor a solution for hybrid and fuel cell vehicles.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	8

Relevance Rating: 1

Relevance Justification

Although magnet R&D is important to FreedomCAR goals and to help develop technologies vital to hybrid and fuel cell vehicles, it is unlikely that high strength magnets will provide any significant advantage over other technologies.

Approach Rating: 2

Approach Justification

Technical approach and future plans are not specific enough. More details about future research plans would be appreciated. Slide discusses plans to evaluate better magnetic materials, but no details about which materials, why they are expected to be "better," what the specific targets are for magnetic materials properties that form the basis for choosing new materials, etc. This also appears to be more of a manufacturing development program than a R&D program.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This project is currently in its 6th year yet we are seeing no appreciable results that indicate that the technology can provide a viable alternative to other technologies. There does not seem to have been a lot of progress over the year.

There is some doubt that high strength magnet motors provide any net efficiency improvement over a vehicle drive cycle.

Question the value of continuing work on a technology that appears to have little value to future hybrid or fuel cell vehicle technologies.

Suggestions for Future Projects

Would recommend that DOE seriously reconsider the value in continuing this line of research. We do not appear to be getting significant results from over 6 years of research. Need to question if this research is in line with the goals of long-term, pre-competitive research that can lead to technologies that can be implemented to help develop hybrid and fuel cell vehicles.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	7	10

Relevance Rating: 1

Relevance Justification

High energy strength magnets are not, but they are not necessary for hybrid or fuel cell vehicles. Actually, if the magnets are too strong, lower system efficiency and they create a lot of fault tolerance issues and as a result, increase overall system cost.

Approach Rating: 2

Approach Justification

Punching magnet shapes does not seem like it will be very practical.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This project is moving at a glacial pace.

Suggestions for Future Projects

Additional Comments

Project has been ongoing for to long, should be stopped.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	***Laboratory/Company***
Cha, Yung	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	1

Relevance Rating: 1

Relevance Justification

No value in continuing this project. It has been six years since the inception of this project with no useful results.

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Net efficiency over the drive cycle may be low with sintered magnets.

3. High strength magnets is neither requirement nor a solution for hybrid and fuel cell vehicles.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	***Laboratory/Company***
Cha, Yung	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	2	6

Relevance Rating: 2

Relevance Justification

High energy magnets are not mandatory for FreedomCar

Approach Rating: 2

Approach Justification

Reasonable approach.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Limited progress, would not benefit FreedomCAR.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	***Laboratory/Company***
Cha, Yung	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	7	8

Relevance Rating: 3

Relevance Justification

Apparent focus on cost of mfg issues.

Approach Rating: 2

Approach Justification

Did not see characterization of any processed compacts → B-H? Thermal cycling, mechanicals? My first review, thus I realize it may be part of program.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Appear to have significantly improved compaction process yield through die/punch modification. Slide 4 claims B-H improvements, data?

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	8	9

Relevance Rating: 3

Relevance Justification

No sintered magnets have the best energy product but they have high temperature application concerns. This project focuses on how to improve the energy product which is valuable but would be interested also in high temperature performance, not just RT.

Approach Rating: 3

Approach Justification

New die and punch design is a good way to remove trapped air problem. Should also examine different compacting and sintering parameters (pressure and temperature, etc.) to optimize energy product.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Very good progress has been made on die and punch design as proven by the manufacture of new compacts. Need test data confirming improved crack resistance and less trapped air. Also need data confirming new design improves energy product.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	7	10

Relevance Rating: 1

Relevance Justification

High energy strength magnets are not, but they are not necessary for hybrid or fuel cell vehicles. Actually, if the magnets are too strong, they create a lot of fault tolerance issues and as a result, increase overall system cost.

Approach Rating: 2

Approach Justification

Punching magnet shapes does not seem like it will be very practical.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This project is moving at a glacial pace.

Suggestions for Future Projects

Additional Comments

It is way past time to cancel this project. The net efficiency over a drive cycle actually decreases if the magnets are too strong.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	*Laboratory/Company*
Cha, Yung	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 3

Relevance Justification

Very good work in eliminating/minimizing air entrainment during compaction process. As well as solving the fracturing problem with modified punch/die set.

Approach Rating: 3

Approach Justification

Good focus on root cause of problem

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

On schedule.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Cost, High-Energy-Product Permanent Magnets

Presenter	***Laboratory/Company***
Cha, Yung	ANL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	3	7

Relevance Rating: 4

Relevance Justification

Cost reduction is the key

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Any progress in reducing the internal thermal resistance of power module is useful.

Approach Rating: 3

Approach Justification

The application of O-rings presents a risk of coolant leakage. Need data to prove it otherwise.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The team recognizes the fact that the first design concept failed and delayed the progress.

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	*Laboratory/Company*
Hassani, Vahab	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	9

Relevance Rating: 3

Relevance Justification

Reduction in thermal resistance of the mounting of the IGBT is consistent with addressing the need for improved thermal efficiency and reduced cost of cooling systems.

Approach Rating: 3

Approach Justification

An interesting approach to thermal management that evaluated alternatives to thermal grease. PI has been thorough in evaluating a number of different techniques for attaching and insulating the IGBT. Each design approach was evaluated for thermal resistance and stress. When issues were identified with one approach, another idea was tried and tested.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Although several design approaches were evaluated, it appears that none so far are likely candidates for high volume automotive applications. The solder joints face stresses that are likely to cause mechanical failure. The O-ring/gasket approach needs further study because experience has shown that most O-ring applications tend to leak under the severe duty cycles autos experience. More work is needed to ensure durability and reliability under automotive operating conditions.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	8	8

Relevance Rating: 3

Relevance Justification

This is an important subject.

