SSC-N-19
W.B.Fowler
7-22-85

DESIGN "D" CRYOSTAT REVIEW PANEL REPORT

The Design "D" Cryostat Review Panel met at Fermilab on July 8 and 9, 1985. The plan set forth in the letter of June 27, 1985 to the panel members from Clyde Taylor (Appendix 1) was followed very closely. The detailed agenda as proposed by R. Niemann (Appendix 2) was changed so that the panel could prepare a set of questions for the design team, which they could work on overnight so the tour was rescheduled for 8 a.m. to 9 a.m. on Tuesday, July 9, 1985. Appendix 3 gives the list of items for further discussion.

The seven major recommendations of the panel are given below:

1. Consider early component test of a single complete column support with glide cradle and bottom adjustment bracket under load conditions.
2. Develop the details of five column or post support system including shoulder stops for fiberglass epoxy cylinders. This should include the complete assembly procedure from roll-in of the single-phase unit into vacuum tank, to rail extraction, alignment and final closure.
3. Consider test of shield to column connection which allows shield to cycle through cooldown and warm-up motions at low temperature, and in vacuum to verify non-galling of the aluminum on aluminum joint.
4. The shields should be studied in detail. A shield fabricated from variable thicknesses might give favorable weight savings with only a minor disturbance in temperature. Deflection between supports must be considered.

5. The Panel recommends that the elliptical arch support work be phased down due to the need for column supports for the ends of the arch which overly complicate the design. This in addition to the large amount of radial space used up in the vacuum tank, justifies the discontinuance of this option.
6. The Panel concurs with the Fermilab decision to select the five column or post design cryostat for the initial long "D" magnets being fabricated by BNL. The concept that this option has the fewest penetrations, and the cleanest, most symmetric penetrations through the 80K shield and the 10K shield along with the advantages listed in Appendix 4 substantiates this choice.
7. Consideration should be given to reducing the number of column supports in order to minimize the penetrations through the heat shields. This would require an addition to the magnet structure (strong back or thicker shell) in order to meet the tolerance on the sag between supports.

SPECIFIC ANSWERS TO THE FIVE POINTS CHARGED TO THE PANEL AS CALLED OUT IN (A-1)

Charge: 1. Review the various cryostat concepts that have been identified as serious Candidate Designs, and review the reasons for rejection of others. Have we selected the best ones?

Answer: The Panel reviewed the serious candidates for the Design "D" cryostat, but did not have time to explore options that had been rejected or to examine the possibility that some option had been overlooked. Our recommendation #6 expresses the Panel's concurrence with Fermilab's decision to proceed with the five column cryostat for the initial long "D" magnets being fabricated by BNL. The Panel does not believe that it should select the best cryostat design, but that the staff which is to be responsible for implementation of the SSC cryostats should make the choice, which the Panel reviews. The best cryostat in this case is the one with the best supports. Arguments for and against different supports are given in (A-4).

Charge: 5. Is there a clear best choice of the initial FY86 cryostat design? Should an alternate design effort be pursued in the event that a better design concept exists, but cannot be executed in time to be used for the first cryostats?

Answer: The Panel's recommendation #6 should be understood in the context of our answer to charge #1. We do not feel that the five column design is <u>clearly</u> the best design but we concur with Fermilab's cryostat development plans as listed in A-5. An alternate design should be supported by the Central Design Group so that when and if problems develop in the implementation of the five column design, the CDG would have the option of switching to the alternate. The degree of support for the alternate effort will, of course, depend to a large extent on the availability of funds for the effort.

Charge: 2. List potential problems with Candidate Designs. Have the problems been adequately solved by analysis or by experimental results? Are structural analyses adequat What verification tests are needed? Are the heat leak predictions reliable?

4. Are mechanical problems of alignment, long-term stability, transportion loads, and thermal expansion solved by the Candidate Designs? What information is needed to resolve outstanding issues?

Answer: Recommendations 1, 2, 3 and 4 are the areas of greatest concern of the Panel relative to problems with the five column design. To summarize, early component testing under as realistic conditions as possible should be given highest priority. Use of the present 12 meter heat leak model should be considered. Consideration should be given to simplification of the design by elimination of adjustments, i.e. an assembly where the component tolerances and assembly procedures result in an aligned magnet cryostat. Perhaps the sagitta can be accomplished by pushing on the vacuum tank supports. Again, the Panel is relying on the "D" cryostat team to carry through the jobs as stated in A-5.

Charge: 3. Review materials choices.

