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QUALITY ASSURANCE AND QUALITY CONTROL FOR THE COMPACT PHYSICS RESEARCH FACILITY (CPRF) AND ZTH EXPERIMENT[†]

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ABSTRACT

In compliance with DOE order 5700.6B, which establishes policies to assure quality achievement in DOE programs, we instituted a quality assurance and quality control program whose primary goal is to assure that reliable components are available with which to assemble the CPRF/ZTH experiment. The Code of Federal Regulations 10 CFR 50, appendix B, and the ANSI standard N45.2 were used as a primary source of guidance in establishing a plan for our QA program. Accepted codes, such as the National Electric Code (NEC), and standards adopted by organizations such as ANSI, IEEE, ASME, and NEMA were used in the design and production of components in keeping with the primary goal of the CPRF program. In setting up the CPRF/ZTH quality assurance program it was our intention to have these standards apply to all suppliers, both within and outside the Laboratory.

INTRODUCTION

To accomplish our primary goal a two part document was written, Los Alamos report LA-UR-89-449, (1). The first part, CPRF/ZTH QA Plan, gives our general QA philosophy. Recognizing that every program has its own special problems, the second part is divided into 11 different procedures to give the specific details of accomplishing QA, the "how to" of the QA program. Areas that have already been addressed by standard Lab practices, safety facilities construction, and procurement, are mentioned since QA must interact with them, but are not dealt with in any great detail since nothing in this QA Program is meant to usurp procedures already addressed by Lab practices.

The secondary goal of this Quality Assurance Program was one of trying to let good engineering practices and common sense solve most QA problems, providing guidelines to solutions of those problems. As a consequence, our view of these 11 procedures has been that they not be rigid set of rules to make sure that QA is done to a certain standard, but a flexible set of guidelines that could be changed if circumstances warranted it. Tasks such as design control, internal Laboratory transportation, tracking, storage, etc. that require extra effort to assure that the primary goal is achieved are thus covered by the procedures with this idea of flexibility in mind.

This paper will cover the CPRF/ZTH QA plan and procedures, some of the problems encountered, and solutions to those problems. Anticipated QA activities will also be discussed.

CPRF/ZTH QA PLAN

Since, in a sense, everyone is involved in QA; So it is not the sole domain of anyone. Our philosophy of applying the 18 QA elements found in NQA-1, N45.2, etc. to our program is to allow the people of each task (sub program) to do their own quality assurance, and control in their own way, but monitor and guide them without getting in the way. Each of the QA elements is addressed in the plan individually to define what we expected to do to fulfill the issues of each element. For our program the 18 elements seemed to fit well into ten procedures, and an eleventh was written to address software development QA. Comments

seemed to fit well into ten procedures, and an eleventh was written to address software development QA. Comments by the Task leader (sub-program leaders) were incorporated into the plan which was then approved by the construction program manager.

CPRF/ZTH QA PROCEDURES

To be effective, issues that must be addressed in any QA program include: design control, purchasing, acceptance, records, and auditing. A technical design committee, finally named the "CPRF Steering committee," CSC, had already been initiated to address the physics and engineering issues, and define the technical design criteria (2). This is really where quality assurance began because the technical criteria establish all design goals. It is the responsibility of each task leader to see that all designs within his particular task meet the technical design criteria.

The 18 QA elements of the Plan needed to be put into procedures that define, in a step-by-step manner, how they would be carried out. Eleven procedures were written that contained detailed steps for carrying out the QA program. They are listed in Fig. 1 along with their QA document identifier.

- CPRF-QA-01, Design and drafting document control, (3).
- CPRF-QA-02, Interface criteria.
- CPRF-QA-03, purchasing.
- CPRF-QA-04, Tracking.
- CPRF-QA-05, "In-house" handling, shipping, and storing.
- CPRF-QA-06, Inspection and testing.
- CPRF-QA-07, Non-conformance and corrections.
- CPRF-QA-08, Component status.
- CPRF-QA-09, Auditing.
- CPRF-QA-10, Records.
- CPRF-QA-11, Software QA.

Fig. 1. A list of the CPRF/ZTH QA procedures.