Approach Rating: 1

Approach Justification

No real understanding of application, what will and will not work.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Project not grounded in volume production realities.

Suggestions for Future Projects

Additional Comments

Vahab listened to the criticism from the EETT and truly tried to address the suggestions.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	8	5

Relevance Rating: 3

Relevance Justification

Good relevant project

Approach Rating: 3

Approach Justification

Technical approach looked reasonable.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Would like to see design concept validated.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 3

Approach Justification

The application of O-rings presents a risk due to coolant leakage. No data was presented to prove it otherwise.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The team recognizes the fact that the first design concept failed and delayed the progress.

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	*Laboratory/Company*
Hassani, Vahab	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	10	9

Relevance Rating: 4

Relevance Justification

Finding a way to run electronics at T < 125° C in high temp coolants is critical to DOE goals. Low thermal resistance IGBT structure is one of few technologies that promises Δ~20°C performance.

Approach Rating: 3

Approach Justification

Low thermal resistance IGBT structure focuses on elimination of thermally resistive layers, especially thermal grease (?)---- which is weak point of system. However, concerns with solution include stress level for metallurgical attach and cost/reliability for pressure approach.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Has examined multiple approaches to low thermal resistance IGBT structure and has identified and mitigated reliability/stress issues associated with the designs.

Suggestions for Future Projects

Should examine jet impingement force vs. force needed to break pressure contact over temperature range and for automotive environment (which includes vibration and shock that can break pressure contact intermittently).

Additional Comments

If you can reduce the 105°C limit to 85°C or so, a world of opportunities open up with new thermal interface materials and heat sinks at a much lower cost and higher reliability as long as the system must operate at T cooling of 105°C with a T junction of 125°C. The ΔT of 20°C drives to novel solutions, such as the IGBT/Jet Impingement structure here.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	3	3

Relevance Rating: 4

Relevance Justification

Targeting the area needed, especially IGVT interface issue.

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need more experiment verification.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	7	8

Relevance Rating: 4

Relevance Justification

Approach Rating: 3

Approach Justification

Continue to look ensure that solutions that will be robust to surface and thermal gradient variability in both sealing and heat transfer surfaces.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good progress despite set backs.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Allen Hefner	8	7

Relevance Rating: 4

Relevance Justification

New approaches to improved heat removal from IGBT package is relevant to achieve goals of FreedomCAR Program.

Approach Rating: 3

Approach Justification

Simulation of cooling capability and stress of new structure is important first step. However, some of the techniques such as o-rings etc., do not seem viable.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Simulation results are interesting, but these are essentially untested ideas. I am not convinced that this is a world-class effort that will accomplish what others have been unable to do, that is, produce a reliable direct cooling package for high power

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	*Laboratory/Company*
Hassani, Vahab	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	7	8

Relevance Rating: 3

Relevance Justification

This is an important subject.

Approach Rating: 2

Approach Justification

Creative, but the idea has a 0% chance of success.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This has been a total failure.

Suggestions for Future Projects

Additional Comments

Vahab listened to the criticism from the EETT and truly tried to address the suggestions

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	***Laboratory/Company***
Hassani, Vahab	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	8	10

Relevance Rating: 4

Relevance Justification

Very relevant. The use of o-ring & gaskets may appear cost sensitive but may be IC-process feasible and inexpensive.

Approach Rating: 4

Approach Justification

Very innovative concept that needs further development and validation.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Need to do stress analysis of solderless concepts.

Suggestions for Future Projects

Continue the project - innovations along the way are likely and of high value.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Low Thermal Resistance IGBT Structure

Presenter	*Laboratory/Company*
Hassani, Vahab	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	7	9

Relevance Rating: 3

Relevance Justification

Requires experimental validation of most promising modeled approaches.

Approach Rating: 4

Approach Justification

Excellent work. See note in No. 1

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Needs experimental validation in overall thermal management modeling effort.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	5	7

Relevance Rating: 4

Relevance Justification

Good material characterization of various films, high relevant.

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Great results, gave good indication to researchers which materials should not be used.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	9	8

Relevance Rating: 4

Relevance Justification

Good Fundamental material science. I'm most pleased with the work on introducing probalistic design sensitivity (PDS) analysis as means to predict Weibul characteristics.

Approach Rating: 4

Approach Justification

I'd like to see PDS methodology extended.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

This project should be tied closer to FreedomCAR efforts, esp. in the PDS and how to predict capacitor life (i.e., Weibul char. life).

Suggestions for Future Projects

Tie this into requirements on warranty and life requirements set by Tech Team.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	9

Relevance Rating: 4

Relevance Justification

Mechanical testing and knowledge improvement of film mechanical properties is essential for moving the film capacitors from the laboratory into production.

Approach Rating: 4

Approach Justification

Development and validation of new mechanical testing techniques is necessary for assessing and facilitating the development of new capacitor technologies and associated manufacturing processes.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

The project has developed a number of techniques: strain based fracture analyses for winding, µFea direct from photo into ANSYS, Mylar backed film testing, which would be very useful in further capacitor development and subsequent defect-free manufacturing.

Suggestions for Future Projects

Correlating mechanical properties and defects of subsequent capacitor failure density and distributions.

Additional Comments

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Mechanical Characterization of Dielectric Polymers

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Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	6	5

Relevance Rating: 3

Relevance Justification

Capacitor mechanical characteristics is important, but most commercial film capacitors are potted in a case, the actual mechanical property that power electronics people deal with is not capacitor itself, but the case and potting material.

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Dielectric level has been tested, but not packaged capacitor.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
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Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 3

Relevance Justification

Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development. Materials development is critical to the ability to deliver capacitors that can meet FreedomCAR needs for hybrid and fuel cell vehicles.

