Report by the DOE/NSF Nuclear Science Advisory Committee on the Steady State Operating Costs for CEBAF

July 15, 1992

Background

On January 11, 1992 NSAC was asked by DOE/NSF for an evaluation of the level of operating funds which the Continuous Electron Beam Accelerator Facility CEBAF at Newport News, Va, will require after completion of construction and after the commissioning phase (the full charge is appended to this report). CEBAF will be the major medium energy nuclear physics facility in the U.S. when it begins its large and varied research program ramping up its accelerator and phasing in various large detectors in all three halls from 1994 to 1995. Beams at 800 MeV are expected to serve hall C in summer 1994, and full service with three independent beams at 4 GeV delivered to all three experimental halls is expected for winter 1994/95. Although the major equipment in halls A and B may not all be completed, steady state operation can reasonably be assumed for 1996. A baseline for steady-state operating funding for CEBAF had been established in 1988 at \$33.1 M (FY87 dollars) by a DOE review panel, and this funding level is contained in the present DOE project sheets for CEBAF.

Two major changes have occurred in the CEBAF program scope since 1988: In 1990 NSAC supported a CEBAF request for an increase in major instrumentation funds in order to prepare equipment in all three experimental halls in a concerted plan. This expands the early experimental program at CEBAF significantly. Secondly, as at other major facilities, the increasing DOE emphasis on ES&H aspects requires substantial increased efforts by the laboratory. Finally, the advanced state of accelerator construction permits a clearer picture of its operational requirements.

Earlier this year, an NSAC Subcommittee on the Implementation of the 1989 Long Range Plan for Nuclear Science reviewed the needs of the entire field under the assumption of several, mostly restrictive, budget scenarios (the Schiffer Report). In its budget projections from 1994 to 1997, the Schiffer Report assumed a need for \$45 M (FY93 dol-

lars) for CEBAF operation, based on available projections, but acknowledged that this issue would soon be reviewed by an expert NSAC subcommittee. The present DOE/NSF charge to NSAC about CEBAF operations explicitly requests that any changes in CEBAF operating funding must be seen in the context of the five year funding plan for the entire field.

In response to the charge, NSAC established the Subcommittee on CEBAF Operations, a fact finding group of seven experts on the operation of large accelerators and of major experimental facilities. This subcommittee, chaired by Dr. Derek Lowenstein from BNL, who was also a participant in the 1988 operations review, did a bottoms-up review of CEBAF operational needs during a two-day site visit on May 26-27, 1992. Its report to NSAC is appended and provides the basis for NSAC's deliberations and recommendations. Subsequently, NSAC held a full meeting at CEBAF on June 11-12, 1992 (schedule appended) where Dr. Lowenstein presented the Subcommittee Report. In addition, CEBAF staff reported on the status and progress of CEBAF construction and of major instruments. CEBAF management re-iterated its own estimates of future needs for operations funding during the first years of operation, from 1994 to 1998. The chairman-elect of the CEBAF user organization (speaking for the chair of the users organization) as well as several individual users presented their views on the future style of, and ensuing needs for, operation of the substantial experimental program planned for CEBAF, recommending an increase in operations funding, even if future increases in funding for the user's research program would have to be sacrificed.

NSAC expresses its appreciation to Dr. Lowenstein and the Subcommittee for completing a difficult assignment in a very short time. It also wishes to thank CEBAF management and staff for the efficient and professional handling of the site visits, and for the open and collaborative spirit of the presentations and discussions. The Committee was impressed by the quality and vigor of the construction activity that was apparent in the laboratory.

Findings

The operations budget at CEBAF includes operation of the accelerator proper, maintenance of major experimental facilities, and the nuclear research performed by laboratory scientists and staff.

CEBAF has developed a plan for a "shake-down phase" which covers the period dur-

ing which accelerator performance and reliability are increased from the turn-on in FY94 to a final steady state operation in FY98. During this time CEBAF management expects accelerator availability to go from an initial 30% to a steady state of 80%. The Subcommittee focussed its estimates for operations on FY96, two years after turn-on. At that time CEBAF expects a 70% accelerator efficiency with better than 90% subsystem availability. Thus this year could be taken as the first year of routine operations, making allowance for the fact that the failure rate of the 338 superconducting resonators and associated cryostats and of the 2K cooling system may be difficult to predict. For the purposes of this report accelerator operations beam time is given in terms of 18-shift weeks (not corrected for efficiency) per calendar year.

At the previous review (1988) CEBAF management had given an FY93 estimate for its operating costs for a 35 week schedule of $44.1M (unless stated otherwise all amounts are in FY93 dollars). At the present review CEBAF presented 40 weeks as an optimal schedule and this was the base schedule for the Subcommittee's estimate. CEBAF management costs such a schedule at $57.9M exclusive of accelerator capital equipment funds (about $1.5M). The Subcommittee estimates costs for a 40 week schedule at $53.5M, but considers this a maximally attainable schedule. A 35 week schedule would reduce operating costs by $1.5M (to $52M), a 25 week schedule by $6.2M (to $47.3M). The CEBAF estimate for the various schedule levels had the same differential reductions, although starting from a higher level.

These Subcommittee estimates represent substantial increases above the earlier numbers, reflecting major additions in projected manpower needs (directly or indirectly), even above the 1988 CEBAF management projections (342) to about 410 FTE's. The Subcommittee attributes these increased needs to the expanded scope of the experimental program, to the new requirements for ES&H activities, and to an increased awareness of the accelerator complexity, specifically of the rf system. Of the Subcommittee's increase by 70 FTE's over CEBAF's own 1988 projections ES&H activities alone account for 40 FTE's. The total overhead positions are increased from 71 (1988 CEBAF projection) to 109 (1993 Subcommittee estimate), 26.3% of total DOE funded staff. Staffing needs associated with accelerator operation increased only slightly from 186 (1988 CEBAF estimate) to 189 (1993 Subcommittee estimate), with 14 positions added for accelerator R&D which were not defined in 1988. NSAC was assured that the ratio of one out of every four staff members being in the overhead category is in line with that at other na-

tional facilities. Similarly the staff associated with ES&H activity appears to be near the average of comparable facilities (however, being new CEBAF does not have the burden of ES&H remedial action that impacts on the operation of the existing facilities). Since CEBAF is a new facility, the large incremental costs arising from the ES&H requirements are becoming explicitly apparent.

