NSTX

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Center Stack Upgrade Diagnostics

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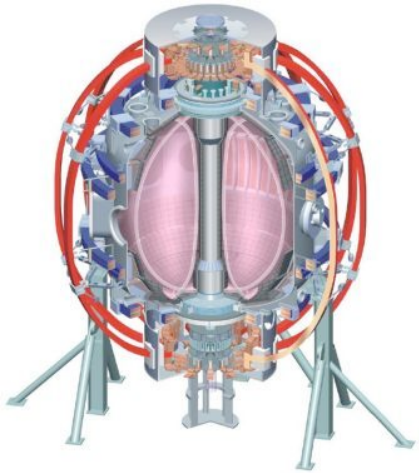
R. Kaita

NSTX Centerstack Upgrade Peer Review
LSB, B318
April 29, 2010



Culham Sci Ctr
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Scope of Center Stack Diagnostics

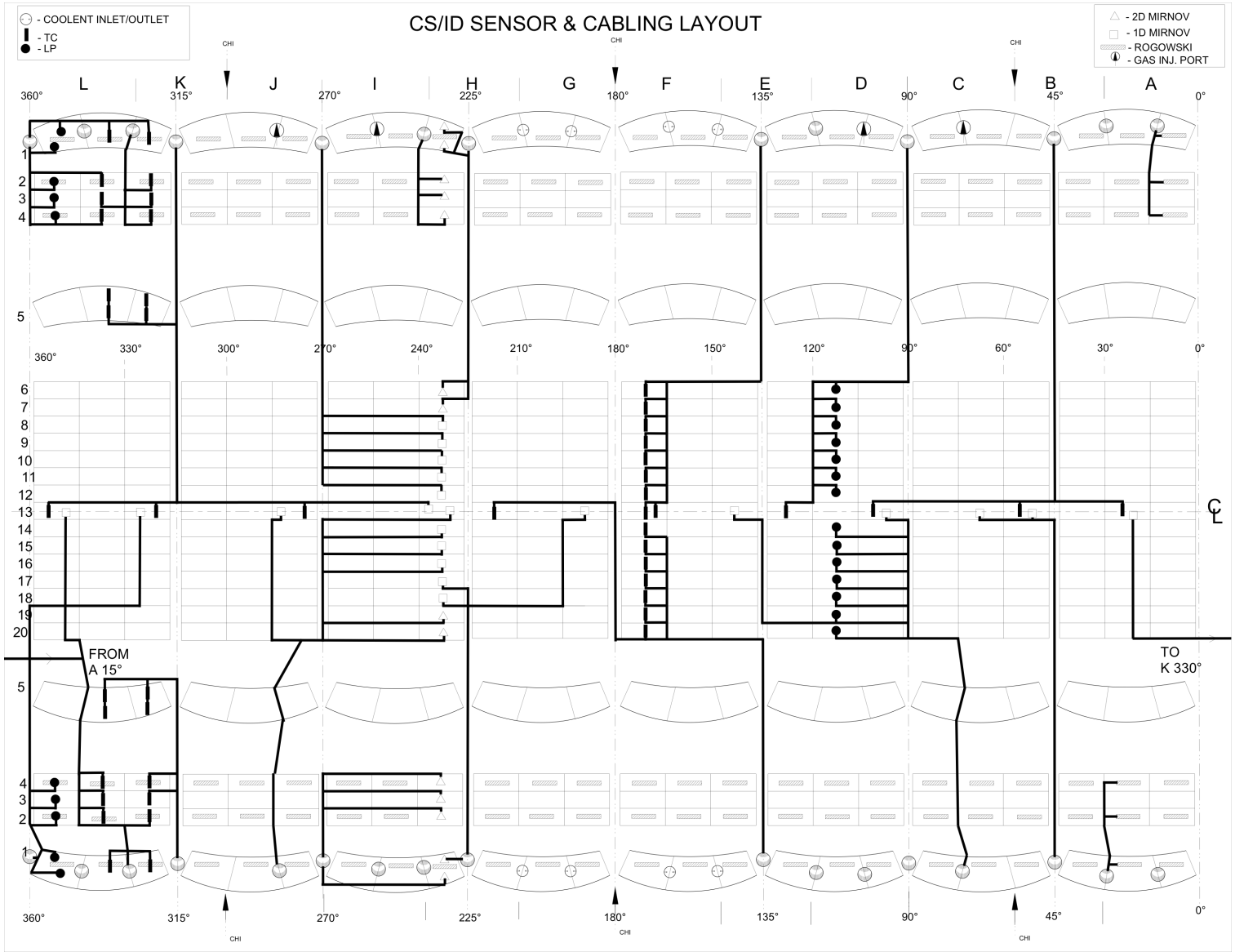
I. Inside Plasma-Facing Components

1) Thermocouples
2) Mirnov/Pickup Coils
3) Halo Current Rogowski Coils
4) Tile-mounted Langmuir Probes