Approach Rating: 4

Approach Justification

PI is using good analytical and experimental design in his experiments and has come up with a novel way to test films.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Good progress and accomplishments. Good and detailed report of work done during the prior year with plenty of technical information and data that is informative. All 'round good work.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	6

Relevance Rating: 3

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

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Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	6	8

Relevance Rating: 3

Relevance Justification

Bulk high temp, low cost capacitance is an enabler.

Approach Rating: 3

Approach Justification

Developing and correlating analytical tools is a critical capability .

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Nice demonstration of progress with results of correlation.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	6	10

Relevance Rating: 3

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Very good results.

Suggestions for Future Projects

Additional Comments

Project focused on mechanical testing of films from SNL. SNL project has since changed focus. As a result, this project will be completed in FY05.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Mechanical Characterization of Dielectric Polymers

Presenter	***Laboratory/Company***
Wereszczak, Andy	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	6	10

Relevance Rating: 3

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Very good results.

Suggestions for Future Projects

Additional Comments

Project focused on mechanical testing of films from SNL. SNL project has since changed focus. As a result, this project will be completed in FY05. Very useful work.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

PI is developing a Jet impingement model for Semikron inverter recommended by the team.

Approach Rating: 4

Approach Justification

Both semi-empirical tool & numerical simulations were used.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	9

Relevance Rating: 3

Relevance Justification

Finite element models for jet impingement cooling can be useful tools when evaluating and designing cooling systems for future hybrid and fuel cell vehicles.

Approach Rating: 3

Approach Justification

PI has developed an analytical tool that will be useful for evaluating jet impingement cooling.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

PI has delivered the jet impingement model as requested. Data was correlated with published literature. However, PI needs to gather additional data points and correlate these experimental data with the model, then compare to real world data.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	5	8

Relevance Rating: 3

Relevance Justification

Having flexible models would be useful.

Approach Rating: 1

Approach Justification

No clear direction.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Zero useful accomplishments.

Suggestions for Future Projects

Additional Comments

This research is not based in reality. There absolutely must be an experimental component which is actually done by the researchers. The researchers are comparing their work to experimental data which has been published by other researchers. In that case, we can just use the other researchers models and save the American taxpayers some money.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	8	5

Relevance Rating: 3

Relevance Justification

Good relevance to our tasks at hand.

Approach Rating: 3

Approach Justification

Reasonable model was developed.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Model accuracy seemed reasonable, need more validation with real operational data.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	7

Relevance Rating: 3

Relevance Justification

PI is developing a Jet impingement model for Semikron inverter recommended by the team.

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).

Suggestions for Future Projects

Additional Comments

PI demonstrated the model accuracy by comparing the results with limited data. However, a through correlation of the model with real life situations is required. The real life operational data may available from ANL (benchmarking efforts).

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	***Laboratory/Company***
Narumanchi, Sreekant	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	7	8

Relevance Rating: 4

Relevance Justification

Jet Impingement is one of the few technologies that can achieve the DOE goal of Δ T < 20° C. Good companion with IGBT structure for low resistance.

Approach Rating: 3

Approach Justification

Modeling is excellent, requires validation testing to confirm results.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Outstanding job of modeling single jet impingement. Needs some experimental validation work and practical assessment of results. Also needs some more complex multiple jet impingement modeling than just closed-form equation.

Suggestions for Future Projects

Experimental validation of single/multiple jet results.
More elaborate modeling of multiple jet.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	***Laboratory/Company***
Narumanchi, Sreekant	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	1	3

Relevance Rating: 3

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	5	8

Relevance Rating: 3

Relevance Justification

Analytical tools to aid design for jet impingement are needed.

Approach Rating: 3

Approach Justification

Good approach to modeling backed up with what appears to be a thorough overview of relevant background.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Would like to see more validation testing over broader range of material and environment conditions.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Allen Hefner	8	5

Relevance Rating: 3

Relevance Justification

I have serious reservations about jet impingement cooling being practical for this application.

Approach Rating: 2

Approach Justification

Although it is interesting to simulate jet impingement cooling, the important issue is if this technology can be made practical and reliable for the FreedomCAR applications.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

There are some interesting results but this is far from a unique world-class effort.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	5	8

Relevance Rating: 3

Relevance Justification

Having flexible models would be useful.

Approach Rating: 1

Approach Justification

You have to be kidding! This is a pointless literature survey.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Zero useful accomplishments

Suggestions for Future Projects

Additional Comments

This research is not based on reality. There absolutely must be an experimental component which is actually done by the researchers. The researchers are comparing their work to experimental data which has been published by other researchers. In that case, we can just use the other researchers models and save the American taxpayers some money.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	*Laboratory/Company*
Narumanchi, Sreekant	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	8	9

Relevance Rating: 4

Relevance Justification

Good detailed investigation of jet impingement cooling. Excellent modeling work.

Approach Rating: 3

Approach Justification

What is the power consumption of providing pressurized fluid flow and recovery required to remove 1 p.u. power dissipation?

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Excellent progress

Suggestions for Future Projects

Why are we doing this? Concerns over erosion, corrosion, package stress are well founded.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Jet Impingement

Presenter	***Laboratory/Company***
Narumanchi, Sreekant	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	5	9

Relevance Rating: 3

Relevance Justification

Good work focused on a specific task/issue. Good connection to IGBT thermal performance of jet impingement.

Approach Rating: 3

Approach Justification

Comparison of jets, fluid type, and single vs. two-phase techniques concise and contributes to system analysis tool set.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Provides solid basis for system evaluation. Requires more experimental validation and comparison.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Edward Jih and Tech Team (OEM)	8	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 1

Approach Justification

Team expressed reservations in using the EXCEL model (which was presented) to model and analyze the thermal performance of Semikron inverter fitted with spray cooling technology.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Team recommended to develop models of Semikron inverter with spray cooling technology and required hardware.

