Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee

October 23-24, 2007
Marriott Hotel, Gaithersburg, MD

Members present:
Dr. Charles Baker, Sandia National Laboratories
Prof. Riccardo Betti, University of Rochester
Dr. Richard Callis, General Atomics
Dr. Jill Dahlburg, Naval Research Laboratory
Prof. Jeffrey Freidberg, Massachusetts Institute of Technology
Dr. Martin Greenwald, Massachusetts Institute of Technology
Prof. Richard Hazeltine, University of Texas-Austin
Prof. Joseph Johnson, Florida A & M University
Dr. Rulon Linford, Lawrence Livermore National Laboratory
Dr. Kathryn McCarthy, Idaho National Laboratory
Prof. Gerald Navratil, Columbia University
Prof. Stewart Prager (chair), University of Wisconsin-Madison
Dr. John Sheffield, University of Tennessee, Institute for a Secure and Sustainable Environment
Prof. Edward Thomas, Auburn University
Dr. Michael Zarnstorff, Princeton Plasma Physics Laboratory

Members absent:
None

Ex-officio members present:
Dr. Roger Stoller (ANS), Oak Ridge National Laboratory

Ex-officio members absent:
Dr. Vincent Chan (APS-DPP), General Atomics
Dr. John Steadman (IEEE), University of South Alabama

Designated Federal Officer present:
Albert Opdenaker III, Executive Assistant for Fusion Energy Sciences, US Department of Energy

FESAC Executive Secretary:
Dr. John Sarff, University of Wisconsin-Madison

Other persons attending the meeting are listed in the appendix.

1. Meeting Agenda and Logistics.
The meeting was called to order at 9:00 am. Prof. Prager announced that Dr. Raymond Orbach was called to a meeting with the Secretary of Energy and therefore unable to attend the FESAC meeting as scheduled in the agenda. He also announced that Dr. Vincent Chan was unable to attend due to fires in the San Diego area.

2. Office of Fusion Energy Sciences Perspective.
Dr. Raymond Fonck, Associate Director, provided an update on the Office of Fusion Energy Sciences (OFES) program. On the budget, Dr. Fonck reported no major change in status since the last FESAC meeting. The DoE is operating under a continuing resolution, which will not be a serious limitation until the March timeframe, at which time ITER allocations could become an issue. The call for the removal of funding for the High Energy Density Laboratory Plasma (HEDLP) program in the House bill is a misunderstanding that OFES is working to clarify. The House misunderstood the program as new rather than a reorganization of existing programs. Dr. Fonck reported that the ratification of the ITER agreement is imminent (next few days), a major step forward that makes ITER a legal entity. The first meeting of the ITER Council will be held in November. Dr. Fonck discussed the ITER design review activities, which will result in a "reference design" to serve as the basis for further design activities. He noted that the U.S. contingent has had a significant impact on the design review. Some of the design effort has been supported by ITER funding, but much of the U.S. effort has been voluntary. He emphasized the continuing need to push for a design that meets U.S. goals. Dr. Fonck then discussed the review of the NCSX compact stellarator project. He thanked FESAC for responding quickly to the charge. He reported that the NCSX construction cost and schedule overruns are projected to be at least $40M larger and two years longer than expected. Such large overruns require re-evaluation for their impact on the Fusion Energy Sciences Program and Office of Science more generally. The causes for the overruns are that the fabrication and assembly costs were underestimated. Dr. Fonck described the steps in the decision process that will result in either a re-baseline or cancellation of the project. A Lehman review in April concluded that the new proposed baseline is credible. The FESAC review of the NCSX and stellarator science program is described in item 5 below. An external technical review of the design will be conducted in November. If the Office of Science decides to re-baseline the project, the Office of Engineering and Construction Management will conduct an external independent review. Dr. Fonck then described the status of the HEDLP program. The report of the interagency Task Force on HEDP has been released. The First International Conference in HEDP will coincide with the April meeting of the APS in St. Louis, MO. He noted the increased international interest in fast ignition and formation of an International Fast Ignition Committee (IFIC) to coordinate international research in this area. A Memorandum of Understanding (MOU) is being prepared between OFES and NNSA to permit legal FESAC and FACA advisory input on the near and midterm directions for the joint HEDLP program. Dr. Fonck then discussed issues affecting the future of the Fusion Energy Sciences Program. He described an urgency to develop the elements of a 5, 10, and 20-year strategic plan. There are a number of factors framing this discussion, e.g., planning for the operation of ITER, anticipating ignition in NIF, identifying opportunities for U.S. leadership embodied in world-class facilities and coordinated theory and computation, and planning effective stewardship of plasma physics generally (as described in the NRC Plasma 2010 study). He noted the need to examine the distribution of resources between the program elements. This planning should involve a combination of community workshops and charge areas for FESAC. Dr. Fonck