As put into practice, the number of procedures could have been reduced even further. I would have combined 01 and 02, 03 and 07, and 04, 05, 06, and 08, and leave the last three as they are. I might have also included software QA with the group of four, but at the time it seemed important to have it separate.

Because our QA program basically consists of only one activity, monitoring, it seemed that to accomplish effective quality assurance it was necessary to reduce the paper work as much as possible, and make an effort to respond to the needs of each task rather than dictate how each QA element would be accomplished.

PUTTING THE PLAN AND PROCEDURES INTO PRACTICE

In implementing our program it was necessary that we make our QA procedures fit within the well established Lab practices of safety, procurement, and Lab engineering. The Laboratory Manual, (4), makes it clear that safety is of prime importance, and nothing shall be done without considering safety first. Our procurement monitoring system fits well with the Lab system. Finally, GPP projects and

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facilities are under the domain of the engineering division of the Lab so that our project QA didn't need to consider monitoring them.

Design Control. As mentioned previously, the source of all design criteria for CPRF/ZTH comes from the CSC. Specifications for materials, etc. are traceable back to the Technical Design Criteria. (2). Design reviews and a design control system also gave assurance that designs met the technical criteria.

Assurance that design approach and the engineered design are viable is accomplished by using internal and external design reviews. A series of design review milestones were scheduled as part of the construction plan. Internal reviews were conducted with the CPRF/ZTH program technical staff as a preliminary to the external review. Necessary changes were made before the external review. For the external reviews, a group of technically knowledgeable experts were invited from industry and other National Laboratories to make suggestions on design approach. Both of these reviews were valuable in the aid of the CPRF/ZTH design.

Figure 2 shows a flow chart for the design control system, and is covered in detail paper 10-p-21. The design control system was instituted for checking design standards, technical criteria, and avoiding design conflicts between tasks. The preliminary and final design reviews are different from the internal and external reviews mentioned above. Once a drafted design has completed this system, it has been subject to review by both physicists and engineers so that chances of incorrect designs have been minimized.

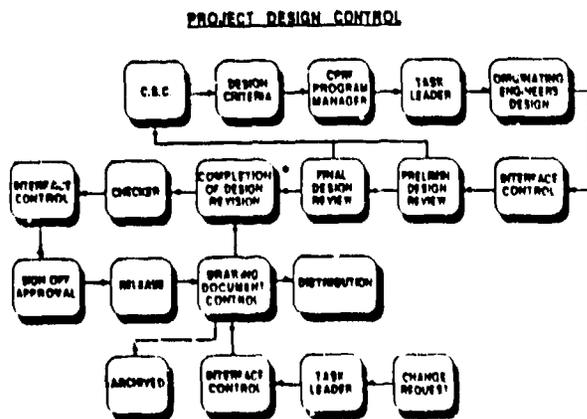


Fig. 2. Design Control Flow Chart.

PROCUREMENT

The Lab procurement system has been part of the Laboratory since its beginning. Its functions include materials procurement, contracts shipping and receiving, and dealing with problems between the vendor and the Lab such as non conformance problems. Almost all procurement is handled outside the CPRF/ZTH program so the involvement of the QA program is minimal. There are several aspects of procurement that the QA program is involved in though.

A procurement liaison from the Materials Division (MAT) spent half time within our division which included the CPRF/ZTH program. This provided the program with direct procurement access. Part of the liaison's function was also to enter information on all purchase requests (PRs), and RFQ's in a database, and update that database as information became available. This improved control of

procurement.

Much of the QA and QC in each subprogram is defined by written specifications in vendor RFQs, and contracts written to the local Lab sub-contractor. Personnel of the program QA office reviewed the QA/QC of each written specification that the prospective vendor was to adhere to. In some cases QA/QC specifications were written separately to assure that vendors had adequate QA plans.

TRACKING SYSTEM

Because the QA program within the CPRF/ZTH is small, consisting of one person, it was necessary to combine some of the procedures into one system to make them more manageable. As mentioned above, in practice, four of the procedures were followed jointly: tracking, "in-house" shipping, etc., inspection and testing, and component status. In the normal course of doing business within the Laboratory these four areas have been easy to neglect, and in my opinion, presented the greatest hazard to items being damaged, lost, non-conformance unresolved, and poor information as to status. Fig. 3 shows the tracking form used for those items we chose to track. As can be seen it is quite comprehensive, and, therefore, can be used for the areas mentioned above.