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	8

Relevance Rating: 3

Relevance Justification

Cooling of electrical components is important to future hybrid and fuel cell vehicle design to improve system efficiency and packaging requirements. This is a good idea in theory but based on the presentation it is unclear where the research is going or if there is any value expected to come from it.

Approach Rating: 1

Approach Justification

PI has tried to model a complex system with what appears to be a simple Excel-based model. The resulting model seems superficial. It is unclear if such a simplistic model can adequately model spray and jet cooling.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

See comments under #2 above.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 1

Approach Justification

Team expressed reservations in using the EXEL model (which was presented) to model and analyze the thermal performance of Semikron inverter fitted with spray and jet impingement cooling technologies.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Team recommended to develop models of Semikron inverter with spray and jet impingement cooling technologies and required hardware.

Suggestions for Future Projects

Additional Comments

Team recommended to develop models of Semikron inverter with spray and jet impingement cooling technologies and required hardware.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	7	8

Relevance Rating: 3

Relevance Justification

In theory, the project is a good idea.

Approach Rating: 1

Approach Justification

A simple literature survey is all that is being done.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Experimental verification is require to verify model. Extremely disappointed that no verification of model planned.

Suggestions for Future Projects

Additional Comments

Cancel this project. It is an absolute waste of DOE money in its current form. There has been zero real progress in the last year.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	***Laboratory/Company***
Bharathan, Desikan	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	8	5

Relevance Rating: 3

Relevance Justification

Good relevant project

Approach Rating: 1

Approach Justification

Using Excel as a modeling tool is inadequate at best.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Must show how this tool could model the inverter.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	7	8

Relevance Rating: 2

Relevance Justification

Cooling is critical to achieving DOE goals. Spray cooling shows promise as a way of achieving ΔT°<20°C goal. However, the relevant problem is not demonstrating spray cooling but rather combining it with packaging to provide a working module that can be cost effective and reliable for automotive applications.

Approach Rating: 3

Approach Justification

Model and software are valuable for performing sensitivity analysis of cooling nozzle, fluid, and target distance selection for optimum cooling.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Model and associated software are ready for use - need to achieve better correlation with test data for heat transfer coefficient of fluorocarbons.

Suggestions for Future Projects

Spray cooling is fairly well demonstrated by prior DOD work. The challenge here is adapting the technology to the cost/reliability/environmental characteristics of commercial automotive applications. New project that stresses cost effective, reliable, long-life design of a spray cooling system for automotive, similar to the jet impingement/IGBT system or the refrigerant loop/inverter packaging system.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	8	10

Relevance Rating: 4

Relevance Justification

Complex closed system cooling loops for liquid circulation, vapor recovery and condensing. Can spray cooling be integrated into the AIPM w/o substantial pkg volume increase?

Approach Rating: 3

Approach Justification

Jet impingement is necessary if heat flux is greater than 150w/cm2 are demanded but would an automotive OE actually put this into serial production?

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Valid as an optimal thermal management ethnology at this time - interior tech., but where is it leading?

Suggestions for Future Projects

Need Tech Team to update/validate the thermal environment requirements for HEV and FCV.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Jason Lai	3	3

Relevance Rating: 3

Relevance Justification

It helps analytical work. The program goal stays with 105°C cooling.

Approach Rating: 3

Approach Justification

Software may be useful for study purpose "spray" to be further verified.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	***Laboratory/Company***
Bharathan, Desikan	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	8

Relevance Rating: 3

Relevance Justification

Difficult area to model, but benefits could be great.

Approach Rating: 2

Approach Justification

This is a good first step to do empirically based model until detailed models are capable.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Need to understand root cause of limited correlation to justify further work on such models. Focus on first principles and shift to detailed models if correlation is not attained.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	***Laboratory/Company***
Bharathan, Desikan	NREL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Allen Hefner	8	5

Relevance Rating: 3

Relevance Justification

I have serious reservations about spray cooling being practical for this application.

Approach Rating: 2

Approach Justification

Although it is interesting to survey the literature and summarize existing theory and empirical data for spray cooling, the important issue is if this technology can be made practical and reliable for the FreedomCAR applications.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

There seems to be no accomplishments other than summarizing and adding a look up interface for previous results of others.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	5	8

Relevance Rating: 3

Relevance Justification

In theory, the project is a good idea.

Approach Rating: 1

Approach Justification

A simple literature survey is all that is being done.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

This is pathetic. All of the effort was spent on a software interface for models the researchers claim need experimental verification. There are zero plans to perform any of the experimental verification that is necessary!

Suggestions for Future Projects

Additional Comments

Cancel this project. It is an absolute waste of DOE money in its current form. There has been zero real progress in the last year.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Modeling High Heat Flux Heat Removal: Spray Cooling

Presenter	*Laboratory/Company*
Bharathan, Desikan	NREL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	6	9

Relevance Rating: 3

Relevance Justification

Good project to evaluate the merits of various working fluids and spray configurations. NREL model improves efficiency of evaluation. Improved empirical connection required to improve correlation.

Approach Rating: 3

Approach Justification

Better connection to improved correlation → experimental validation. Connection to system in terms of reliability, cost, volume and weight.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Only progress appears NREL model evaluation. No system connectivity.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	*Laboratory/Company*
Tuttle, Bruce	SNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	8

Relevance Rating: 4

Relevance Justification

Film capacitors are the proper type for automotive. But this need for a new chemistry to go from 100°C to 150°C is disappointing.