II. Around OH Ground Plane

1) Plasma Current Rogowski Coils
2) Flux Loops

Thermocouple, Mirnov coil, halo current Rogowski coil, and Langmuir probe locations close to finalized



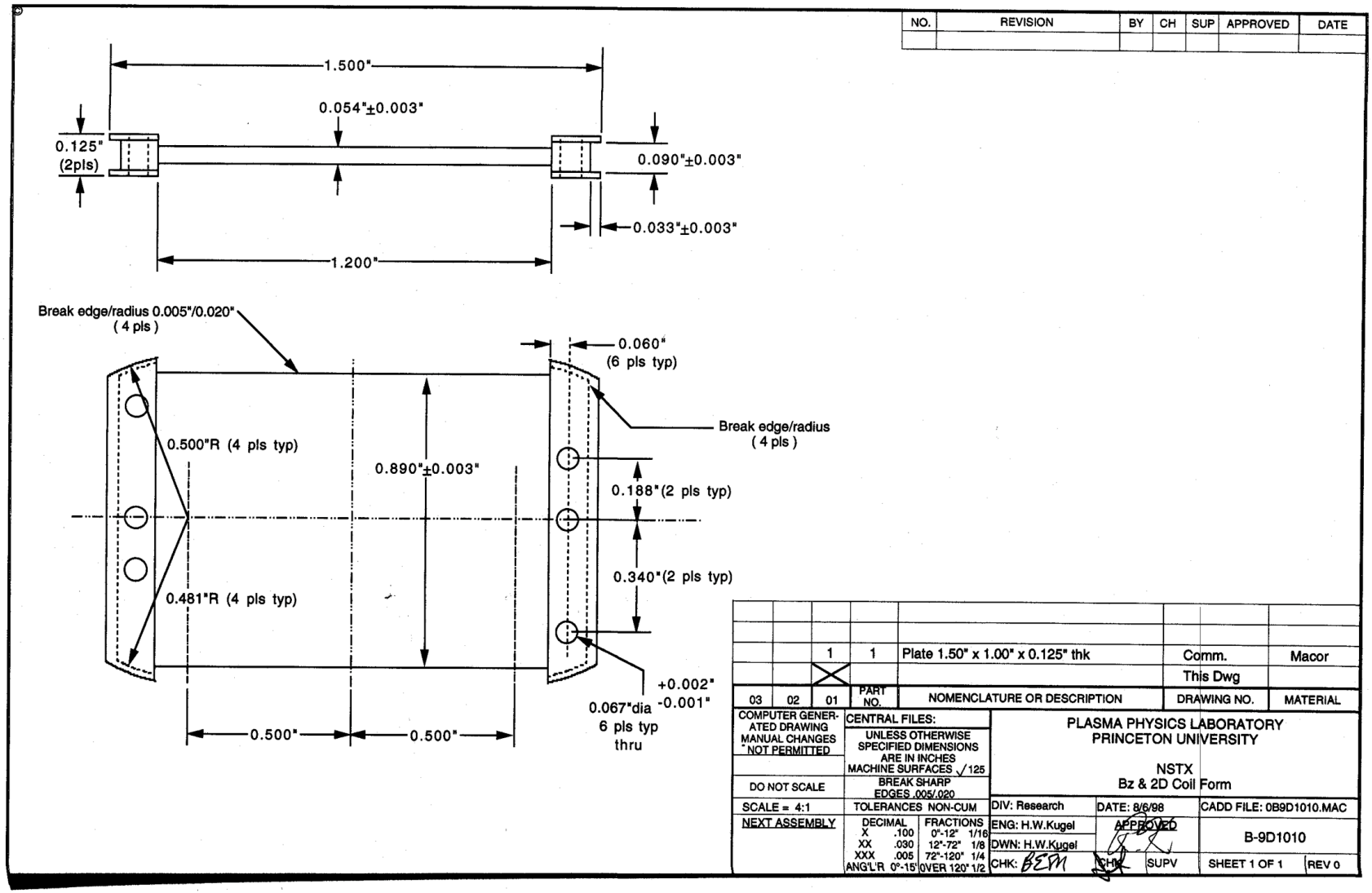
Thermocouple Summary

- Status
  - Locations
    - Specified in detail since August 13, 2009 peer review
  - Design
    - Unchanged
  - Documentation
    - Installation procedure needs modification to accommodate new tile design (channels for cable routing and means for securing to tiles)
  - Impact of upgrade on diagnostic
    - No temperature issues: Nextel insulation rated to 1375 °C continuous
    - No mechanical issues: Wires held in place by tiles

