High Energy Facilities

Accelerator Development Branch

BROOKHAVEN NATIONAL LABORATORY

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INDUSTRIAL PRODUCTION OF SSC DIPOLE MAGNETS

THE PROCESS OF ENGAGING IN A CONTRACT AND DEALING WITH INDUSTRIAL VENDORS

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Preface

The purpose of this report is to briefly outline what I feel are essential procedures to follow when engaging in a dipole magnet production contract with a vendor or multiple vendors. The present estimated cost of a Design "D" dipole magnet is approximately $81,000. The Design "D" collider will require almost eight thousand dipole magnets, this brings the total cost of these magnets to roughly 650 million dollars. A contract of this size to one prime vendor is an extremely large undertaking. Even if the job was divided among two or three vendors, where each built a fraction of the dipoles, this would still be a large job for each vendor. There will be a small amount of interested vendors that are capable of handling this job in the United States. These vendors I expect will be large multi-division corporations.

The magnets that we propose to build are complex pieces of equipment requiring close control of quality in their fabrication. It is extremely important that contracts written to vendors be specific in detailing what it is that we wish to purchase. The buyers of these magnets must have control over what is being supplied by the vendor. Large corporations can be unwieldy and costly to deal with after a contract is awarded if specific control conditions are not agreed to at contract negotiations.

In this report I attempt to outline what will be required to solicit proposals from prospective magnet fabricators. The time required to negotiate these contracts is finite, and it should not be ignored in planning for industrial production of these magnets. I will also suggest a minimum time that I feel will be required to engage a large corporation in the fabrication of these dipole magnets. As an example I will use an excerpt from my "Proposed Design D Magnet and Cryostat Fabrication Schedule", dated June 12, 1985 and revised July 16, 1985. The buyer must also have a staff of administrative, scientific, engineering, and quality control personnel during the period covered by the dipole production contract. This will be required for manufacturing engineering, quality assurance and magnet testing by the buyer.

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1. A proposal for beginning magnet production of dipoles by an industrial vendor.

2. The buyer. What information must the buyer have to solicit proposals from prospective vendors.

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Appendix

Copy - "Proposed" Design D Magnet and Cryostat Fabrication Schedule
Dated June 12, 1985 and revised July 16, 1985.

1. A proposal for beginning magnet production of dipoles by an industrial vendor.

I foresee the SSC magnet program passing through three phases of development. These are: Research & Development (R & D), pre-production, and production. The Magnet Division at Brookhaven National Laboratory is currently in the mid-R & D stage of dipole magnet development. Fermilab is entering the R & D stage of cryostat development, while LBL is in the final stage of cable development.

The R & D stage of development is rightly being handled by the laboratories such as BNL, FNAL and LBL. At this stage the preliminary development which will lead to the next stage is conducted. The pre-production is the evolution of R & D efforts which should result in a magnet design that closely resembles the one required in the SSC Collider. This stage should start in the laboratories and eventually become a combined effort involving both laboratory and private industry. The R & D and pre-production stage should overlap by about one to two years. This is the first introduction or learning phase for private industry to actually fabricate and assemble complete dipole magnets. It will end with the completion of magnets for a string test. During this stage the production of magnets should be divided with a laboratory and an industrial vendor each assembling magnets. The laboratory may also be involved in the R & D stage concurrently. Changes in design as they develop may be incorporated in the laboratory assembled magnets and then introduced into the vendor magnets. All of the magnets in the pre-production stage should be cold tested by the laboratory, and some of these magnets may be used in the SSC Collider.

The production stage involves industry assembling magnets on a large scale for a buyer. It will utilize the final magnet design that was developed in the pre-production stage. There will be an overlap of the pre-production and production stages of approximately one year. The cold testing of all production magnets should be conducted by the buyer and will probably be at the collider site.