Approach Rating: 4

Approach Justification

Excellent process, collaboration, and industry interaction.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Still haven't achieved the 140°C target.

Suggestions for Future Projects

Why should this have a future?

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	9

Relevance Rating: 4

Relevance Justification

High temperature, high energy density capacitors are an important enabling technology for hybrid vehicles. The study of improved polymer and ceramic capacitors is very worthwhile.

Approach Rating: 3

Approach Justification

Chemical modification of polymers for higher temperatures and greater volumetric efficiency and nanoparticle compactions for higher breakdown strength and increased energy density both show promise.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Of the two areas, polymers and nano-ceramics, the molecularly modified polymers seem to have shown the most development and promise for hybrid applications and the achievement in the area have been impressive.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	5	6

Relevance Rating: 3

Relevance Justification

Remain in materials level. Should push forward for a large-size capacitor that can be used in power electronics/motor drive inverter DC Bus.

Approach Rating: 4

Approach Justification

Different materials have been evaluated comprehensively. Sample capacitors have been built for testing.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Has the capacitors made for evaluation. Has interactions with key manufacturers and capacitor suppliers. Has addressed FreedomCAR needs.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	*Laboratory/Company*
Tuttle, Bruce	ANL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
James Scofield	8	9

Relevance Rating: 4

Relevance Justification

Modified PPS and ceramic piezoelectric film focus is a very good approach to incrementally improving cap ED and temp. performance. Criticality of cap's to PE reliability, volume and weigh cannot be understated.

Approach Rating: 3.5

Approach Justification

Appears to be a slightly more modest element of risk for the film portion of the work. Availability and ability to fabricate appropriate poly0films may be an obstacle.

Technical Accomplishment and Progress Rating: 3.5

Technical Accomplishment and Progress Justification

PLZT ceramic aerosol deposition composition control very appealing for indication of reduced temp. sintering. Packaging and metallization impact.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 1

Approach Justification

Developing and evaluating so many materials for bulk capacitors will require resources and time. Team is concerned about the resources, which may spread thin.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Team would like to recommend selecting few promising materials and focusing on them.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 3

Relevance Justification

Power capacitors is one of the areas where more FreedomCAR research is needed. Much progress has been made by the world industry in recent years and it is important to have a US R&D effort to develop knowledge and experience in capacitor design and development.

Approach Rating: 1

Approach Justification

PI seems to be taking a shotgun approach to identifying and evaluating candidate materials. According to the presentation this project has been ongoing since 1999 yet there is no indication of what work actually was accomplished in the prior year.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Several slides are devoted to detailing what is planned for the remainder of the year; and milestone plans for FY05, but I wonder about the limited discussion of technical data or results presented. It is unclear if there were significant technical accomplishments during the prior year and the presentation did a poor job of reporting them; or if there were no significant results and that was the reason for a technically superficial presentation.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	*Laboratory/Company*
Tuttle, Bruce	SNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Vijay Garg	10	6

Relevance Rating: 3

Relevance Justification

Approach Rating: 1

Approach Justification

Developing and evaluating so many materials for bulk capacitors will require resources and time. Team is concerned about the resources, which may spread thin.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Team would like to recommend to select few promising materials and focus on them.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	7	10

Relevance Rating: 2

Relevance Justification

The subject area and goals seem admirable.

Approach Rating: 1

Approach Justification

No focus. No capacitor industry involvement in work.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

The output of this project continues to be a disappointment. It is way beyond time that the resources be redistributed to projects which are making progress.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	5	7

Relevance Rating: 3

Relevance Justification

Relevant project for FreedomCAR

Approach Rating: 2

Approach Justification

Seemed to be "shot-gunning," too many materials are being tried.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Not much progress since last year.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	*Laboratory/Company*
Tuttle, Bruce	SNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
M. Mehall	3	8

Relevance Rating: 3

Relevance Justification

Need lower cost, high life, and high temp bulk capacitance.

Approach Rating: 2

Approach Justification

Cover the waterfront initially, but narrow down and demonstrate winners & losers quickly. Identify where we need more study because there are big opportunities.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Good exploratory work but need a means to use results to communicate progress more effectively. Materials cost and capability are the critical metrics.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Polymer Film and Nano-Dielectric Capacitors

Presenter	***Laboratory/Company***
Tuttle, Bruce	SNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 2

Relevance Justification

The subject area and goals seem admirable.

Approach Rating: 1

Approach Justification

This is a complete shotgun approach.

Technical Accomplishment and Progress Rating: 1

Technical Accomplishment and Progress Justification

The output of this project continues to be a disappointment. It is way beyond time that the resources be redistributed to projects which are making progress.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
John M. Miller	9	10

Relevance Rating: 3

Relevance Justification

Very important area to DOE and to DOE-industry interactions.

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need the reports.

Suggestions for Future Projects

Yes, have an interagency workshop.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	8	9

Relevance Rating: 4

Relevance Justification

With limited resources today, it is important to leverage resources w/other agencies and corporations that have similar applications and interests. This provides a method for achieving that leverage which can accelerate and enhance the research.

Approach Rating: 4

Approach Justification

Good plan to get a wide range of collaborations involved. Good assessment of the cross-cutting research area and applications.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good identification of key players and collaborators and significant progress make toward future cross-cutting proposals.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Power Electronics Crosscut Activities for EERE and OETD

Presenter	*Laboratory/Company*
Smith, Richard	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Jason Lai	6	5

Relevance Rating: 3

Relevance Justification

Try to make good use of program money

Approach Rating: 3

Approach Justification

To identify key players. It's difficult to know who's doing what, especially worldwide. Researchers attending international conferences would know more.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

I think auto manufacturers need to be involved.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	4

Relevance Rating: 2

Relevance Justification

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Power Electronics Crosscut Activities for EERE and OETD

Presenter	*Laboratory/Company*
Smith, Richard	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	5

Relevance Rating: 3

Relevance Justification

Cross cutting activates support is a necessary function of DOE and its collaboration with other government activities.