Issues

Accepting the Subcommittee's findings about the base costs of a given program level, we now address three issues that define the operating costs of CEBAF.

Projected annual beam time: In considering the target FY96 operating schedule for CEBAF, NSAC concurs with the statements from the Subcommittee and from CEBAF: The facility is large and complex; systematic operating experience for this type of accelerator does not yet exist, and mature operation of detectors in FY96 can only be expected for Hall C. In light of the developing experimental program NSAC views a high efficiency (70%) physics operation of 7 to 8 months (30 to 35 weeks) as an appropriate level, consistent with the experience at other facilities of comparable scope and complexity. For the long term, 40 week operation at 80% efficiency is a laudable goal, but will be difficult to sustain over a longer period, straining both the capabilities of the technical staff to maintain and improve the facility and of the scientific community to process the data. Thus we base our recommendations on a 35 week schedule. The optimum schedule beyond 1996 will be determined better following initial experience both with accelerator operation and with the experimental program

Support for experimental facilities: One of the significant differences between the Subcommittee's and CEBAF's projections is the support required for experimental equipment. CEBAF is basing its needs on a model for conduct of operation in which the laboratory assumes direct line responsibility for the experiments using the major facilities. This model requires a relatively large role of laboratory staff physicists for experimental shift operation. Spokesmen for the CEBAF users expressed support for this mode of operation, citing the complexity of the targets and facilities used in CEBAF experiments. The Subcommittee concluded that such direct line responsibility by CEBAF staff was not necessary, nor even desirable from a scientific point of view, and that the user community

should provide the necessary manpower to staff experimental runs and operate much of the equipment associated with a given experiment (often in collaboration with CEBAF scientists). This agrees with standard practice at other large accelerator facilities.

NSAC concurs with the Subcommittee's judgment. Recognizing that a certain level of manpower is required to effectively use the large and sophisticated CEBAF experimental equipment the user community must assume a primary role in the execution of their experiments. It must participate in the lead responsibility for the experimental program at all levels including the long-term operation of experiments. We believe that the resources necessary to do this effectively are available in the large CEBAF user community. The most appropriate role for CEBAF is to provide support where there are particular issues of timeliness, economies of scale, or long term ES&H. We note that the professional and technical staffing level at the laboratory supporting the experimental program is lean, and its level should be monitored as the program develops.

Scope of in-house research program: While CEBAF will operate as an outside-user facility, it is also essential that there be a small but active in-house group of high quality researchers. As part of their research roles, these in-house staff physicists should also be important expediters of the CEBAF research program by having some fraction of their effort identified with facility support and development activities but without taking line responsibility for every experimental run (as discussed above). This philosophy is most likely to attract the best people to CEBAF, thereby assuring a capability for first rate research, leadership within the program, and for facility development.

In a forefront facility like CEBAF, using a new technology, it is appropriate that improvements in accelerator performance be sought through ongoing research and development activities. For instance, the resonator performance may significantly exceed initial expectations. Both CEBAF and the Subcommittee agree that such R&D activities should be supported.

NSAC endorses the funding levels for inhouse research and for facility R&D given in the Subcommittee report.

Recommendations

1. NSAC takes FY96 as a reference for steady state operation, accepting the fact that the accelerator may at that time still be in a shake-down phase and that much of the experimental equipment will not yet be in mature operation.

2. We accept the finding of the Subcommittee that funding for CEBAF operation (which includes in-house research activity) needs to be increased above the level projected in the project data sheet and even beyond the amount of $45M identified by the Schiffer report in its 1993 - 1997 five-year base funding plan.

3. The committee foresees a productive and efficient research program at CEBAF at a level of 30 to 35 weeks/year. NSAC recommends a 35 week schedule and accepts the conclusion of the Subcommittee that a 35 week operation will cost $52M (in FY93 dollars), exclusive of operations related capital funds (scaled to $1.5M by the Subcommittee, without discussion of merit, from the CEBAF request).

   NSAC acknowledges the claim by CEBAF management that, depending on the shake-down experience, sustaining a 35 week operation may require, on an interim basis, an addition of $1.5M per year to the operations budget in the early years following commissioning of the accelerator. At this time NSAC is not in a position to make an expert judgment on this possible need and defers an evaluation to a later time if and when this issue arises.

4. This report recommends a substantial increase in the projected operations budget for CEBAF over the amount planned so far. The Schiffer Subcommittee funding scenario for the Long Range Plan was crafted prior to this CEBAF operations review, although it was recognized that CEBAF operations funding was an open issue. Consequently, within this plan the recognition that an additional $7M is needed in FY96 for an efficient CEBAF operation requires a re-prioritization of funds. In a constant-effort scenario, the funds might be found in the research and equipment budget (this category had been projected to increase in the Schiffer Report). While this would obviously subtract from the projected users activity, the timely and efficient operation of CEBAF is a very high priority for nuclear physics.

Department of Energy
Washington, DC 20585

MAR 10 1992

Professor Peter Paul
Chairman
DOE/NSF Nuclear Science Advisory Committee
State University of New York
Stony Brook, New York 11794-3800

Dear Professor Paul:

The Continuous Electron Beam Accelerator Facility (CEBAF) construction project is scheduled to be completed in March 1995. At this time the full experimental equipment for Hall C and one spectrometer in Hall A will also be complete. The second spectrometer in Hall A and the Hall B experimental apparatus will still be under construction. CEBAF will therefore be available for commencing its research program soon after the construction project is complete.