presented a draft, new conceptual organizational structure for OFES consisting of three divisions: Projects and Planning, Magnetic Fusion Sciences, and Plasma Sciences. He explained that creation of the Plasma Sciences division allows a possibility for acquiring new resources, whereas there is low likelihood for near term growth in magnetic fusion science that presently dominates the OFES portfolio. Lastly Dr. Fonck described the future of FESAC membership, noting the expectation to turn over 1/3 of the membership every two year cycle. Expanded representation of the HEDLP and Plasma Science will be considered in new FESAC membership. Suggestions and nominations are welcomed.

FESAC discussion: Most of the discussion concerning the future direction of the program was conducted on the second day (see item 8 below). It was noted that research in other agencies such as NIH and DoD seems to have higher visibility than fusion research, so is now a good time to discuss the priority of fusion research at a national level? Dr. Fonck replied that Dr. Orbach has had success raising the visibility of research in the Office of Science (SC), and the goals for SC are becoming more clear in time. He noted that the role of fusion research is not under attack and the program has support, but there is a need to develop a strategic plan that makes clear what it is the program needs to accomplish. In terms of outreach, he noted that all must help, OFES as well as the research community. For example, he has commissioned the Burning Plasma Organization to develop new multimedia educational materials suitable for a broad audience. On the draft reorganization of OFES, Dr. Fonck replied to a question on the organization of the Magnetic Fusion Sciences division by confinement concept instead of by facility that, yes, it should be viewed as a matrix. The research needs to be concerned with the self-consistent development of specific confinement concepts as well as the development of common science.

3. Report from the Panel on the Fusion Simulation Project.

Dr. William Tang, PPPL, presented the findings and recommendations of the FESAC sub-panel on the assessment of the Fusion Simulation Project (FSP). Dr. Tang described the panel's view that the FSP is a unique opportunity for U.S. leadership in fusion research, and a recurring theme in the panel's assessment is that, in order for the FSP to succeed, it must work closely with other elements of the fusion program, particularly theory and experiment. He also noted that SciDAC provides a solid basis for collaboration with the Office of Advanced Scientific Computing Research (OASCR). Dr. Tang described the five charge questions, panel membership, and the process for the review. Following the FSP workshop (reported on at the last FESAC meeting), the panel met through eight teleconferences. Dr. Tang summarized the panel's general impressions on the FSP iniative: the primary objective would be to produce world-leading, realistic, multi-scale predictive simulation capability with unprecedented physics fidelity through the development of advanced software designed to use leadership class computers. Verification and validation would be prominent, working with the theory and experimental programs. The project has a 15 year timeline with an anticipated budget of $25M/year. The panel responded with "conditional yes" to each of the five charge questions, i.e., a substantial number of suggestions for how to improve the FSP vision formed the bulk of the panel's feedback.

FESAC discussion: The members' comments in discussion were generally supportive of the report. A few expressed reservations on whether or not the FSP vision is sufficiently compelling and ready to proceed. Some expressed the opinion that the components (e.g., theory and codes) are more important than their integration, which is central to the FSP mission. A number of

comments were made in regard to the lack of clear executive summary for the report, and that an improved summary would be able to communicate to a broad audience the compelling value for an FSP. Hence FESAC requested that the panel draft an executive summary that addresses these concerns.