I recognize its need but question the need to formally review and evaluate it as if it were a research and development project. I would recommend that in the future this continue to be reported as an information item, but that there not be a requirement to evaluate the presentation in the same context as the technical R&D projects reported during the remainder of the meeting

Approach Rating: 3

Approach Justification

See comment above.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

See comment above.

Suggestions for Future Projects

See comment above.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	6	2

Relevance Rating: 2

Relevance Justification

Some relevance to FreedomCAR.

Approach Rating: 3

Approach Justification

Good approach.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Modest findings. Not sure how this really benefits FreedomCAR.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	2

Relevance Rating: 2

Relevance Justification

Approach Rating: 2

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	5

Relevance Rating: 3

Relevance Justification

I hope we find a GEM.

Approach Rating: 3

Approach Justification

Need to be aggressive.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Seems like a slow start considering FY04 start.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Power Electronics Crosscut Activities for EERE and OETD

Presenter	***Laboratory/Company***
Smith, Richard	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	3

Relevance Rating: 2

Relevance Justification

Approach Rating: 3

Approach Justification

Approach makes sense.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

This is a good idea in theory to leverage the funds of other branches of the government.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Power Electronics Crosscut Activities for EERE and OETD

Presenter	*Laboratory/Company*
Smith, Richard	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	7	1

Relevance Rating: 2

Relevance Justification

Approach Rating: 3

Approach Justification

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

This is a good idea in theory to leverage the funds of other branches of the government.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

The OEM team recommends benchmarking of technologies. Benchmarking data is important for future R&D reference purposes.

Approach Rating: 2

Approach Justification

It is not clear that the analytical model developed in this project can be applied successfully to other IPM motor designs at operating conditions other than 900 RPM.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

The benchmarking efforts and competitive product data collection represents a step in the right direction.

Suggestions for Future Projects

If possible, please perform thermal test of Prius motor at other motor speeds (i.e., 2000 & 4000 RPM). Then more test measurements can be used to validate the motor temperature simulation tool.

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.
2. Team would like seeing the list of other investigators helping Dr Hsu in these projects. Team observed Dr. Hsu's name on a number of big projects (in terms of dollars).

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

Benchmarking work is important for reference and for establishing a base line identifying the current state of the art in technology so that future technical work can "leapfrog" present practice.

Approach Rating: 2

Approach Justification

Experimental test set up only evaluated components under one test condition (sinusoidal waveform at 900 rpm). Need to do testing under more than the one condition especially if one of the intents of the research is to develop an analytical model that will be versatile enough to predict outcomes under varying operating conditions.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

I question how representative the results are of real world conditions; would have preferred to see some form of duty cycle evaluated that represented real world operating conditions. Analytical model is only correlated to the one test condition so may have limited usefulness.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	9

Relevance Rating: 4

Relevance Justification

The OEM team recommends benchmarking of technologies. Benchmarking data is important for future R&D reference purposes.

Approach Rating: 2

Approach Justification

It is not clear that the analytical model developed in this project can be applied successfully to other IPM motor designs at operating conditions other than 900 RPM.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

The benchmarking efforts and competitive product data collection represents a step in the right direction.

Suggestions for Future Projects

Additional Comments

1. A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

2. Team would like seeing the list of other investigators helping Dr Hsu in these projects. Team observed Dr. Hsu's name on a number of big projects (in terms of dollars).
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FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Greg Smith	4	10

Relevance Rating: 3

Relevance Justification

Good project.

Approach Rating: 4

Approach Justification

Results are as desired implies the approach was successful.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Project is completed. This is a good engineering analysis but what have we learned from it? There does not seem to be any indication of how this information could be used to improve any future designs.

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Anson Lee	8	8

Relevance Rating: 4

Relevance Justification

Benchmarking best-in-class is highly relevant.

Approach Rating: 3

Approach Justification

Good approach but test set-up needs to be more versatile to run higher speeds.

Technical Accomplishment and Progress Rating: 2

Technical Accomplishment and Progress Justification

Model is only good for 1 motor speed, not valid for all speeds.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	7	8

Relevance Rating: 3

Relevance Justification

Benchmarking current hybrid technology efficiency is crucial to understanding if program goals are reasonable, to select promising technologies and to rule out less successful or limited approaches. Power limitation and motor heating are important concerns.

Approach Rating: 3

Approach Justification

Tools developed can be valuable for DOE prototypes. This includes both modeling and measurement tools. However, project does not address fundamental engineering design reasons for the power limitation level in Prius motor & how it might be redesigned (needed materials or technology) to improve the power limits.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good examination of the limits of current technology. Showed current efficiency and power levels are below DOE goal.

Suggestions for Future Projects

Expansion of these measurements & models to power electronic temp in Prius as well as motor windings.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Study on Prius Motor Temperature Rise and Ratings

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	10

Relevance Rating: 4

Relevance Justification

This work is very relevant to hybrid and FC vehicle thermal projects. The Prius traction motor is thermally sized to match power split continuous circulating power but only transient power levels as demanded for drivability (engine augmentations).

Approach Rating: 4

Approach Justification

Excellent laboratory mock-up for realistic thermal performance.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Project shows excellent guidelines for FCVT motor design goal of 30 kw continuous rating.

Suggestions for Future Projects

DOE should require vehicle thermal survey of hybrid sedan and light truck/SUV to validate continued use of legacy thermal environmental spec.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	6	

Relevance Rating: 4

Relevance Justification

Good study, but hopefully it's not to serve Toyota.