Answer: Details of some of the proposed materials were in the material supplied to the Panel, however in other cases only sketchy information was available. A complete material list and complete material properties are part of the planned program and when this is available it should be reviewed.

Some of the Panel members are not convinced that the spacer for the Multiple-Layer-Insulation (MLI) is the best choice.

WBF (A

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WBF
7/3/85

June 27, 1985

To: Members of the "Design D" Cryostat Review Panel

Thank you for agreeing to serve on the Cryostat Review Panel. This letter gives some background, details, and lists some questions to be considered by the Panel.

As you know, selection of magnet style for intensive further development in FY 1986 will probably be done during August and September 1985. However, to insure that we do not lose momentum in case the "Design D" style is selected, we must be prepared to proceed with dispatch to build and test full-length magnets in FY 1986.

Recently, there has been experimental verification at FNAL of several features of a "Design B" cryostat, some of which are pertinent to any similar cryostat. In addition, conceptual designs have been made at FNAL and elsewhere based on different suspension and fabrication schemes and a manufacturing analysis of an example design has been made at FNAL, designated as the Cost Design.

FNAL is analyzing the results of these design exercises and experiments, and will recommend a design for construction of cryostats to accommodate the first "long" Design D magnets. Also, there have been active discussions at FNAL of the Design D Cryostat Working Group and this has been a useful forum for exchange of information and opinions.

It is now appropriate to conduct a design review of these designs prior to construction of long models.

The main purpose of the review is to identify critical problems that might be expected with a specific "Design D" cryostat design and to assess the proposed solution to such problems.

The Review Panel is asked to:

1. Review the various cryostat concepts that have been identified as serious Candidate Designs, and review the reasons for rejection of others. Have we selected the best ones?

2. List potential problems with Candidate Designs. Have the problems been adequately solved by analysis or by experimental results? Are structural analyses adequate? What verification tests are needed? Are the heat leak predictions reliable?

3. Review materials choices.

4. Are mechanical problems of alignment, long-term stability, transportation loads, and thermal expansion solved by the Candidate Designs? What information is needed to resolve outstanding issues?

5. Is there a clear best choice of the initial FY86 cryostat design? Should an alternate design effort be pursued in the event that a better design concept exists but cannot be executed in time to be used for the first cryostats?

The Panel will meet at Fermilab on July 8 and 9 in the Headquarters Conference Room, second floor, of the Industrial Center Building, beginning at 8:30 a.m. The first day will begin with oral presentations on highlights of the designs to be considered. The Panel will compile a list of questions that were not resolved during the presentations, and interview selected Laboratory staff members to obtain additional information. The Panel should plan to compile a preliminary summary of its findings on Tuesday afternoon and plan to adjourn by 5 p.m. Written comments are requested, where appropriate, and a report submitted to Maury Tigner by July 22.

You should receive a package of background information directly from Fermilab. However, the design(s) are still actively being developed, so I expect much new information, especially design analyses, will be presented during the review. Also, for background, I am sending a copy of a general-purpose introductory report on the SSC, and a report of the Reference Designs Study Group made about one year ago.

Members of the Panel are: Frank Berrera, SLAC; Kurt Kennedy, LBL; James Van Sant, LLNL; and William Fowler, FNAL. Bill Fowler has agreed to act as chairman.

Sincerely,

Clyde Taylor

Clyde Taylor
CDG

CT:al
Enclosures
cc: M. Tigner
P. Reardon
R. Lundy
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Agenda

SSC Design D Magnet Cryostat Review

. Monday	July 8, 1985	
8:30	-Executive Session	Review Panel
9:00	-Opening Remarks	W. Fowler
9:15	-Cryostat R&D Program Review	R. Niemann
9:45	-Cryostat Design Criteria	R. Niemann
10:15	-Single Phase Assembly - Cryostat Implications	T. Nicol
10:30	-Shields	T. Nicol
11:00	-Suspension-Recent LBL Work	R. Wolgast
11:30	-Suspension	T. Nicol
noon	-Lunch	
1:00	-Insulation	R. Powers
1:30	-Vacuum Vessel	N. Engler
2:00	-Interconnections	N. Engler
2:30	-Manufacture	N. Engler
3:00	-Lab Tour .Suspension Heat Leak Dewar .12m Heat Leak Model .Alignment Mockup .Arch Load Test .6m Magnetic Effects Model	
4:00	-Executive Session	Review Panel
5:00	-Adjourn	
.Tuesday	July 9, 1985	
9:00	-Technical Interviews-as determined by panel	
noon	-Lunch	
1:00	-Executive Session	Review Panel
5:00	-Adjourn	

D R A F T

QUESTIONS

1. What are the important jobs remaining that need to be completed prior to ordering parts for "D" cryostats?
2. Advantages and disadvantages list for different support designs given verbally. Could we have a written list?
3. List quality control considerations for materials and installation of S.I.
4. Further discussion on support as relates to initial installation and alignment; (1) at time of installation of magnet into vacuum tank and (2) in tunnel.
5. Further discussion of slide joint between post rings and shield.
6. Further discussion on materials selection.