4. Report from the FESAC Panel on Strategic Planning.
Dr. Martin Greenwald, MIT, presented the Final Report from the FESAC sub-panel on strategic planning. He reviewed the three charge questions in the letter from Dr. Orbach that directed FESAC to "identify the issues arising in a path to DEMO, with ITER as a central part of that effort." Dr. Greenwald described the panel's view on the scope of the charge, interpreted not to span the entire fusion sciences program. Inertial fusion energy (IFE) was not included, and alternates to the tokamak in magnetic confinement were considered only to the extent they could facilitate the development path in the short term. It was also assumed that ITER would be successful in its "baseline" mission. For this charge, "DEMO" was assumed to be a prototype, electricity producing fusion reactor demonstrating high availability, reliability and all relevant technologies, consistent with previous studies and reports and the FESAC "35 year plan" for fusion development in particular. A broad view of the technical issues was adopted to ensure the program is prepared for various possible DEMO instantiations. The panel sought community input through presentations at two workshops (hosted by General Atomics and PPPL) as well as through white papers submitted to an internet-based discussion forum that drew more than 90 registered users. The panel met in person at three 2-day meetings and held more than 20 conference calls. Dr. Greenwald described 14 broad scientific and technical issues, organized into three themes, that the panel used to organize discussions on research gaps and priorities. This set and organization is not unique, but served to cover all of the important issues. To prioritize the issues, the panel created a scoring system with as precise definitions as could be managed for the importance, urgency and generality of the issues. The panel's priority ranking was expressed by grouping the issues into three tiers defined to suggest overall judgment on the state of knowledge and relative requirement and timeliness for more intense research for each issue. Dr. Greenwald emphasized that all of the issues are important and must be resolved to establish readiness for a DEMO. To identify the "available means" as requested in the charge, the panel compiled a comprehensive inventory of existing and planned programs in the world. The panel also assessed U.S. strengths and opportunities, identifying areas of current and historical U.S. leadership, areas where the U.S. is in danger of losing leadership or competitiveness, and areas for U.S. opportunity to sustain or gain leadership by strategic investment. To identify research gaps, the panel identified residual questions or issues that are likely to be left after completion of the existing and planned programs. The gaps were groups into 15 broad categories similar to (but different from) the issue categories. These formed the basis for the panel's identification of nine major initiatives to address the research gaps. Typically, each of the major initiatives would make contributions to more than one gap, and alternate approaches are embodied in the initiatives. The relationship between the research gaps and major initiatives was condensed graphically in a table that illustrated the major and minor contributions of the initiatives.

FESAC discussion: Generally FESAC members praised the report. The discussion focused primarily on issues that some members perceived to be not adequately addressed. It was noted that "predictive modeling" appears repeatedly in the report, but that theory does not. Dr.

Greenwald explained that this was not intended, and that it would be straightforward to add additional language to make more clear the role of theory. Members also expressed concern that the issue of availability did not come out as visibly as needed. It was noted that a reactor requires availability two orders of magnitude greater than will be attained in ITER, and that different approaches and a great deal of testing will be required to achieve high availability. Dr. Greenwald explained that the panel choose to not make important cross-cutting topics as stand alone issues (including availability and economics) to make sure all of the issues were exposed. He also explained that a main purpose of the report is to inform next step options, and while availability is clearly vital, it cannot be addressed directly for quite a while yet. It was concluded to modify the report by including availability as a 15th issue, but not to include it in the panel's prioritization process, which would require substantial additional panel deliberation. Some members questioned the relatively low priority for high field magnet development, noting that a larger magnetic field could permit higher power density with less challenging plasma beta. Dr. Greenwald and others noted that the panel consensus was that the technology for the magnetic field requirement in DEMO is relatively mature. It is also important that poloidal beta must be large in a tokamak in order to permit access to large bootstrap current, key for steady-state operation. Larger toroidal field alone does not permit higher bootstrap current fraction. It was concluded that adding explanatory words for why high magnetic field was not higher priority would weaken the report, as this would call into question the conclusions regarding the priority of other issues. A question was raised on whether or not the nine initiatives are to be considered a basis set, all of which must be undertaken. Also, some of them appear to be genericized versions of proposals already under discussion in the fusion community. Dr. Greenwald noted that the important issues are not a secret, and that it is not a surprise if community proposals would address the report's issues. He agreed that the initiatives may be viewed a basis set, but not orthonormal set. The U.S. program does not have to do everything itself, but the world program collectively must cover all gaps.