CEBAF has proposed a steady state operating funding level which includes all funding required for laboratory operations (research, accelerator operations, ES&H requirements, general purpose equipment, plant requirements, etc.). It is necessary and important to examine the proposed operating funding requirements in detail to understand the steady state operating level for CEBAF which will take full advantage of the important new research capabilities of this laboratory. At the same time, the actual CEBAF operating level must be correct in the context of the funding limitations which are foreseen for the next few years within the Nuclear Physics program.

The Nuclear Science Advisory Committee (NSAC) is requested to arrange for a review and analysis of the steady state operating funding level which CEBAF has proposed, and to provide advice to the Department of Energy (DOE) and the National Science Foundation on the appropriate level of steady state operating funding for CEBAF. This advice should be given in the context of the NSAC Long Range Plan, and the recent evaluation of nuclear physics priorities resulting from the projected outyear funding levels.

In order to properly prepare for steady state laboratory operating funding needs, the DOE must have input on an appropriate funding level by June 30, 1992.

Sincerely,

David A. Sanchez

David A. Sanchez
Assistant Director
Directorate for Mathematical
and Physical Sciences
National Science Foundation

William Happer

William Happer
Director
Office of Energy Research
U.S. Department of Energy

MEETING OF THE NSF/DOE NUCLEAR SCIENCE ADVISORY COMMITTEE

AGENDA

Thursday, June 11, 1992

8:30 a.m. - 8:40 a.m.	Opening Remarks by NSAC Chairman and Agencies
8:40 " - 9:30 "	Overview Presentation by CEBAF
9:30 " - 10:30 "	Presentation of Sub-Committee Report on CEBAF Operations Funding (D. Lowenstein; includes time for questions)
10:30 " - 10:50 "	Break
10:50 " - 11:10 "	CEBAF Response to Sub-Committee Report
11:10 " - 12:15 p.m.	Discussion of CEBAF Operations Issues
12:15 p.m. - 1:15 "	Lunch
1:15 " - 3:00 "	CEBAF Tours
3:00 " - 4:00 "	Discussion of CEBAF Operations Funding
4:00 " - 4:20 "	Public Comment (including CEBAF User's Representative)
4:20 " - 5:30 "	Discussion of NSAC Response to the Agencies' Charge on CEBAF Operations Funding (includes writing assignments)

Friday, June 12, 1992

8:30 a.m. - 12:30 p.m.	Preparation of NSAC Response
12:30 p.m. - 1:00 "	Lunch
1:00 " - 2:00 "	Final Discussion with CEBAF Management
2:00 "	Meeting Adjourn

REPORT OF THE NSAC SUBCOMMITTEE ON CEBAF OPERATIONS

EXECUTIVE SUMMARY

A fact finding review of the operating funding requirements of the Continuous Electron Beam Accelerator Facility (CEBAF) was held at CEBAF in Newport News, Virginia on May 26-27, 1992. The projected CEBAF operating costs were last reviewed by DOE on March 28-30, 1988. This review was necessitated by a significant discrepancy between the operating budget requirements as stated by the CEBAF management and the projected DOE guidance. The Nuclear Science Advisory Committee (NSAC) was therefore asked by DOE and NSF to review the CEBAF steady-state operating cost projections. A Subcommittee of seven scientists from five national laboratories and two universities (Appendix B) was assembled to provide information to NSAC through a thorough review of the CEBAF requirements for the steady-state program operating funding in response to a charge from NSAC (Appendix A). The review was chaired by Dr. Derek I. Lowenstein, Brookhaven National Laboratory.

The Subcommittee focused its deliberations on the following three areas: (1) Accelerator Division, (2) Physics Division, and (3) Directorate and Administrative Division. The Subcommittee identified the physics research, accelerator operations, accelerator research and development, experimental areas operations, experimental areas research and development, and laboratory overhead costs. All costs are given in FY-1993 dollars. The Subcommittee did not review the capital equipment, AIP, GPP, etc. needs of the Laboratory. The Subcommittee's findings and conclusions are detailed in the accompanying sections. We summarize the major findings, comments, and conclusions below.

Any estimate of the operating costs of a facility as complex as CEBAF can vary significantly depending upon the model one chooses of how the facility is to be operated. One must consider such items as the yearly length of machine operations time, the complexity of the accelerator and detector systems, the estimation of failure frequencies and acceptable repair times, the level of support to the experimental users, the level of in-house research, the level of computational support, the scope of both accelerator and experimental facilities research and development that is consistent with the DOE long-range upgrade plans, and the effort needed to meet compliance with regulatory directives. The CEBAF management presented the Subcommittee (Appendix C) with a detailed and rigorous bottoms-up estimate of an optimum program of 40 weeks of beam delivered to experiments with intensive operational support for the execution of the experimental program. They arrived at an annual operating cost of $59.5 M (FY93 $s). The projected costs were distributed as follows:

CEBAF Projected Budget (40 weeks)

	$ M (FY-1993 $s)	FTEs
Accelerator Operations	29.5	199
Accelerator R&D	1.2	14
Experimental Facilities Operations	12.5	92
Experimental Facilities R&D	0.6	5
Physics Research	1.4	17
Administration (Overhead)	14.3	114
TOTAL	59.5	441

The Subcommittee thoroughly evaluated each of the above areas and makes the following comments and recommendations in response to 40 week, 35 week, and 25 week physics operations scenarios.

First, the Subcommittee finds that 40 week operations is the maximum operating time for a facility as complex as CEBAF and takes this as the base scenario. During the first few years the schedule of running periods may have to be rearranged when more information becomes available about failure and repair rates.