P.R. No.: _____ Description: _____
 Revision: _____ Comments: _____
 Group: _____ Part. No. (if it exists): _____
 Activity No.: _____ Program Code: _____

1. Date Received: _____ By Whom (initial): _____ Cost: _____

Is there any obvious damage (i.e., is it scratched, cracked, etc.)? _____
 If YES, was the Buyer notified? _____ When? _____
 If YES, was FBI notified to stop payment? _____ When? _____
 Who did you talk to? _____
 Did you by any chance remember to tell the Transportation Management Office (7-5115)? Who did you talk to there? _____
 Describe Cracks: _____
 Is there anything else wrong with it? What? _____

2. Date Tested: _____ By Whom: _____ (initial) _____
 Inspection and test OK? If NOT, what are you going to do about it? _____
 Other comments: _____

3. Where do you intend to store the item? Please notify Kousch (CTR 1 MS 7644) of possible shipping problems. I'll try to help.
 Date Shipped? _____
 Status: _____

By some stroke of luck or genius did you _____ Provide shipping number if item
 TAG the item so it will get good _____ shipped back to vendor
 If it's good and not get used if it is _____ SR NO _____
 deficient? _____

FIG 3. CPRF/ZTH Tracking Report.

By the end of September 1989 more than 1100 purchase requests had been written for the CPRF/ZTH Project. To track all of them would be an enormous problem. We decided to limit the number of PRs tracked to a reasonable number. The criteria for tracking a PR was the following: (1) no PR under \$1000 would be tracked, (2) between \$1K and \$10K PRs chosen would be designated by the task leader, and (3) all PRs \$10K and over would be tracked. This turned out to be a good criteria because, as seen in Fig. 4, the number of PRs over \$10K only represent 10% of the PRs written, but 95% of the dollars. With the additional PRs between \$1K and \$10K to be tracked, the actual number represents about 15%.

To combine the four procedures mentioned above, a database derived from the procurement database was used to store information on each of the activities defined by the procedures for each PR to be tracked. After an item was received a report was generated and given to the task leader to be filled out so that information on receiving, inspection, testing, storage, status, and problems, etc., could be entered into the database. This report

CPRF/ZTH CONSTRUCTION

PURCHASE REQUESTS AND COMMITMENTS

Total Purchase Requests: 1115 9/21/89 data
Total Commitment: \$21.42 M

Purchase Request Range	NO. in Range	% of Total PRs	% of Total Dollars(\$)
<\$1000	636	60.18	0.9
\$1k - \$10k	342	32.60	5.2
> \$10 k	103	9.23	93.9

Fig. 4. A comparison of the number of PRs in several dollar ranges and the percentages each range represents of the total dollars.

included some of the initial procurement information so that it was traceable to the Materials Division in the event of non-conformance. Request for updated information was carried out periodically by issuing reports with the last information so it could reflect current information. This feedback mechanism has been fairly successful in keeping track of equipment and materials.

INTERNAL MATERIALS HANDLING

The procedure on "In-House" shipping, etc. was written as a guideline of precautions to be taken when materials are moved on the Lab site. The Lab contractor, Pan American World Services, has experience in moving large equipment. Outside vendors have also been relied on for handling large equipment. The 1430 MVA generator was moved by a vendor with specific expertise in moving large generators.

INSPECTION AND TESTING

Most of these written specifications define inspection, testing and other acceptance criteria by which to evaluate the particular item in question. From these specifications technical personal in each task were now able to develop their own test sheets rather than having a standard imposed on them. Our formal QA program then became responsible for collecting and archiving documents that showed QA/QC was being carried out. Such a method of documenting QA has disadvantages where tight controls are needed, but in a relatively small research program, such as ours, it seems to allow needed freedom for researchers to accomplish their jobs effectively.