Approach Rating: 4

Approach Justification

Both analytical and experiment are done!

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Solid numbers are given.

Suggestions for Future Projects

Perhaps the same approach can be used for the entire drive package, including inverter.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	8

Relevance Rating: 4

Relevance Justification

Benchmarking to establish state of art or application is necessary!

Approach Rating: 2

Approach Justification

Demonstrate or confirm that single operating point measures are sufficient.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Please compare to prior baselines or state of art. Nice correlation of models.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	*Laboratory/Company*
Hsu, John	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	4	10

Relevance Rating: 3

Relevance Justification

Good Project

Approach Rating: 4

Approach Justification

Results are as desired implies the approach was successful

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Project is completed. This is a good engineering analysis but what have we learned from it? There does not seem to be any indication of how this information could be used to improve any future designs.

Suggestions for Future Projects

Additional Comments

Who are the additional researchers for this project? John Hsu is listed on multiple projects, each with significant funding levels. Furthermore, each of these projects would require the work of more than one full time equivalent person. Without additional personnel resources, the funding level does not seem justified.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Study on Prius Motor Temperature Rise and Ratings

Presenter	***Laboratory/Company***
Hsu, John	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	5	9

Relevance Rating: 4

Relevance Justification

Critical to the FC ultimate design criteria as thermal management to maintain performance and reliability must begin with highly accurate heat load models.

Approach Rating: 4

Approach Justification

Excellent application of theory → FE analysis→ empirical results. Consumer acceptance will require performance under all load conditions. Control of thermal loads are the key.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Data speaks for itself. FE analysis - experimental agreement indicate validity of process and model. Should continue to evaluate other motor types and core-winding materials.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	8

Relevance Rating: 4

Relevance Justification

SiC is the kind of leapfrog technology that can benefit from long range federal research funding. The need for high reliability, low cost component is critical to future applications for hybrid and fuel cell vehicles.

Approach Rating: 4

Approach Justification

This project has been evolving as the needs of the program and as the commercial/technical marketplace have been changing. The flexibility of the PI and the research increase its value.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Research has made good progress. PI has listened and reacted positively to recommendations from reviewers. PI has shared results & data and has associated the project with valuable collaborators resulting in appreciable progress.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Vijay Garg	10	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 4

Approach Justification

Good approach.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	8	10

Relevance Rating: 4

Relevance Justification

Very important research area.

Approach Rating: 4

Approach Justification

Good approach and shows flexibility to adjust to changes in the marketplace.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Very good results.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	6	9

Relevance Rating: 4

Relevance Justification

Highly relevant research.

Approach Rating: 4

Approach Justification

Outstanding approach.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Great progress in a relatively short period of time.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	9

Relevance Rating: 4

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good reporting of final results on Semikron.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Allen Hefner	10	9

Relevance Rating: 4

Relevance Justification

SiC power devices have the ability to increase the thermal budget and therefore could solve one of the most difficult issues for power devices in the vehicle environment, that is the cooling with low thermal budget.

Approach Rating: 4

Approach Justification

Comprehensive approach including SiC device characterization, theory, inverter, application, and system impact studies.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

The work presented is accurate and results are consistent with the finding for high voltage SiC device work being performed by others. This could become a world class effort with high probability of having a large impact on FreecomCAR goals.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	10	8

Relevance Rating: 4

Relevance Justification

Investigation of SiC, and other WBG candidates, impact on component efficiency, power density, and thermal mgmt requirements relaxation is OUTSTANDING. Focus is on the critical aspects of PE performance, reliability, and cost.

Approach Rating: 4

Approach Justification

Excellent balance of modeling, and especially empirical performance determination/validation of SiC utilization impact on components. Key focus on reliability and system impact.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Inverter comparison of Si and SiC device utilization results correlate well with our performance measurements in DC/DC converter applications.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Pat McCluskey	9	9

Relevance Rating: 3

Relevance Justification

SiC is a very promising technology for achieving high efficiency power modules at 105°C without the cost/reliability/performance complications of active cooling technologies. The analysis of SiC Diode/MOSFET/VJVET devices is very useful. Program needs to have a goal of either improvement or adaptation to automotive needs - not just measurement.

Approach Rating: 3

Approach Justification

Benchmarking and confirmation was well done. Experimental analysis was fine. Interesting conclusions drawn in SiC MOSFETS. Adaptation, modification, and improvement for the automotive environment was missing. What are the suggestions/recommendations for device selection/packaging and integration?

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Good collaboration with industrial and academic partners. Excellent characterization work and conclusions on SiC MOSFET. Needs to focus now on device selection and incorporation into package or system.

Suggestions for Future Projects

More work on packaging and integration, especially its effect on SiC performance and reliability in final module.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Brian Welchko	7	10

Relevance Rating: 4

Relevance Justification

Very important research area.

Approach Rating: 4

Approach Justification

Good approach and shows flexibility to adjust to changes in the marketplace.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Very good results.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	*Laboratory/Company*
Ozpineci, Burak	ORNL

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	8	9

Relevance Rating: 3

Relevance Justification

RPI and others have already made Si vs. SiC comparisons in power electronics converters. However, not in the context of APEEMD.

Approach Rating: 4

Approach Justification

Very good coverage over temperature extremes and explanation of Rds (?) increase below +50°C.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent industry partners collaborations, but need application with ------- OE's.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	10

Relevance Rating: 4

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Suggestions for Future Projects

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like to see additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Wide Bandgap Materials

Presenter	***Laboratory/Company***
Ozpineci, Burak	ORNL

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	9	4

Relevance Rating: 3

Relevance Justification

SiC may seem attractive but it is too early to show any promise for FreedomCAR.