5. Report from the FESAC NCSX Review Panel.

Prof. Richard Hazeltine presented the report from the FESAC sub-panel on a review of the NCSX project. This review was charged by Dr. Orbach to inform a decision on the future of NCSX, by addressing certain scientific and technical questions about the NCSX experiment, its capabilities, and its role in the international fusion program. The charge questions were unusually many in number and detailed in scope. The review was completed in five weeks time, immediately beginning after the population of the panel and ending just before this FESAC meeting. Although the available time was short, the panel achieved a thorough and unhurried discussion by setting aside questions not central to the charge. Prof. Hazeltine noted that the NCSX team was helpful in providing background information and in responding to requests from the panel. He described the important and unique scientific contributions of stellarator research, the role of quasi-symmetric stellarator configurations, and the quasi-axisymmetric (QAS) configuration in particular, which forms the design basis for NCSX. Key advantages of the QAS configuration are that it has relatively low aspect ratio compared to conventional stellarator designs, which helps reduce the size of a stellarator-based fusion power source, and that the QAS configuration is most closely connected to the axisymmetric tokamak configuration. Key disadvantages are the cost and complexity of the magnet coils, whose precise design and alignment are essential for acceptable plasma confinement, and that the three dimensional nature of the coils complicates external access to the plasma and the plasma blanket

in a stellarator-based fusion reactor. The panel concluded that, assuming successful construction and testing phases, the NCSX device is likely to perform at a level sufficient to address its scientific and technical mission. Therefore the panel expects the NCSX program to have a profound impact on stellarator research worldwide. The panel expressed concern about the practical realism of the alternating-year operation of NCSX and NSTX as proposed by PPPL, noting that the resolution of key experimental issues is likely to require five years of actual operation. With respect to the U.S. stellarator program, the panel concluded that, in the absence of NCSX, the other existing devices could be upgraded to address at various levels a subset of physics and technology issues, but that no present or planned program could provide the breadth of scientific and technical information expected to come from NCSX, which is the only U.S. stellerator proof-of-principle scale facility. If NCSX is cancelled, the panel recommends that the construction decision on the quasi-poloidal stellarator (QPS) proposed by ORNL be expedited. However, they found it illogical to cancel a stellarator project that is nearing final construction phases only to begin a new stellarator with poloidal rather than toroidal quasi-symmetry. The panel also concluded that, if NCSX is cancelled, the U.S. Stellarator program should consider a variety of approaches to stellarator optimization in proposing a new proof-of-principle stellarator project.

FESAC discussion: The bulk of the discussion of the report concerned three areas: (1) the practicality of the proposed alternate-year operation of NCSX and NSTX, (2) technical issues concerning the QAS configuration and the stellarator in general, and (3) the ramifications of canceling NCSX on the U.S. stellarator program. Prof. Hazeltine was asked to elaborate why the panel doubted the efficacy of the alternate-year operation plan. It was observed that having one set of scientists work on both a tokamak (NSTX) and stellarator (NCSX) might be an intriguing scientific opportunity. Prof. Hazeltine replied that the experts on the panel who have experience operating a large facility such as NCSX voiced extreme skepticism in the plan and such benefits. Issues of concern include personnel management, interruption of project momentum, and negative consequences of turning equipment off for long periods. Members asked for clarification of the plan details, for example would there be two separate research teams, and if so how this would provide budgetary savings? Prof. Robert Goldston, PPPL director, explained that each year's operation would be, in effect, a double run of the single operating device. The technical staff would be shared between the two facilities. A portion of the PPPL scientific staff would also be shared, but other scientific collaborators specific to each of the two programs would represent a substantial fraction of the personnel involved in the programs. The shared staff represents the primary budgetary savings. Dr. Fonck emphasized that the alternate-year operation is only a proposal, not necessarily to be followed, and that much further discussion will occur. Concerning the QAS configuration, the question was asked that, if quasi-symmetry is necessary to reduce neoclassical transport, how is it that stellarator configurations that are not quasi-symmetric attain good confinement? Prof. Hazeltine replied that there are other approaches to control the particle orbits associated with poor neoclassical confinement (e.g., quasi-omnigeneity and iso-dynamics), which were adopted as the design basis for the W7-X and LHD large stellarator devices. Several questions were asked regarding the precision requirements for the construction of the magnet coils. Stellarator research experience is that if the coils are constructed with high precision, then good magnetic flux surfaces can be obtained. In a reactor, with a blanket of conducting materials between the plasma and the coils, is there concern that the desired magnetic field can be obtained? Also, have experiments been designed to evaluate and