COMPONENT STATUS

This procedure is fulfilled by using the combined tracking system and reporting. The tracking report has a query for component status, i.e., whether the item in question has been inspected, tested, etc. and is available for assembly or use in the CPRF/ZTH experiment

QUALITY ASSURANCE RECORDS

The QA Records procedure provides for the keeping of QA records. Most of these records and documents not specifically listed as databases in Fig. 5 at least have an index kept on a database similar to a computer card catalog. The computer databases make an easy reference to locate needed documents.

1. Management documents - DOE orders, and internal Lab documents.
2. Specifications Library - Specifications written for RFQs.
3. Manuals Library - Maintenance and operational manuals from vendors.
4. Vendor QA documentation - Required QA reports by vendors.
5. Procurement database - Information on all CPRF/ZTH purchase requests.
6. Tracking database - Information on tracked items.
7. Tracking reports - Hard copy reports from the tracking database.
8. Inspection and Testing data sheets - QA testing by task personnel
hard copies.
9. DOE quarterly review reports - Mostly viewgraphs from DOE reviews.

Fig. 5. A list of the CPRF/ZTH QA Databases.

PROBLEMS

Since our QA office is small, solutions to most of the QA problems, out of necessity, have been left up the individual task leaders. In industry I expect this could be a severe problem; however, ours is a unique situation. In reality good engineering practices include attention to quality assurance. For the most part the CPRF/ZTH technical staff of physicists and engineers included quality assurance as part of their planning even before a quality assurance program was formally in place. As mentioned earlier, this has minimized the work by the QA office which has now become monitoring the work of others who would do quality assurance and control regardless of a formal program.

To accommodate QA problems that required special attention, such as the maintenance of the 1430 MVA generator, provision was made in the original QA plan for special procedures.

As implemented, the QA program has had to be flexible to assure that it did not hinder progress. Some of the unanticipated problems are shown in Fig. 6.

1. Barely adequate PR control.
2. Lack of information given on equipment arrival.
3. Little attention to tracking.
4. Necessity of expediting drafted design reviews.
5. Drafting reproduction.
6. Having design control system accommodate prototype designs.
7. Restrict unreleased designs from procurement.

Fig. 6. Unanticipated QA problems.

Of these problems, 1 and 3 have been discussed earlier. A monthly report on anticipated materials arrival solved no. 2. Expediting the review of drafted designs has been on an as needed basis using whatever solution fits the particular situation. In some cases meeting one-on-one with reviewers helped. In others, laying all drawings out in one room for a "mass review" expedited the review.

Drafting reproduction was a problem initially. For a while we used other groups in the Lab with more sophisticated copying equipment, then an outside vendor became available at a cheaper price. Finally, we got our own copying equipment, and a part time clerk

Expediting prototype designs so that the engineer could have information to complete the design required coordination between drafting and design engineers. A special procedure was introduced to allow for quick release of prototype designs.

Trying to restrict the release of designs for fabrication or procurement is a continual problem. There always seems to be a way of circumventing the control system. We have tried to develop a reputation for accommodating unusual requests so as not to hinder progress. This seems to alleviate the problem, but I am not sure it can be considered a solution.

FUTURE QUALITY ASSURANCE

Thus far an audit of our QA program has not been conducted. The Laboratory has a quality assurance plan, (5), that allows a wide degree of freedom for each division in determining their own QA Plans. We expect to conduct an audit within the next year.

When CPRF/ZTH becomes operational in 1993 it will present problems not yet encountered on earlier fusion research programs in our Division. No longer will a researcher be able to shut down the machine in the midst of a charge cycle to make a last minute adjustment on a particular diagnostic. We have begun to look at some of the problems that will, no doubt, occur.

A "technical operations manager" will be necessary to coordinate experimental activities. It will be necessary to limit access to the machine area, and account for all personnel exiting the experimental area for machine operation. A formal technician training program may have to be instituted. A number of other aspects of machine operation will have to be considered in preparation for physics experiments. Certainly, machine maintenance will affect experiment schedules. Experimental activities will have to be carefully planned out in advance and be coordinated according to necessary rules and regulations. Preparations for this "Operational Quality Assurance" program will continue as the next phase of QA and QC for the CPRF/ZTH experiment.

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