



FUSION ENGINEERING DESIGN CENTER

CONF-8507100--1

By acceptance of this article, the publisher or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering the article.

CONF-8507100--1

DE86 002212

MINIMARS CENTER CELL MAGNET DESIGN OPTIONS

SWARN S. KALSI
FEDC/GRUMMAN

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Presented by W. D. Nelson
at
MINIMARS DESIGN REVIEW
GENERAL DYNAMICS, SAN DIEGO, CA
July 17-19, 1985

MASTER

* Research sponsored by the Office of Fusion Energy, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Incorporated.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED



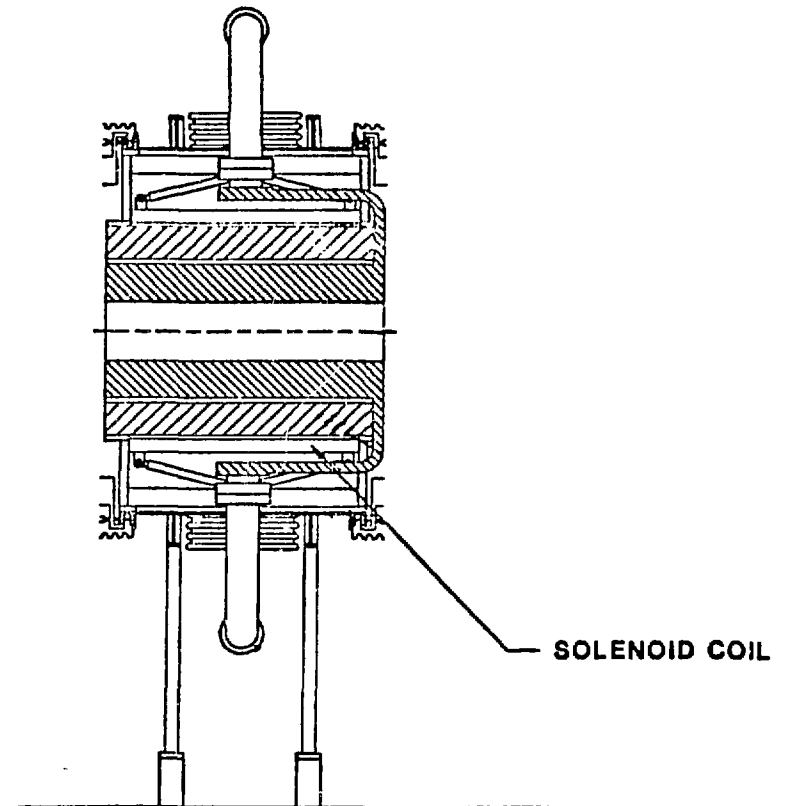
CENTER CELL MAGNET REQUIREMENTS

MEAN RADIUS	2 m
AXIAL LENGTH	2-8 m
FIELD ON AXIS	3 T

PRESENT BASELINE ASSUMES FORCED-FLOW COOLING
POTENTIAL COMPLEXITY OF MANIFOLDING REQUIRES
RE-EVALUATION OF DESIGN OPTIONS

DESIGN OPTIONS ARE:

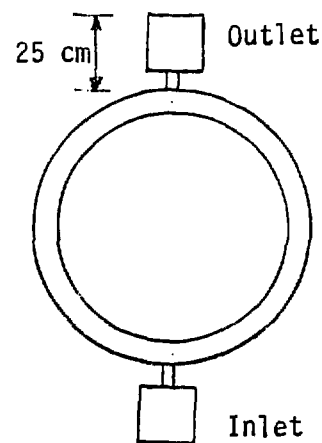
- WINDING COOLED WITH FORCED-FLOW HELIUM
- WINDING COOLED WITH POOL BOILING HELIUM





CENTER CELL COIL DESIGN COOLED WITH FORCED-FLOW HELIUM

- EMPLOY LCP-TYPE Nb_3Sn CABLE-IN-CONDUIT CONDUCTOR COOLED WITH FORCED-FLOW HELIUM
- CONDUCTOR CURRENT 60 kA
- NUMBER OF TURNS/m LENGTH OF COIL 40
- PEAK NUCLEAR HEATING AT WINDING 0.1 mW/cm^3
- NO. OF TURNS IN A COOLED LOOP 10
- HELIUM TEMP. AT INLET 4.2 K
AT OUTLET 5.5 K
- HELIUM INLET PRESSURE 15 atm
PRESSURE DROP 0.25 atm
- HELIUM MASS FLOW 1 g/s
- RADIAL SPACE REQUIRED FOR HELIUM MANIFOLDING 25 cm



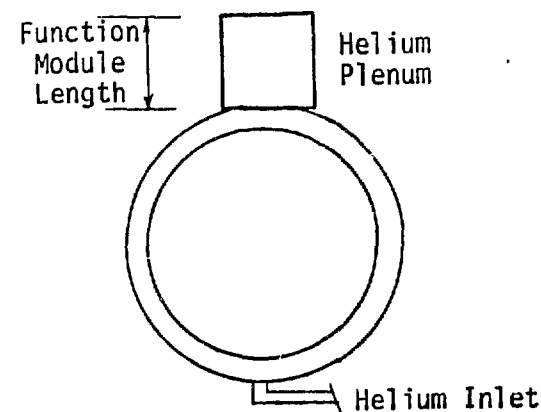
OBSERVATIONS

- THIS DESIGN HAS MANY HYDRAULIC JOINTS, MAKING AN UNFAVORABLE IMPACT ON THE AVAILABILITY.
- HELIUM LINES TO A MODULE MUST BE DISCONNECTED BEFORE REMOVING A CENTER CELL MODULE.
- RADIAL SPACE OCCUPIED BY HELIUM INLET AND OUTLET MANIFOLD WILL LEAD TO A LARGER OVERALL MODULE DIAMETER.



CENTER CELL COIL DESIGN COOLED WITH POOL BOILING HELIUM

- EMPLOY LCP-GD TYPE NbTi CONDUCTOR COOLED WITH POOL BOILING HELIUM
- CONDUCTOR CURRENT 10 kA
- PEAK NUCLEAR HEATING AT WINDING 0.1 mW/cm³
- HELIUM BATH TEMPERATURE 4.2 K
- RADIAL SPACE REQUIRED FOR HELIUM PLENUM (ONLY ON TOP)
FOR MODULE LENGTH 2 m 0.25 m
 4 m 0.45 m
 6 m 0.65 m



OBSERVATIONS

- DESIGN REQUIRES TALLER (RADIALLY) HELIUM PLENUM AND WILL LEAD TO LARGER OVERALL MODULE DIAMETER
- WINDING RADIAL BUILD IS LARGER BECAUSE POOL BOILING CONDUCTORS OPERATE AT LOWER CURRENT DENSITY
- FEWER HELIUM SUPPLY/DISCHARGE LINES TO BE DISCONNECTED BEFORE REMOVING A MODULE



CONCLUSIONS

- CHOICE BETWEEN POOL-BOILING AND FORCE-COOLED WINDING APPROACHES IS NOT CLEAR
- MAGNET CONFIGURATION SHOULD BE DEVELOPED FOR THE TWO OPTIONS BEFORE MAKING A SELECTION