In early June I developed a suggested magnet and cryostat fabrication schedule for FY 1986 into FY 1989. It shows the R & D and beginning of the pre-production phase with an overlap between them. If enough resources were to be concentrated on this area of the project it still may be possible to meet this schedule. The following is a suggested scenario for phasing private industry into dipole magnet assembly based upon this schedule:

INDUSTRIAL PHASE IN - 17 m LONG DESIGN "D" DIPOLE MAGNETS IN CRYOSTATS

1.	Solicit proposals	4 months	Oct. 1, 1985 to Feb. 1, 1986
2.	Evaluate proposals	2 months	Feb. 1, 1985 to Apr. 1, 1986
3.	Contract preparation	3 months	Apr. 1, 1986 to Jul. 1, 1986
4.	Award contract		Early July, 1986
5.	Vendor performs: Engineering, Design, Develop Manufacturing Plan	6 months	Jul., 1986 to Jan., 1987

6.	Vendor performs: Tooling fabrication	14 months	Nov., 1986 to Jan., 1988
7.	Final design review by the buyer.	1-1/2 months	Jan., 1987 to Feb., 1987
8.	Approval of buyer for vendor to proceed with fabrication.		Feb., 1987
9.	Vendor performs: First production magnet ready for testing.		Feb., 1988

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2. The Buyer. What information must the buyer have to solicit proposals from vendors?

In this case I will contain my recommendations specifically to the Design "D" dipole magnet presently in the R & D phase. Most of these recommendations will be identical for the quadrupole, or correction magnets as well.

The buyer when ready to solicit proposals must be fully cognizant of three factors. He must know exactly what it is that the prospective vendor is to perform for him, he must have a good idea of what the cost of this work will be and he must know what is a reasonable time for the vendor to do the job. The laboratory that is engaged in the R & D phase is in the best position to have this information, and probably would be the buyer. Keep in mind that design and specification changes can and will be used by a vendor to boost up price and extend delivery. Once a vendor is awarded a contract the buyer will be locked in. Whatever performance is required by the buyer should be spelled out in the contract. To avoid misunderstanding I will specify what I think is the minimum information required by the buyer in order to solicit a proposal from a group of vendors.

A. Engineering Information

1. The buyer must have a complete set of engineering drawings of the Design "D" magnet and cryostat. This should include assembly drawings, details, and bill of materials.

2. Have on hand a parameter list, (list of technical specifications and tolerances), which the vendor will be required to build the magnet to.

3. Have prepared written specifications on any aspect of the design which cannot be specified on an engineering drawing. Examples:

   a. Magnet iron specification,

   b. specifications for handling and storage of age sensitive materials such as epoxy,

   c. etc.

B. Production Information

1. The buyer should be able to show prospective vendors the methods used to fabricate and assemble the R & D magnets. This would best be accomplished by entertaining visiting vendors for the purpose of acquainting them with the R & D methods of producing these magnets. Superconducting magnet fabrication is an area of high technology that the prospective vendors will have little or no experience with. It will be the responsibility of the laboratory that is engaged in the R & D phase to impart their expertise to the vendors. In all cases this exchange of experience will be an important factor in the prospective vendors ability to submit a proposal.

2. Production flow charts showing the step by step sequence of events in the fabrication and assembly of the magnet will be extremely helpful to the vendor. These charts, in conjunction with visits to the R & D magnet factory and access to tooling drawings, will provide assembly information for the successful preparation of the proposal.

3. Provide the prospective vendors with a list of the present vendors and suppliers that are being used in the R & D phase.

C. Quality Assurance

1. It is important that the prospective vendor in preparing a proposal be cognizant of how the components and finished magnet will be inspected for acceptance by the buyer. This will require written quality control procedures which the vendor will be expected to adhere to in producing magnets. It is in these specifications that the buyer can control how the vendor performs the job. These procedures may be as detailed as to specify how a critical component is to be inspected. In the least they must specify how the magnet will be inspected and cold tested by the laboratory for adherence to the specified parameters. The procedures will be written by engineers and time will be required prior to solicitation of proposals for the engineers in the R & D phase to perform this critical task.