Approach Rating: 4

Approach Justification

Devices and inverters are characterized extensively.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Good progress so far with hard data experimental results.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
K Fiegenschuh	5	9

Relevance Rating: 3

Relevance Justification

Innovative new approach to design topology that may (or may not) prove beneficial in the long run to improved power electronics for future fuel cell and hybrid vehicles.

Approach Rating: 4

Approach Justification

Commendable that DOE has funded new innovative design approaches to inverter design. Initial results seem promising analytically and now we need more testing with hardware (and further analysis based on experimental tests) to fully understand the design implications and determine if the initial promise/optimism was justified.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

There has been good progress in a little over 11/2 years of work, but we still need to see the hardware tested for reliability and other design attributes and a technical assessment of the results.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer
Vijay Garg

Ability to Rate (1-10) (10 being expert)	***Important to FreedomCAR (1-10) (10 being strongly agree)***
10	9

Relevance Rating: 3

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

No data was presented to prove reliability of the device.

Suggestions for Future Projects

Continue the project to optimize and develop technology for application in hybrid vehicles.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like seeing additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Anson Lee	6	9

Relevance Rating: 4

Relevance Justification

Highly relevant project.

Approach Rating: 4

Approach Justification

Clever approach, but need to verify if new failure modes could be created.

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Good progress so far, need more thorough testing for prove-out.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
M. Mehall	5	7

Relevance Rating: 3

Relevance Justification

Novel concept with potential.

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Await reliability and efficiency due to ripple effects.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
James Scofield	7	8

Relevance Rating: 4

Relevance Justification

Significant potential to impact cost and reliability by eliminating converter switch bridge. Inclusion of buck functionality.

Approach Rating: 3.5

Approach Justification

Highly novel topology with good mix of simulation, fabrication test, and design validation in 55kW inverter. Reliability assessment should be included as switches appear to be doing double duty.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Results to date appear to verify predicted performance.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Peng, Fang	MSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Pat McCluskey	4	8

Relevance Rating: 3

Relevance Justification

Z-Source inverter shows promise as a low cost, high efficiency device for hybrid electric vehicles.

Approach Rating: 4

Approach Justification

Approach of design development and testing is well thought out and on schedule.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Prototype designed and developed and preliminary testing already completed. Project already shows some advantages of prototype Z-Source inverter.

Suggestions for Future Projects

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Peng, Fang	MSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
Brian Welchko	8	8

Relevance Rating: 2

Relevance Justification

The importance of this project has diminished as the deficiencies of the topology have become known.

Approach Rating: 4

Approach Justification

Excellent

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent

Suggestions for Future Projects

An extension of the project looking to adapt the topology to hybrid applications should be funded at a low level, perhaps $50K.

Additional Comments

This project is wrapped up.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Greg Smith	8	8

Relevance Rating: 2

Relevance Justification

The importance of this project has diminished as the deficiencies of the topology have become known.

Approach Rating: 4

Approach Justification

Excellent.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Excellent

Suggestions for Future Projects

An extension of the project looking to adapt the topology to hybrid applications should be funded at a low level, perhaps 50k.

Additional Comments

This project is wrapped up.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Edward Jih and Tech Team (OEM)	8	7

Relevance Rating: 3

Relevance Justification

Approach Rating: 4

Approach Justification

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

No data was presented to prove reliability of the device.

Suggestions for Future Projects

Continue the project to optimize and develop technology for application in hybrid vehicles.

Additional Comments

A general comment, this year (2005) the presentation format was considerably improved as compared to last year (2004). Team would like to see additional improvements with regard to hardware demonstration and analytical data supporting the claims.

FreedomCAR Advanced Power Electronics Annual Review (May 05)
Reviewer Forms (listed by title)

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Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	*Laboratory/Company*
Peng, Fang	MSU

Reviewer	*Ability to Rate (1-10) (10 being expert)*	*Important to FreedomCAR (1-10) (10 being strongly agree)*
John M. Miller	10	9

Relevance Rating: 4

Relevance Justification

Power Electronic innovation well worth the investigation.

Approach Rating: 3

Approach Justification

Good, novel application of C-C's to replace Si-devices. But can the Z-source meet the FreedomCAR specific power (gravimetric and volumetric) requirements?

Technical Accomplishment and Progress Rating: 3

Technical Accomplishment and Progress Justification

Need to very that the Z-source satisfies all 5 HEV modes: 1)Batt-EV (fwd pwr flow) 2) Batt charge at idle (reverse pwr flow) 3) Boosting (augment engine) 4) Regen to energy storage via traction motor 5) Vehicle reverse mode (but this is more of a transmission reqm't than inverter requirement) Need temperature tests yet.

Suggestions for Future Projects

If the Z-source satisfies the 5 HEV modes, then perhaps the OEM's will pick up further development.

Additional Comments

FreedomCAR Advanced Power Electronics Annual Review (May 05)
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Title

Z-Source Inverter for Hybrid Electric and Fuel Cell Powered Vehicles

Presenter	***Laboratory/Company***
Peng, Fang	MSU

Reviewer	***Ability to Rate (1-10) (10 being expert)***	***Important to FreedomCAR (1-10) (10 being strongly agree)***
Jason Lai	9	8

Relevance Rating: 4

Relevance Justification

A very innovative circuit topology that allows versatile application.

Approach Rating: 4

Approach Justification

Controls are being developed to address all possible issues.

Technical Accomplishment and Progress Rating: 4

Technical Accomplishment and Progress Justification

Experimental results are available for further understanding.

Suggestions for Future Projects

Additional Comments