The Subcommittee evaluation of estimated personnel levels concludes that the Accelerator Division personnel could be reduced by 5% (10 FTEs) and the Physics Division personnel could be reduced by about 10% (12 FTEs) without any undue harm to the program. These changes result in about a 5% reduction (5 FTEs) in the overhead areas. The Subcommittee projections thus yield about a 6% (27 FTE) reduction in the CEBAF personnel estimate for a 40 week operating program.

The Subcommittee evaluation of the associated materials, etc. category resulted in reductions of $1.5M in the Accelerator Division, $0.7M in the Physics Division, and $0.3M in the overhead areas. The Subcommittee also identified $1.6M, which is more appropriately categorized as capital equipment purchases, and these were thus moved out of the operating budget estimates ($0.3M in the Accelerator Division and $1.3M in the Physics Division).

The Subcommittee thoroughly discussed the level of in-house physics support for the experimental program. The Subcommittee concludes that the user community must take on a much greater role in the execution of "their" experiments. This conclusion is reflected in the reduction of 12 experimental physics staff positions to 22.5 FTEs in the areas of experimental facilities operations and physics research of the Physics Division.

The Subcommittee agrees with CEBAF on the need for continued research and development efforts for such a complex facility.

In the case of a reduced yearly physics operation of 25 weeks, the Subcommittee concludes that the total CEBAF budget could be reduced by an additional $6.2M from the Subcommittee's 40 week operating budget of $53.5M (see table below) plus $1.6M of operations related capital equipment. This would result in an annual operating budget of $47.3M plus $1.3M of operations related capital equipment. Both the CEBAF and Subcommittee estimates of the difference between the cost of 40 and 25 weeks of physics operation are very much the same. We differ on the absolute values. In response to its charge, the Subcommittee concludes that for 35 weeks of physics operation the operating budget, as compared to that for 40 weeks, could be reduced by $1.5M, for an annual operating budget of $52.0M plus $1.5M of operations related capital equipment. This decrement is consistent with CEBAF estimates.

In the area of overhead functions, the Subcommittee found that the scope was correct and we estimate that about 30% of the total is proportional to the direct parts of the operating budget. The remaining 70% was found to be independent of the operating schedule of the Laboratory. This resulted in a $0.6M reduction in this area for the 40 week scenario.

The Subcommittee projects a maximum (40 week beam delivery) steady-state operating budget as follows:

Subcommittee Projected (40 weeks)

	$M (FY-1993 $s)	FTEs
Accelerator Operations	27.0	189
Accelerator R&D	1.2	14
Experimental Facilities Operations	9.8	83
Experimental Facilities R&D	0.6	5
Physics Research	1.2	14
Administration (Overhead)	13.7	109
TOTAL	53.5*	414

*1.6 M of purchases assumed to be covered by capital equipment funds are not included here.

The Subcommittee would like to point out that the major causes for the large change between the 1988 and 1992 reviews can be attributed to an almost 40 FTE increase in ES&H activities, a significant increase in the scope of the experimental program, and a much better appreciation of the rf system technology difficulties.

Finally, the Subcommittee would like to recognize the professional and rigorous effort by the CEBAF staff to develop and present the operations budget models.

I. INTRODUCTION

A fact-finding review of the proposed steady state operating budget that would allow CEBAF to become a major center for nuclear science research was carried out by a Subcommittee (see Appendix B) appointed by the Nuclear Science Advisory Committee of the Department of Energy and the National Science Foundation. The Subcommittee met at CEBAF on May 25 and 26, 1992 (see Appendix C) to hear presentations by CEBAF staff and review their budget proposals.

The Subcommittee findings are divided into the following three areas: (1) Accelerator Division Operations and Research, (2) Physics Division Operations and Research, (3) Administrative Division. The Subcommittee did not review the capital equipment, AIP, GPP, etc., needs of the laboratory. CEBAF has proposed that optimum use of the facility would be two 20 week periods of physics operation. This is taken as a base scenario. All costs are given in FY-1993 dollars. The Subcommittee also identified approximate cost reductions possible with 35 weeks and 25 weeks of physics operation as compared to the base budget for 40 weeks.

II. ACCELERATOR OPERATIONS

A. Findings

CEBAF has determined that optimum use of the facility would consist of two running periods a year: 20 weeks of physics operations to be followed by a five-week shutdown for machine modifications and a one-week startup period. CEBAF's staffing plans and cost estimates are based on 40 weeks of physics operation, which is probably also the maximum amount of running that is consistent with accelerator maintenance and development.

The operations staff has estimated that the availability of the accelerator will increase rapidly from 35% in FY-1994 (the startup year) to 55% in FY-1995, 68% in FY-1996, and reach an asymptotic level of 80% by FY-1998. These estimates were built up from an availability analysis of the subsystems that took into account learning curves and availability data from other accelerator facilities of similar complexity. The results appear to be realistic expectations for a state-of-the-art facility such as CEBAF.

The Committee was presented with a detailed analysis of the staffing requirements and costs of operating the accelerator facility consistent with the above program. This was a bottoms-up estimate where operating costs and personnel requirements were derived from studies of realistic operating scenarios that included estimates of mean time to failure of components and the personnel and supplies required to meet the operating efficiency goals. There were two areas where we thought that this method might lead to an overestimate. These areas will be discussed below.

The Accelerator Division functional organization is shown in Table 1. There are three functions, ES&H, Operating Units, and Systems - support units, reporting to the Division Office. The latter two functions are each made up of three operating groups.

Tables 2 and 3 show the estimated personnel and budget distributed

by function and category. As mentioned above, there was considerable background material presented which constituted bottoms-up estimates leading to these summary estimates. There was considerable discussion of the personnel estimates by each group and of the underlying assumptions. We felt that the personnel estimated in the Operating Units was consistent both with the program requirements and the Conduct of Operations. It is more difficult to analyze the System Support groups because so much depends on estimates of equipment failure rates and therefore the staffing and repair time estimates to maintain a viable program. The two largest groups, Cryogenics and Controls/RF have a combined staff estimate of 113 people. The Subcommittee felt that this was overestimated. However, the Arcs Group that maintains magnets, power supplies, vacuum and alignment, is a lean group and plans to depend on support from the above groups to handle peak loading.