2. A change transmittal and approval procedure must be specified. This will set up procedures for the exchange of revised engineering drawings, specifications and parameter changes between the buyer and vendor.

3. Specifications must be prepared to ensure vendor control of procurement, special processes, and shipping of the finished magnet to the laboratory for cold testing.

4. The in-process control of magnet assembly is important to the buyer. In this case the buyer must have access to the vendors factory during all phases of the production process. To accomplish this a system must be set up to allow resident inspectors in the vendors factory. These inspectors will be employed by and trained by the laboratory. They will be full time employees who will protect the buyers interest for the duration of the contract with the vendor. These inspectors

must have the authority to stop the job in the vendors plant if the workmanship or quality by the vendor is not being adhered to.

5. A system of production travelers will be developed in the R & D phase by the cognizant laboratory. These asre detailed written steps which are to be followed in certain critical fabrication and assembly areas. An example would be coil winding and curing. It will be specified in the traveler where in the process an inspection of workmanship is to occur. These will be a part of the package required by the prospective vendor to prepare a proposal.

3. Staff and Organization of the Buyer

Once the buyer sends out a Request for Proposal (RFP) he then becomes responsible to service prospective vendors. This service will be in the form of answering technical questions and indoctrinating prospective vendors on the production techniques used in the R & D phase. From this time to the completion of the contract with a vendor the buyer must have a staff of administrative, scientific, engineering, and quality control personnel to administer the contract. This staff must be organized into a cohesive organization whose sole responsibility is to obtain quality dipole magnets from the vendor. For purposes of this report only, I will refer to this group of Magnet Contract Administers as the (MCA).

During and after the time that the MCA is originated a laboratory, or a group of laboratories, will be engaged in the R & D and pre-production phases of magnet development. The prime responsibility of these laboratories will be to develop a quality magnet for the SSC Collider. The industrial manufacturer comes into the picture because the laboratories do not have the facilities to fabricate and assemble this quantity of magnets. The MCA will then become the liaison between the laboratories and the producing vendor or vendors. At some point in the pre-production phase the magnet detail design will be frozen, magnet development on Design "D" dipoles will cease, and the MCA will become the sole link with the vendor to produce magnets.

The makeup of the MCA group in respect to size of staff and skills required is something that must be planned once the scope of a proposed contract is decided upon. The type of work that this group performs will change as the contract progresses. In the early stages there will be a need for people with contract and procurement skills, and legal help. As the vendor gets into production this need will diminish and the quality control aspect will increase. Scientific and engineering expertise will be heavier in the beginning of the contract and as the vendor gets more proficient at producing magnets this need will decrease.

I will assume that the SSC Design "D" dipole program for industrial production stands in the pre-production phase as I propose. I will also assume that it starts to solicit proposals in Oct., 1985 for magnets for a string test. My recommendation for personnel in the MCA group is as follows:

Phase 1 - Preparing information required to send out an RFP.

Engineering and design help to: prepare engineering drawings, write specifications, prepare production flow charts.

Scientific help to: prepare parameter list, set up quality assurance procedures and requirements for cold testing of magnets.

Engineering help to: write up quality assurance specifications and production travelers.

Quality Assurance help to: write up procedures for change transmittal and approval, control of procurement processes, shipping, and access to the vendor factory for engineering and quality control personnel.

Contracts and Procurement help to: prepare the RFP.

Legal help to: check the RFP and procedures for selecting the vendor.

Phase 2 - Proposal writing by vendor.

Engineering and scientific help required to: indoctrinate prospective vendors on what a superconducting magnet is, and how they have to be fabricated and assembled.

Phase 3 - Evaluation of proposals & preparation of contract.

Contracts & Procurement, engineering, scientific, and quality control help to: evaluate proposals and prepare contract.