define the required precision? Prof. Hazeltine replied that these issues have concerned the stellarator community for a long time, citing successful experimental efforts to validate the magnetic flux surface quality. Trim coils are included in the NCSX design to correct and optimize flux surface quality. Some trim coils are being constructed while others can be added later if necessary. These trim coils provide an experimental means to destroy the flux surface integrity and thereby quantify the magnet coil precision requirements. He added that the ARIES team investigating the compact quasi-axisymmetric stellarator as a reactor system concluded that issues such as the blanket's impact on magnetic field quality were not insurmountable, and that a continuing goal in stellarator research is to simplify the coil design. Prof. Hazeltine reiterated that the panel was in full agreement with the statement that, assuming successful construction and testing phases, the NSCX device is likely to perform at a level sufficient to address its mission, but that they did not feel that they were asked to evaluate whether or not the device was being constructed correctly, and that the panel assumed this to be the case. In regard to the U.S. stellarator program in the absence of NCSX, an explanation of why QPS would not replace the scope of NCSX was requested. Prof. Hazeltine explained that NCSX is a proof-of-principle scale facility, whereas QPS is smaller and not designed to study in an integrated fashion a full range of scientific issues, as expected for a proof-of-principle scale project. The question was asked why not consider building an additional concept exploration level facility instead of a proof-of-principle scale facility? Prof. Hazeltine replied that the panel felt strongly that the U.S. needs a proof-of-principle scale facility to influence worldwide stellarator research, although he also noted that the U.S.'s existing concept exploration stellarator experiments and 3D theory and computation expertise do have significant impact on stellarator research. In regard to the recommendation that, if NCSX is cancelled a variety of approaches to stellarator optimization should be considered in proposing a new proof-of-principle project, this does not imply the panel was concerned in any particular way about the QAS approach, rather that a broad view on stellarator optimization should be considered in that event. A procedural note, FESAC member Dr. Michael Zarnstorff, PPPL, recused himself from this discussion following Prof. Hazeltine's presentation.

6. Public comments (3).

Prof. Miklos Porkolab, MIT, reported that a symposium on magnetic fusion research will be held in conjunction with the AAAS meeting in Boston, on Feb. 16. The symposium will be a three hour session with six speakers: E. Velikov, P. Kaw, R. Fonck, R. Stambaugh, K. McCarthy, and C. Llewellyn-Smith. The symposium, co-organized by Prof. Porkolab and Barrett Ripin, celebrates the 50th anniversary of the Geneva Conference. There will also be a symposium on inertial fusion energy. Prof. Porkolab also offered his views on the high magnetic field approach to fusion (see FESAC discussion above). He noted the potential advantage using a lower beta, higher reliability approach. He also noted that RF current drive is easier at higher field. He commented that it is inconceivable there would not be advances in the several decades leading to a fusion reactor.

Dr. Stephen Dean, Fusion Power Associates, presented to FESAC a white paper titled "The Rationale for an Expanded Inertial Fusion Energy Program" by Dr. Dean. The paper acknowledges 14 other individuals for their assistance. Dr. Dean noted that the MFE and IFE communities have worked together well, going back to the Snowmass meetings and the 35 year

plan. He expressed concern that the lack of inclusion of IFE in the Strategic Planning process described in item 4 above will break consensus between the MFE and IFE communities. He said that the IFE and ICC communities would like to be included in the planning process. He noted that DOE has no timetable for DEMO, so there is no need to narrow the field at this point. Dr. Dean also described what he views a policy issue. The fusion program has been operating under a statement of knowledge development. Given a charge on how to get to DEMO, he argued that there should then be a new statement of policy for fusion energy development. Dr. Dean also expressed his concern that the strawman reorganization of the Office of Fusion Energy Sciences proposed by Dr. Fonck does not give equal treatment to IFE, since there would be a Division on Magnetic Fusion Energy, whereas IFE would fall under Plasma Science.

First day, adjourned, 5:00 pm
Second day, called to order, 8:30 am

Prof. Robert Goldston, PPPL, noted changes occurring in the country's view on energy. He sees a risk that the discussion could pass over fusion energy, in part because most of the focus is the relatively near term when fusion will not play a major role. He suggested a community effort or FESAC action to refresh the arguments for fusion energy as the energy debate goes forward. This is also timely with a new presidential administration coming in.