The laboratory estimates of costs associated with operation of the accelerator on the proposed 40-week schedule are summarized in Table 3. Here the breakdown into activities is the same as in the table of personnel (Table 2).

In Table 3, the category "supplies and expenses" and part of "maintenance/repair hardware" are what is termed "material and services" in most DOE laboratories. The other part of "maintenance/repair hardware" for procurement of hardware items appear to be more appropriate for the Capital Equipment budget. The projected cost for this Capital Equipment component is $0.32M.

The category "utilities" covers costs for electric power and for cryogens. For 40 weeks of operation, these costs are $7.87M and $1.50M for power and cryogens, respectively. The inventory of liquid helium in the cryogenic system is ~ 100,000 liters (cost~ $0.25M). The inventory of liquid helium can be moved to liquid storage in an emergency. In this storage system, the inventory of helium will be lost due to evaporation in about 200 days since there is not sufficient capacity to store the inventory in gaseous form at CEBAF. Thus, in the event of a major failure of the refrigeration system there is some risk that the helium inventory will be lost.

TABLE 1

ACCELERATOR DIVISION ORGANIZATION

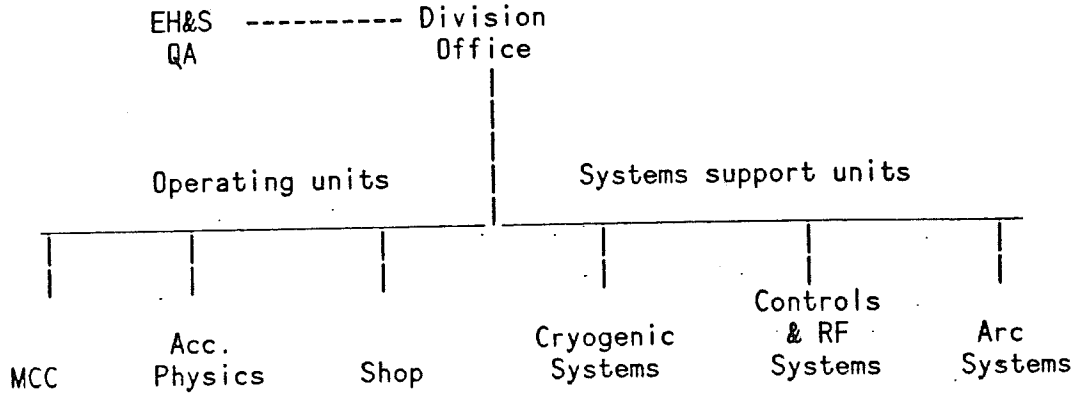

TABLE 2

ACCELERATOR DIVISION MANPOWER SUMMATION
Operations and Beam Development

CATEGORY	TOTAL	Division Office	EH&S	Machine Operations	Machine Shop	Cryogenics	Controls and RF	Arc
Management	14.1	2	1.0	2.0	0.5	3.6	2.6	2.4
Management Support	27.4	8.2	5.0	3.0	1.0	3.6	4.9	1.7
Operations	30.0			25.0		5.0	0.0	
Maintenance/ Repair	82.9		1.5	1.0	1.0	26.5	39.9	13.0
Reliability Improvements	27.4	0.5		3.0	0.5	4.5	12.7	6.2
Facility Support	17.4	0.5	0.5		10.0	1.8	1.0	3.6
Beam Development	13.8	0.8		5.0	1.0	1.0	5.9	0.1
TOTAL	213.0	12.0	8.0	39.0	14.0	46.0	67.0	27.0

TABLE 3

ACCELERATOR DIVISION BUDGET SUMMATION (FY93$M)
Operations and Beam Development

CATEGORY	TOTAL	Division Office	EH&S	Machine Operations	Machine Shop	Cryogenics	Controls and RF	Arc
Salary & Fringes	14.95	0.90	0.56	2.87	0.74	3.34	4.71	1.82
Supplies & Expenses	2.71	0.81	0.00	0.37	0.52	0.42	0.37	0.22
Utilities	9.37	0.00	0.00	9.37	0.00	0.00	0.00	0.00
Maint/Repair Hardware	3.64	0.00	0.00	0.55	0.00	1.05	1.84	0.20
TOTAL $M	30.67	1.71	0.56	13.16	1.26	4.81	6.92	2.24

B. Comments and Conclusions

The goal of 40-week operation for physics research is to optimize the utilization of the facility. The Subcommittee considers this also to be the maximum running that is consistent with accelerator maintenance and development. It may be that the peak staffing loads required for the 5-week shutdowns that are associated with the 40-week scenario may seriously stretch the availability of staff at this small laboratory. In this case, the Laboratory might have to plan for longer shutdown periods to stay within its staffing levels.

We suggest that the Capital Equipment component of the "maintenance/ repair hardware" estimate should be moved from the operating budget to the Capital budget.

The projected cost for materials and services (after removing Capital Equipment items) is somewhat greater relative to total cost for accelerator operations than is experienced at other laboratories. Based on the collective experience at other accelerator facilities, we suggest that ~$1.5M can be removed from the CEBAF estimate for materials and services without much damage to operating efficiency.