Phase 4 - Award of Contract - vendor prepared manufacturing plan

Engineering, scientific, and quality control help to: work with vendor in a liaison capacity between the vendor and the laboratories.

Phase 5 - Final design review.

Engineering, scientific, and quality control help.

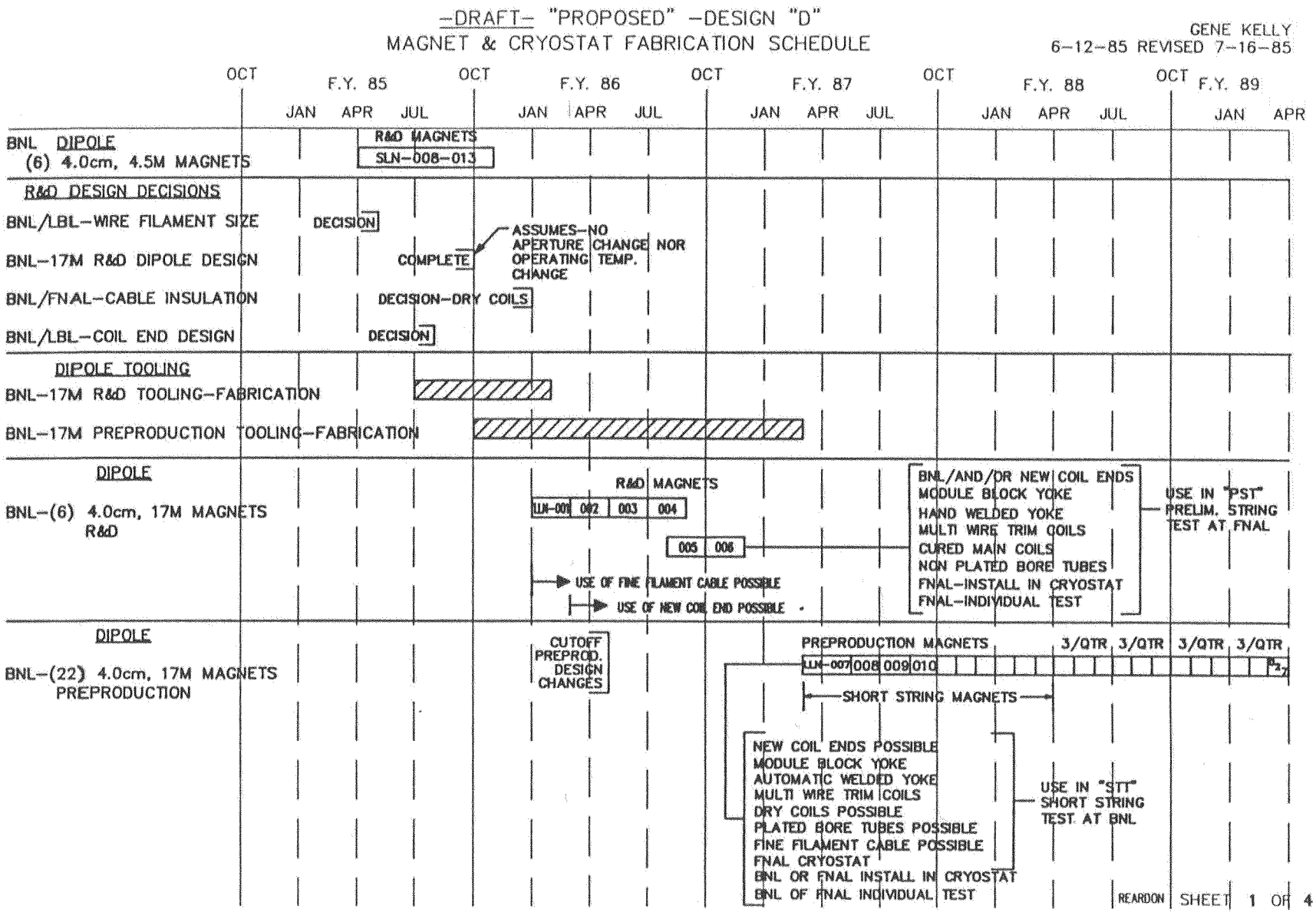
Phase 6 - Magnet production by the vendor.