Mirnov/Pickup Coil Summary

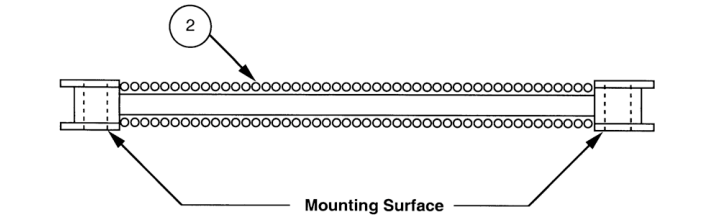
- Status
  - Locations
    - Specified in detail since August 13, 2009 peer review
  - Design
    - Essentially unchanged
    - Slightly larger tiles may mean mandrels could be enlarged and simplified for ease of fabrication
  - Documentation
    - Drawings available from archived NSTX engineering drawings
      - Machinist on main campus unavailable for fabrication of 35 mandrels
      - Awaiting response from Zenex about interest in bidding for job
    - Statement of Work for winding available (Airex Corporation)
    - Installation procedure needs modification to accommodate new tile design (channels for cable routing and means for securing heavier gauge cables to sensors)

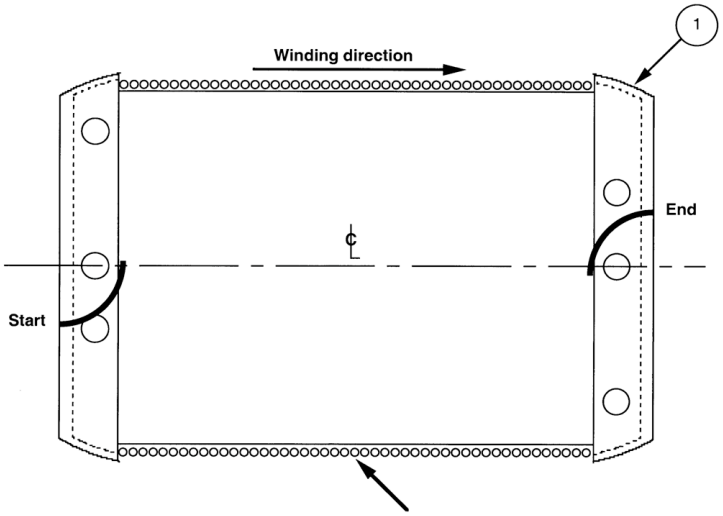
Mirnov Coil Mandrel Fabrication Drawing



1D Mirnov Coil Winding Drawing

NO.	REVISION	BY	CH	SUP	APPROVED	DATE





Bz Coil winding
Uninsulated copper Awg #40 magnet wire
1 layer wound with a pitch of 0.007"±0.001"

Winding Notes:
1) The coil winding shall be a continuous winding with NO SPLICES using part #2 which is an uninsulated, hard tempered Awg #40 magnet wire. Identify the "Start" and "End" leads; wind maximum number of turns per layer and ALL ASSEMBLIES PER ORDER MUST HAVE THE SAME NUMBER OF TURNS. The number of turns shall be documented with the serial number and data information. Shorted turns shall be avoided using best engineering approach.
2) The self leads should be a minimum of 3" long.
3) DO NOT TWIST WINDING LEADS; SECURE LEADS WITH MYLAR TAPE OR EQUIVALENT.