The Subcommittee concluded that the staff needed in the Accelerator Division for the 40 week per year physics program was slightly overestimated. An overall reduction of 5% (10 FTE) can be accommodated with a few people removed from the Division Office and the Operating units with the majority coming from Systems Support. A reduction of 10% (20 FTE) could possibly be accommodated in a similar way, but only with the acceptance of potential jeopardy to the program. Estimates of equipment reliability have been used to estimate the personnel in each group. These estimates, with new equipment in a new accelerator complex, have a large error bar. A reduction of 10% in the personnel of the Accelerator Division would increase the impact of a subsystem failure on the overall operating efficiency and the physics program should the equipment reliability be less than expected.

A major accelerator facility, such as CEBAF, needs to invest some of its resources in development for improved performance to maintain it at the forefront of its technology. The Accelerator Division has allocated about 4% of its budget to R&D activities ($1.2M, 14 FTE). The Subcommittee considers this level of effort appropriate.

III. PHYSICS OPERATIONS

A. General Considerations

The Subcommittee was presented with projecting operating costs for CEBAF whose mode of physics operations will be different in a number of important aspects from the operation of other nuclear and high energy physics laboratories. Hence, CEBAF and the nuclear physics community, in partnership with the DOE, will be faced with developing a mode of operation for CEBAF experiments that will maximize productivity of the nuclear physics community within the constraints of funding and the "new culture."

Traditionally the nuclear physics community (and, indeed, in earlier days

the high energy physics community) has operated in the small-group, fixed-target experiment mode. In this mode a university group or a small collaboration of groups constructed an experiment and was fully responsible for its operation during relatively short running periods, typically a few weeks or months. Where general facilities (spectrometers) were available, the spectrometers were relatively simple and their operation, support, and maintenance could be handled by a collaboration between a very small laboratory staff and the university groups who used the facility.

The complexity of CEBAF detectors, particularly the Hall B detector, is more comparable to those of High Energy Physics collider experiments, e.g., CLEO, CDF, SLD, and the experiments at LEP and HERA. Each of these detectors was constructed by a large collaboration. The collaboration continued as a unit to operate and maintain the detector and to produce and publish the physics results.

This HEP model differs in an essential aspect from the picture of how CEBAF detectors should operate that is widespread in the nuclear physics community. The nuclear physics community would like to remain as close as possible to the traditional nuclear physics model, where a university group or a collaboration of a small number of university groups cooperate in taking and analyzing the data for a particular physics experiment. Typically, the data-taking period is short compared to the time spent between runs analyzing the data and preparing the results for publication. The majority of the proposals received by CEBAF and approved by the PAC are based on this model. In general, there is agreement that the first period of operation of each detector will involve a collaboration among all the physicists who have been active in designing and constructing the equipment. It is expected that the more traditional model will be followed after the first-round experiments.

As the CEBAF detectors take shape and the end of construction and start of operations is in sight, a number of considerations has forced the laboratory, the nuclear physics community, and this committee to reexamine the assumptions of how the CEBAF facilities should operate:

* The complexity of the individual detectors is becoming more evident as construction proceeds and operation comes into view.

* The requirement of Conduct of Operations from DOE is demanding new thinking about how a detector can be operated safely and responsibly.

* The validation and documentation requirements of the "new culture is having a measurable effect on the physics productivity of the laboratory staff and the user community.

Unquestionably, all of these challenges might be most conveniently addressed by increasing CEBAF staff to provide the basic operational support and management of the detector facilities. The only other possible source for operational support is the user community. If the user community were to provide a substantial fraction of this operational support out of current resources, user personnel available for analyzing and publishing data will be reduced. Either way, operational support of these facilities in a constant budget picture amounts to a reduction

of the capability of the nuclear community to analyze and publish data. Hence, the Committee is forced to report a dilemma to the nuclear physics community and to NSAC.

* In a constant funding scenario, funds for increased CEBAF staff will have to come from some other part of the nuclear physics program that has already faced severe cuts.

* If a substantial fraction of operational support comes from the user community, then fewer personnel in the user community will be available for analyzing and publishing data.

Two additional factors make choices between these alternatives more complex:

* Careful organization will be needed to see how the line-responsibility requirements of the "new culture" can be satisfied if a substantial fraction of the support for a detector is the responsibility of members of the user community who are not employees of the laboratory.

* Support of detector operations is often considered to be an essential component of the education of graduate students and postdoctoral research associates. Students and postdocs learn how to build future detectors by detailed study of performance limitations of existing detectors. Thus, this mode of user contribution to CEBAF operations should be considered to be one of the traditional functions of the user community.

TABLE 4

PHYSICS DIVISION EXPENDITURES
User Liaison, Research, and Division Office
(FY93 K$)

	Hall A	Hall B	Hall C	Technical Support	User Liaison	Research	Division Office	Computer Center	Totals
Salaries	1220	1540	1150	1650	150	1190	550	540	7990
S&E	240	300	230	320	40	250	90	190	1660
Consumables	200	410	190					60	860
Maintenance & Repair Hardware	550	840	520	580			300	1250	4040
Totals	2210	3090	2090	2550	190	1440	940	2040	14550

TABLE 5.

PHYSICS DIVISION STAFFING
User Liaison, Research, and Division Office
Full Time Employees (FTEs)

	Hall A	Hall B	Hall C	Technical Support	User Liaison	Research	Division Office	Computer Center	Totals
Physicist	9	11	8.5			10			38.5
Prof. Support & Engineer	2	2	2	15	1		3	9	34
Technician	4	6	4	7				3	24
Postdoc						6			6
EH&S	1	1	1				1		4
Administration	0.5	0.5	0.5		2	1	2.5		7
Totals	16.5	20.5	16	22	3	17	6.5	12	113.5

B. Findings

The Subcommittee was presented with a scenario that included operation of three experimental halls and a computer center. Additional funding was included for a technical support group, a division office, user liaison, and for in-house research. Summaries of the proposed expenditures and personnel are given in Tables 4 and 5.

An overview of the proposed experimental activity showed a strong level of user involvement. The potential users are in most cases already involved in the construction of experimental equipment and hardware.