Engineering, scientific, and qualilty control help. This will include at least one resident manufacturing engineer and two resident quality control inspectors at the vendors site for the duration of the contract. Engineering, scientific, and support people to cold test magnets as received from the vendor.

Conclusion

Industrial production of dipole magnets will become essential to the SSC program. The planning and preparation by the laboratories prior to the RFP phase will be a key factor to the success of industrial introduction into the magnet program. A liaison group must be set up to deal with the industrial vendors and the laboratories who will be concurrently developing magnets in the R & D and pre-production stages. The quality of the magnets that industry supplies to the SSC program is going to depend in part to the control that the liaison group has over the vendors. If we are to start the process of engaging industry in magnet production starting in FY 1986 then preparation for this by the laboratories must get underway as soon as possible.

APPENDIX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MAGNET & CRYOSTAT FABRICATION SCHEDULE
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6-12-85 REVISED 7-16-85
OCT
F.Y. 85
OCT
F.Y. 86
OCT
F.Y. 87
OCT
F.Y. 88
OCT
F.Y. 89
JAN
APR
JUL
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BNL DIPOLE
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R&D MAGNETS
SLN-008-013
R&D DESIGN DECISIONS
BNL/LBL-WIRE FILAMENT SIZE
DECISION
BNL-17M R&D DIPOLE DESIGN
COMPLETE
ASSUMES-NO APERTURE CHANGE NOR OPERATING TEMP. CHANGE
BNL/FNAL-CABLE INSULATION
DECISION-DRY COILS
BNL/LBL-COIL END DESIGN
DECISION
DIPOLE TOOLING
BNL-17M R&D TOOLING-FABRICATION
BNL-17M PREPRODUCTION TOOLING-FABRICATION
DIPOLE
BNL-(6) 4.0cm, 17M MAGNETS
R&D
R&D MAGNETS
LLN-001
002
003
004
005
006
BNL/AND/OR NEW COIL ENDS
MODULE BLOCK YOKE
HAND WELDED YOKE
MULTI WIRE TRIM COILS
CURED MAIN COILS
NON PLATED BORE TUBES
FNAL-INSTALL IN CRYOSTAT
FNAL-INDIVIDUAL TEST
USE IN "PST" PRELIM. STRING TEST AT FNAL
USE OF FINE FILAMENT CABLE POSSIBLE
USE OF NEW COIL END POSSIBLE
DIPOLE
BNL-(22) 4.0cm, 17M MAGNETS
PREPRODUCTION
CUTOFF PREPROD. DESIGN CHANGES
PREPRODUCTION MAGNETS
3/QTR
3/QTR
3/QTR
3/QTR
LLN-007
008
009
010
SHORT STRING MAGNETS
NEW COIL ENDS POSSIBLE
MODULE BLOCK YOKE
AUTOMATIC WELDED YOKE
MULTI WIRE TRIM COILS
DRY COILS POSSIBLE
PLATED BORE TUBES POSSIBLE
FINE FILAMENT CABLE POSSIBLE
FNAL CRYOSTAT
BNL OR FNAL INSTALL IN CRYOSTAT
BNL OF FNAL INDIVIDUAL TEST
USE IN "STT" SHORT STRING TEST AT BNL
REARDON
SHEET 1 OF 4