DESIGN "D" CRYOSTAT
REVIEW OF SUSPENSION CANDIDATES - ADVANTAGES AND DISADVANTAGES

FERMILAB
JULY, 1985

Compacted Post:

Advantages

1. Comparatively low heat leak.
2. Fewest penetrations in vacuum vessel.
3. Lends itself well to slide-in assembly.
4. Fewest adjustments at installation.
5. Allows complete internal assy to be assembled and insulated outside vacuum vessel.

Disadvantages

1. Highest stress levels during lateral loads.
2. High precision required for piece parts.

Tension Straps:

Advantages

1. Most efficient use of material.
2. Lowest conduction heat leak.
3. Easy incorporation of shipping restraints.

Disadvantages

1. Many (approximately 18) penetrations in vacuum vessel, shields, and MLI.
2. Large number of individual adjustments required.
3. Separate shield supports required.
4. Difficult to heat station.
5. Large self-weight deflection ("soft").
6. Largest potential radiation heat leak.

Compression Struts:

Advantages

1. Efficient use of material.
2. Potentially low heat leak.

Disadvantages

1. Many (approximately 18) penetrations in vacuum vessel, shields, and MLI.
2. Large number of individual adjustments required.
3. Separate shield supports required.
4. Large self-weight deflection ("soft").

Elliptical Arch:

Advantage

1. Insensitive to load direction (arch piece).

Disadvantages

1. Requires a lot of radial space.
2. Large 4.5K heat leak.

DESIGN "D" CRYOSTAT
PREPARATION TO MANUFACTURE PROTOTYPE CRYOSTATS
DESIGN & DEVELOPMENT TASKS

FERMILAB

JULY, 1985

A) LIQUID HELIUM ASSEMBLY

1. Investigate both analytically and experimentally, if time allows, the mechanical characteristics of the liquid helium assembly. To be considered are cooling, pressure drop and bowing.

2. Establish vessel and its extensions lengths.

3. Obtain an improved and agreed to definition of tunnel installation and alignment procedures.

4. Finalize assembly reference fiducial system.

5. Develop tooling supports for assembly.

6. Develop alignment tooling.

7. Develop handling tooling.

8. Define post assembly electrical test requirements.

B) THERMAL RADIATION SHIELDS

1. Complete magnetic and mechanical design analysis.

2. Finalize extrusion requirements.

3. Finalize rolled shape drawings for short production runs.

4. Develop welding techniques for short production runs.

5. Develop welding and assembly fixtures for short production runs.

C) INSULATION

1. Continue evaluation of MLI systems in the Suspension Heat Leak Dewar.

2. Prepare insulation blanket drawings and specifications.

3. Mock up post and shield interconnection region for pattern development and develop patterns.

4. Prepare insulation attachment, overlap, and end specifications.

D) VACUUM VESSEL

1. Complete engineering pressure-vacuum analysis.

2. Complete cryo spill test and analysis.

3. Design handling fixture.

4. Develop assembly tooling.

E) SUPPORTS

1. Continue to optimize the compacted post suspension system.

2. Complete engineering drawings.

3. Thermally and structurally evaluate prototype post supports.

4. Develop short term assembly tooling.

5. Test heat sink attachment schemes.

6. Test shield attachment schemes.

7. Model and test adjustment and cold slide mechanisms.

8. Develop welding fixtures.

9. Extend tests of cryostat concepts using the 12m Thermal Model, if applicable.

F) ASSEMBLY

1. Develop support, insertion and alignment tooling.

2. Develop shipping contraints.

3. Develop shipping container.

4. Develop alignment lugs and tooling.

5. Design and develop mounting feet and cryostat adjustment.

6. Develop factory layout and material flow plan.

G) INTERCONNECTIONS

1. Complete engineering analysis of joints, bellows, insulation, etc.

2. Develop optimum end to end spacing.

3. Develop lead connection mock up.

4. Draw final interconnection parts.

H) TESTING

1. Develop test procedures.

2. Develop MTF facilities.

3. Develop MTF procedures.

3. Design handling fixture.

4. Develop assembly tooling.

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