A breakdown of the budget for each area clearly identified the associated personnel, supplies and expendables, consumables, and maintenance and repair costs. Estimates of the latter have been made on a bottoms-up model, that is, by identifying failure rates for components and combining these to get overall repair needs.

The proposed operating costs reflect the increase in scope of the CEBAF experimental equipment. Although the general philosophy has not changed in the last five years, it is clear that a full realization of the experimental facilities has required considerably more funding than initially perceived. Operating, maintenance, and repair costs of this complement of detectors are what is now being addressed.

The in-house physics group proposed by CEBAF was projected to consist

of both the personnel identified in each hall combined with the physicists in the Research Group, i.e., 34.5 experimentalists, 4 theorists, and 6 postdoctoral fellows. Most experimental physicists were expected to rotate between shift operation (18) and the smaller research team (6). Rotation to the research team was considered as a form of in-house sabbatical.

C. Comments and Conclusions

(i) Personnel. The staffing levels proposed should allow for a smooth, user-oriented operation of the facility. The Subcommittee considers the staffing levels for the computer center, professional and technical support, and ES&H to be appropriate. However, the experimental physics staff proposed, especially those on shift during experiments, appears to be excessive for steady state operation. The peak in personnel that is required during commissioning of the major detectors should be handled by making use of the Hall Collaborations. All members of the Hall Collaborations must be expected to be involved during this critical learning period. Arrangements should be made to have sufficient Users scheduled for extended periods at CEBAF during this period. Given the needed coordination of User support by the Collaborations during all phases of operation, it is proposed that the in-house group of experimental physicists be reduced from 34.5 to 22.5.

The role of the users should be reevaluated and existing MOU's should be modified to include responsibilities during the period of initial operation of CEBAF and beyond. DOE/NSF should provide the necessary support to the users to fund research staff, postdocs, and graduate students for this purpose. CEBAF staff should assist the users by providing initial calibrations and setup of the spectrometers and detectors built by CEBAF. The Users could then assume essential roles including full responsibility for validation of all data, electing experiment leaders, providing shift supervisors, and generation of summary tapes.

The users also should assume responsibility for a portion of the Formality of Operations required under the "new culture" of DOE. In order that CEBAF carry out its responsibilities under Conduct of Operations, CEBAF staff, with review by DOE, should prepare operating procedures, should develop the necessary training, and should provide testing so that users can be fully qualified for positions of responsibility for experiments. A graded approach to Conduct of Operations would allow for different levels of training appropriate for shift supervisors, for counting house staff, etc., consistent with their responsibilities. Users and CEBAF staff should have identical training requirements for identical positions of responsibility under Conduct of Operations.

During the commissioning phase, it may be appropriate that CEBAF provide a shift supervisor on each shift in each of the Hall-A, Hall-B, and Hall-C counting houses. The physics research staff envisaged by this committee for CEBAF is large enough to provide this function during the transition phase.

(ii) Supplies and Expendables, Consumables, and Maintenance and Repair. CEBAF provided the Subcommittee with a comprehensive bottoms-up estimate of repair frequency, consumables, etc. The results of this analysis appear

overly conservative based on collective experience at other facilities. We thus propose that a reduction of $700K be made in the three categories of S&E, Consumables, and M&R.

In addition, we find across this division budget in these areas $1.25M of items that are normally considered to be capital equipment. These should be moved to the capital equipment part of the overall laboratory budget.

(iii) The proposed level of R&D within the Physics Division Support Group seems appropriate for a laboratory of this scale.

(iv) The Subcommittee was presented with lists of possible upgrades for the three experimental halls. Many of these items appear to be highly desirable or indeed necessary for the proposed science program. However, these items are capital equipment and thus do not fall under the mandate of the Subcommittee.

IV. DIRECTORATE AND ADMINISTRATION DIVISION

A. Findings

The Subcommittee was presented a description and costing of the CEBAF overhead functions which are carried out by the Directorate and the Administration Division. The major overhead expenses are in the areas of: laboratory management (19 FTE), finances (11 FTE), human resources (18 FTE), materials management (15 FTE), environmental health and safety (19 FTE), technical performance functions (10 FTE), plant maintenance (19 FTE), education (3 FTE), plant utilities and SURA management fee. Not included in CEBAF's overhead costs are the machine shops function (14 FTE) which is costed in the Accelerator Division and the computer center (12 FTE) which is costed in the Physics Division. The projected CEBAF overhead rate is applied to all budget categories except for accelerator power ($7.9M) and cryogen costs ($1.5M). The resulting $14.3M budget supports 114 FTE ($6.4M), supplies and expendables ($2.0M), service contracts ($2.5M), plant utilities ($2.1M) and SURA management fee ($1.3M). This results in an overhead rate of 39.9%. This overhead rate is consistent with the rates of other DOE laboratories. The Subcommittee was informed that DOE expects to conduct a review of the overhead costs and functions by the end of FY1992 and that the CEBAF M&O contract status is presently under negotiations. The M&O contract negotiations have raised various issues such as configuration management practices, task order contracting, increased security and approvals for users, visitors and publications that could significantly impact upon future costs. CEBAF has assumed a compromise position which is reflected in the projected overhead costs. The Subcommittee was also presented with a summary of the contributions from the State of Virginia. The projected contributions will continue to support 22 FTE as well as provide for some privileges, buildings and vehicles from the College of William and Mary, amounting to approximately $2.0M per year.

B. Comments and Conclusions

1. The Subcommittee finds that the overhead functions as

presented are appropriate and adequate for the scope of the CEBAF laboratory. The Subcommittee estimates that about 30% of the present overhead budget is directly scaleable to the size of the operations budget. The other 70% of the overhead costs are "fixed," e.g., management fee, "mandated" regulatory functions. We therefore apply this rule when the overhead is recalculated for each proposed reduction in the direct budget.