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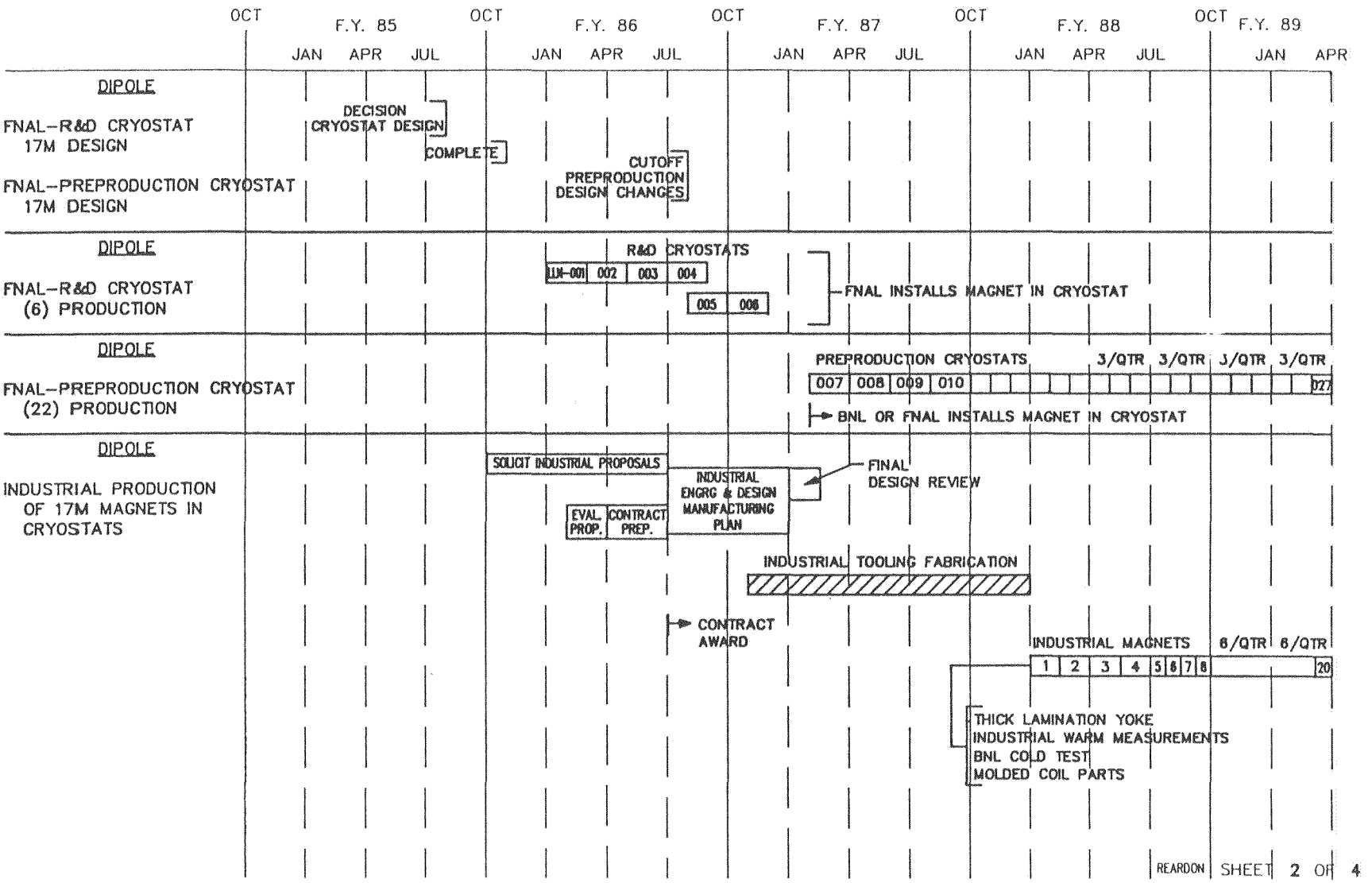