7. Drafting of Transmittal Letters for Panel Reports.
Prof. Prager led the drafting of transmittal letters for the three panel reports described above on: The Fusion Simulation Project (FSP), Strategic Planning, and the NCSX Review. The members' discussion on the letter for the Fusion Simulation Project report concluded that it would be revised after the meeting to include reference to the 2002 FESAC report on FSP and note the report's recommendation that FSP move to a project definition phase.

8. FESAC discussion.
Dr. Orbach was unable to attend the meeting as scheduled. FESAC used the available time to continue discussion on strategic planning and program policy. The discussion concentrated on a few main themes, some main points noted below:
On program policy: Questions were raised related to the policy statement for fusion energy, if it should adopt an energy mission and encompass fusion technology explicitly, and if science alone is sufficient to justify the fusion program. It was also noted that basic plasma science is important to fusion (e.g., low temperature plasma boundary), and that there are strategically important non-fusion applications associated with basic plasma science. Dr. Fonck noted that there is no outside opposition to the fusion program emphasis on science. He also said that the strategic planning charge (item 4 above) is often misinterpreted to imply that the fusion program is transitioning to an energy development path. It was observed that science issues extend well beyond plasma science, and there is opportunity to shore up all fronts as indicated in the Stategic Planning Panel report.
On High Energy Density Laboratory Plasmas and Inertial Fusion Energy: Dr. Fonck summarized the Office of Science view that there is a desire to see the large inertial confinement fusion (ICF) facilities be used for developing the science of inertial fusion energy (IFE) and high energy density laboratory plasma (HEDLP) research. However, there is no support for an IFE energy program. This parallels the emphasis on science for MFE research. He also said HEDLP

program has momentum and good opportunity for growth. He reiterated that creating a new "Plasma Sciences" division in OFES, with HEDLP as the flagship for this portion of the program, may allow growth in funding, whereas placing HEDLP/IFE in one "Fusion Sciences" division with MFE research would be a zero-sum funding scenario. He noted that advisory responsibility for HEDLP and IFE science should fall under the purview of FESAC. If there were to be separate advisory committees, this would institutionalize a separation of MFE and IFE science. An understanding will need to be forged with NNSA, since DOE cannot legally advise on NNSA facilities. It was noted that NIF does not lead to an IFE DEMO path, unlike the role of ITER in the MFE DEMO path. Dr. Fonck said it is necessary to map out the 10-15 year plan to identify the scientific opportunities that would follow on after NIF.
On next steps to planning: It was noted that the fusion community has not had a community-wide meeting to maintain and forge consensus as developed at the past Snowmass meetings. It was also noted that planning activity that seeks to develop an integrated program plan should have a broad scope of plasma science, not just fusion science. Dr. Fonck said that there are several streams of issues, and that these need to be treated separately. There need to be information gathering processes that define the compelling scientific issues. The start for this with respect to large tokamaks is provided by the Strategic Planning Panel report. Similar definition of issues needs to be created for the other program elements before a grand meeting of the whole community. There are no decisions yet on how to approach this process, but it will likely include additional FESAC charges, workshops, and other meetings on targeted elements of the program.

Meeting adjourned at 11:45 am

Appendix: public attendees.

Rich Hawryluk, PPPL
Hutch Nielson, PPPL
Mark Haynes, GA
Rich Walsh, AREAV Fed. Svcs.
Stephen Dean, Fusion Power Associates
Michael Roberts
Steve Gourlay, LBNL
Don Rej, LANL
Rob Goldston, PPPL
Chris Carter, Princeton University
Arnold Kritz, Lehigh University
Steve Knowlton, Auburn University
Mohamed Abdou, UCLA
Karen Pao, DOE/NNSA
Dale Meade, Fusion Innovation Research and Energy
Martin Peng, ORNL
Karen Summers, DOE SC-41
Miklos Porkolab, MIT
Ed Synakowski, LLNL
Tom Vanek, DOE SC
Bill Tang, PPPL
Kin Chao, DOE SC
Steve Meador, DOE SC
Stewart Smith, Princeton University
DOE OFES:
Raymond Fonck
Erol Oktay
Mike Crisp
John Mandrekas
John Glowienka
Marvin Singer
Al Opdenaker
T.V. George
Steve Eckstrand
Gene Nardell
Rostom Dagazian
Sharon Stevens
Francis Thio
Sam Barish
Curtis Bolton
John Sauter