2. The ES&H technical performance functions (QA, etc.) which are distributed between the central laboratory (29 FTE) and the operating divisions (12 FTE) should be adequate to meet the present DOE regulatory climate. We note that the 1988 operations cost estimate did not include any specific personnel for these areas.

V. IMPACT OF REDUCTIONS IN THE OPERATING SCHEDULE

There are two components to cost reductions with reduced operating schedules. They are the utilities such as power and cryogens and the reduction in staff levels. At CEBAF, as in most accelerator complexes, the operating cost is a weak function of the operating schedule and therefore the leverage of a small increment in funding on the laboratory output is large.

The large cryogenic plant at the laboratory must continue to operate independent of the running schedule and this is also true for the non-accelerator utilities. Overall the site-wide utilities costs are reduced by less than fifty percent during an accelerator downtime.

Reductions in personnel in accelerator operations come about because there is less peak load on maintenance activities during scheduled downtimes. However, one must maintain a base level which can continue to handle routine operation and unscheduled downtime.

The difference in accelerator operating costs between a 25-week and a 40-week schedule is estimated to be approximately $4M. To refine this number, the laboratory has to start with an actual personnel and budget plan and do a detailed study of incremental changes. This will require guidance from NSAC and DOE as to what should be used as the base budget.

Further reductions in the Physics Division Operations budget also would be possible with a shorter operation schedule. Assuming a 25 week schedule, it would be possible to separate somewhat operation from scheduled maintenance and allow a further reduction in personnel by about 15 FTE (cost about $1M). Shorter operation should also permit an additional reduction in all materials and supplies of $700K.

In total, after adding an increment cost reduction part from the administrative budget of $0.5M, we project an annual operating budget of $47.3M plus $1.3M of operations related capital equipment for reduced operation of 25 weeks.

APPENDIX A

Charge to the Subcommittee on CEBAF Operations

May 22, 1992

In a charge dated March 19, 1992, the agencies requested NSAC "to arrange for a review and analysis of the steady state operating funding level which CEBAF has proposed, and to provide advice on the appropriate level of steady state operating funding for CEBAF. This advice should be given in the context of the NSAC Long Range Plan, and of the recent evaluation of nuclear physics priorities resulting from the projected outyear funding levels."

In preparation of its response to DOE/NSF, NSAC charges the Subcommittee on CEBAF Operation to make an assessement of the operational costs of the CEBAF facility which will permit CEBAF to play the intended role as a major center for nuclear science research. This assessment shall be based on an on-site review by the Subcommittee and should evaluate the costs of a 35 week per year operation as a reference scenario. Other scenarios, such as a running schedule which optimizes research effectiveness per unit operating costs, as well as a 25 week running schedule, should also be considered. In accordance with the present definition of the CEBAF operations budget, the review and assessment should explicitly cover cost and staffing levels for facility operation and maintenance, facility development, equipment maintenance and support for in-house physics research. Consideration of possible models and their associated costs for the user support on detectors and other experiment-related needs would be very helpful.

The Subcommittee should make its findings available to NSAC in a report which should give details on the various scenarios listed above and any others that are found appropriate by the Subcommittee. This report will be important input for the evaluation and review by the parent committee.

APPENDIX B

Subcommittee Membership

Dr. Klaus Berkner, Lawrence Berkeley Laboratory
Dr. Lowell Bollinger, Argonne National Labortory
Dr. John Cameron, Indiana University (NSAC member)
Dr. David Cassell, Cornell University
Dr. Derek Lowenstein, Brookhaven National Laboratory (Chairman)
Dr. Ewan Paterson, Stanford University/SLAC
Dr. H.A. Thiessen, Los Alamos Scientific Laboratory

APPENDIX C

NSAC SUBCOMMITTEE ON CEBAF OPERATIONS
REVIEW AGENDA
CEBAF CENTER ROOM L102/L104
MAY 26-27, 1992

Tuesday, May 26, 1992

8:00 a.m.	Executive Session	
8:30 a.m.	Laboratory Overview	H. Grunder
	Operations Overview Philosophy, Assumptions, Subgroups Summary of Costs by Category	
9:15 a.m.	Accelerator Division Accelerator Operation Accelerator R&D	C. Leemann
10:10 a.m.	Break	
10:25 a.m.	Physics Division Experimental Area Operations Experiment R&D Physics Research	J. Domingo
11:15 a.m.	Institutional Overhead	J. Coleman
11:45 a.m.	Lunch/Executive Session	

Detailed Cost and Staffing Presentations (Parallel Sessions)

Accelerator Operations (Room L102/L104)

12:30 p.m.	Accelerator Tour	
1:00 p.m.	Machine Operations and Power Usage	C. Rode
2:00 p.m.	Controls and RF	G. Neil
3:00 p.m.	Break	
3:15 p.m.	SRF and Cryogenics	F. Dylla
4:15 p.m.	DC Power, Magnets, Vacuum, Mechanical	L. Harwood
5:15 p.m.	Discussion	
5:45 p.m.	End of Session	

Physics Operations (Room B207)

12:30 p.m.	Experimental Area Support: Hall B	B. Mecking
1:30 p.m.	Experimental Area Support: Hall A	J. Mougey
2:20 p.m.	Break	
2:40 p.m.	Experimental Area Support: Hall C	R. Carlini
3:30 p.m.	Physics Research	J. Domingo
4:00 p.m.	Discussion	
4:30 p.m.	Tour	
5:15 p.m.	Computing	R. Whitney
5:45 p.m.	End of Session	

End of Parallel Sessions

5:45 p.m.	Executive Session
6:45 p.m.	Dinner

Wednesday, May 27, 1992

8:00 a.m.	Committee Executive Session and Report Writing CEBAF staff available as needed (Typing support provided)
12:30 p.m.	Lunch
1:15 p.m.	Continued Executive Session/Report Writing