REARDON SHEET 2 OF 4

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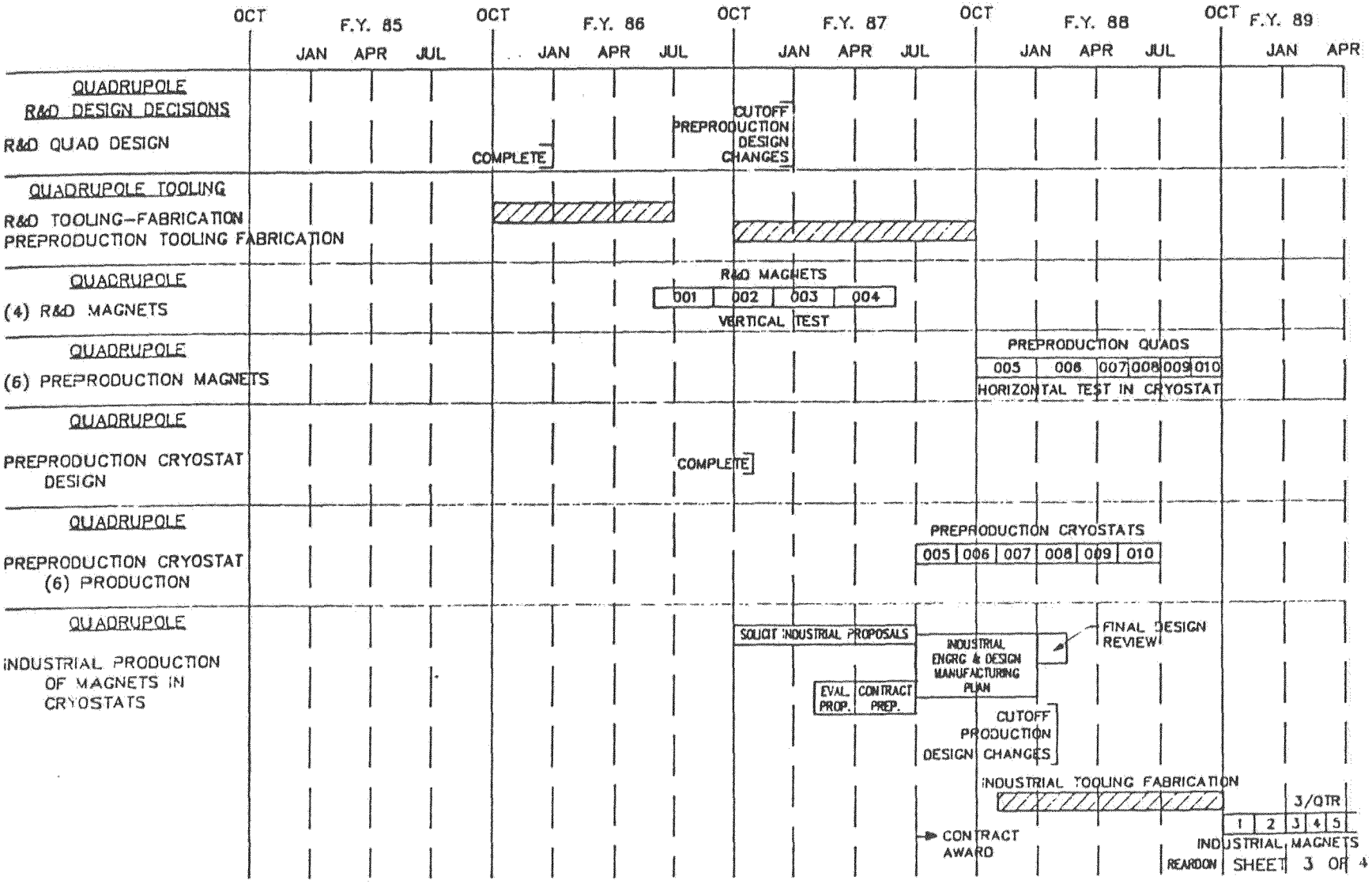

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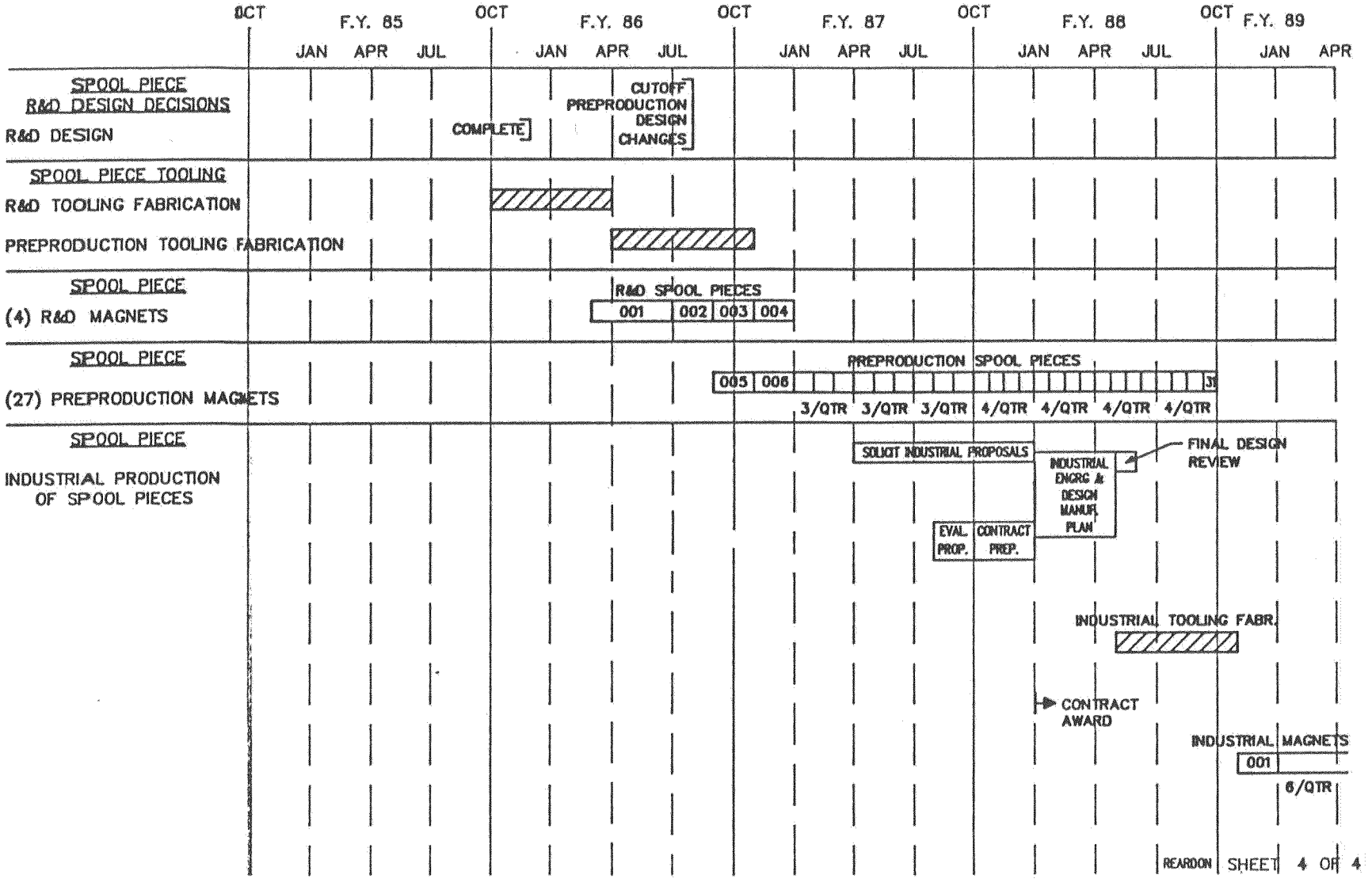

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