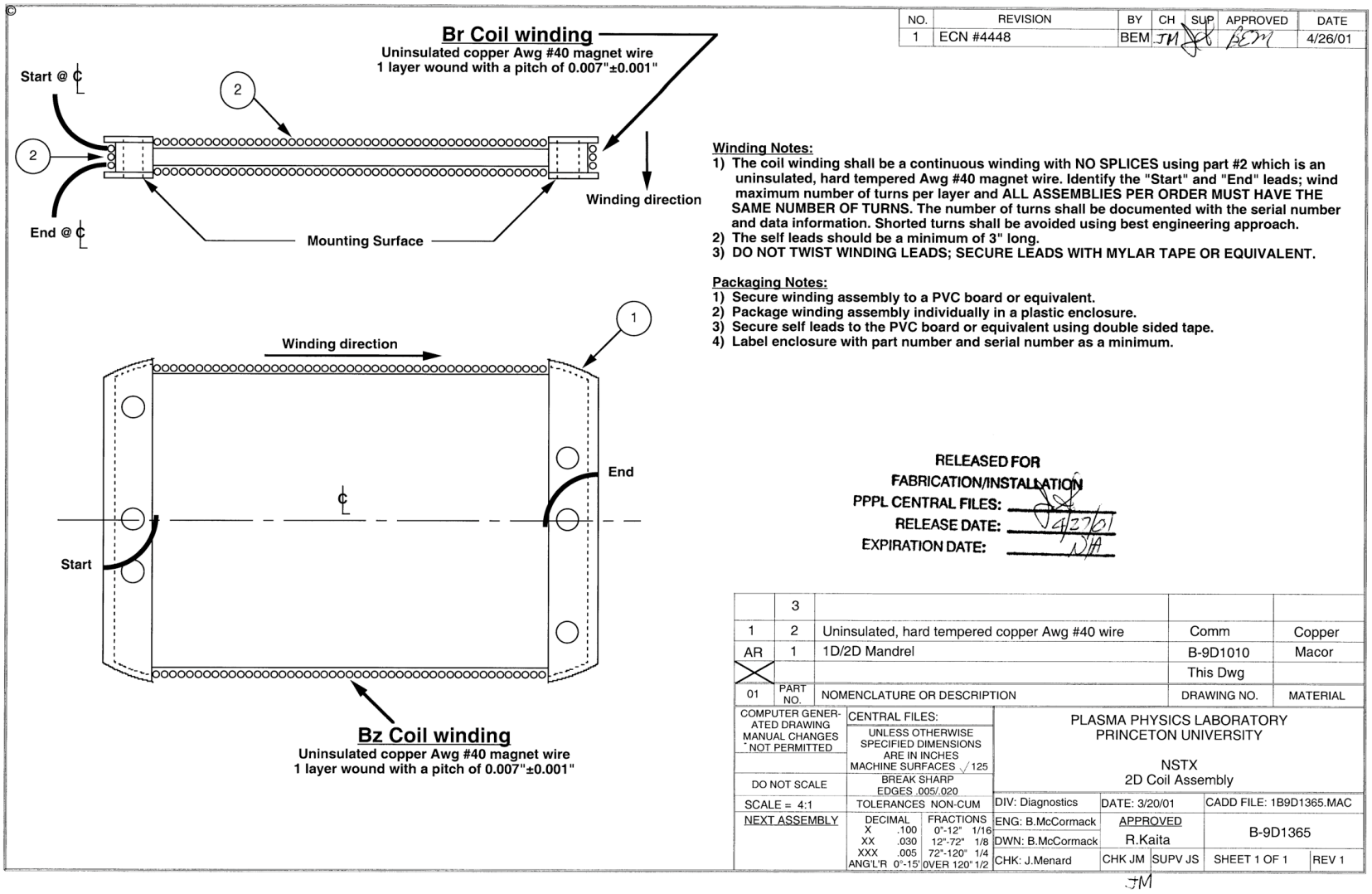
Packaging Notes:
1) Secure winding assembly to a PVC board or equivalent.
2) Package winding assembly individually in a plastic enclosure.
3) Secure self leads to the PVC board or equivalent using double sided tape.
4) Label enclosure with part number and serial number as a minimum.

RELEASED FOR FABRICATION/INSTALLATION
PPPL CENTRAL FILES:
RELEASE DATE: 4/27/01
EXPIRATION DATE:

	3			
1	2	Uninsulated, hard tempered copper Awg #40 wire	Comm	Copper
AR	1	1D/2D Mandrel	B-9D1010	Macor
X			This Dwg	
01	PART NO.	NOMENCLATURE OR DESCRIPTION	DRAWING NO.	MATERIAL

COMPUTER GENERATED DRAWING MANUAL CHANGES NOT PERMITTED	CENTRAL FILES: UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES MACHINE SURFACES √125	PLASMA PHYSICS LABORATORY PRINCETON UNIVERSITY		
DO NOT SCALE	BREAK SHARP EDGES .005/.020	NSTX 1D Coil Assembly		
SCALE = 4:1	TOLERANCES NON-CUM	DIV: Diagnostics	DATE: 4/26/01	CADD FILE: 0B9D1364.MAC
NEXT ASSEMBLY	DECIMAL X .100, XX .030, XXX .005, ANG'L'R 0°-15' / FRACTIONS 0"-12" 1/16, 12"-72" 1/8, 72"-120" 1/4, OVER 120" 1/2	ENG: B.McCormack	APPROVED B.E. McCormack	B-9D1364
		DWN: B.McCormack		
		CHK: J.Menard	CHK JM SUP	SHEET 1 OF 1 REV 0

2D Mirnov Coil Winding Drawing



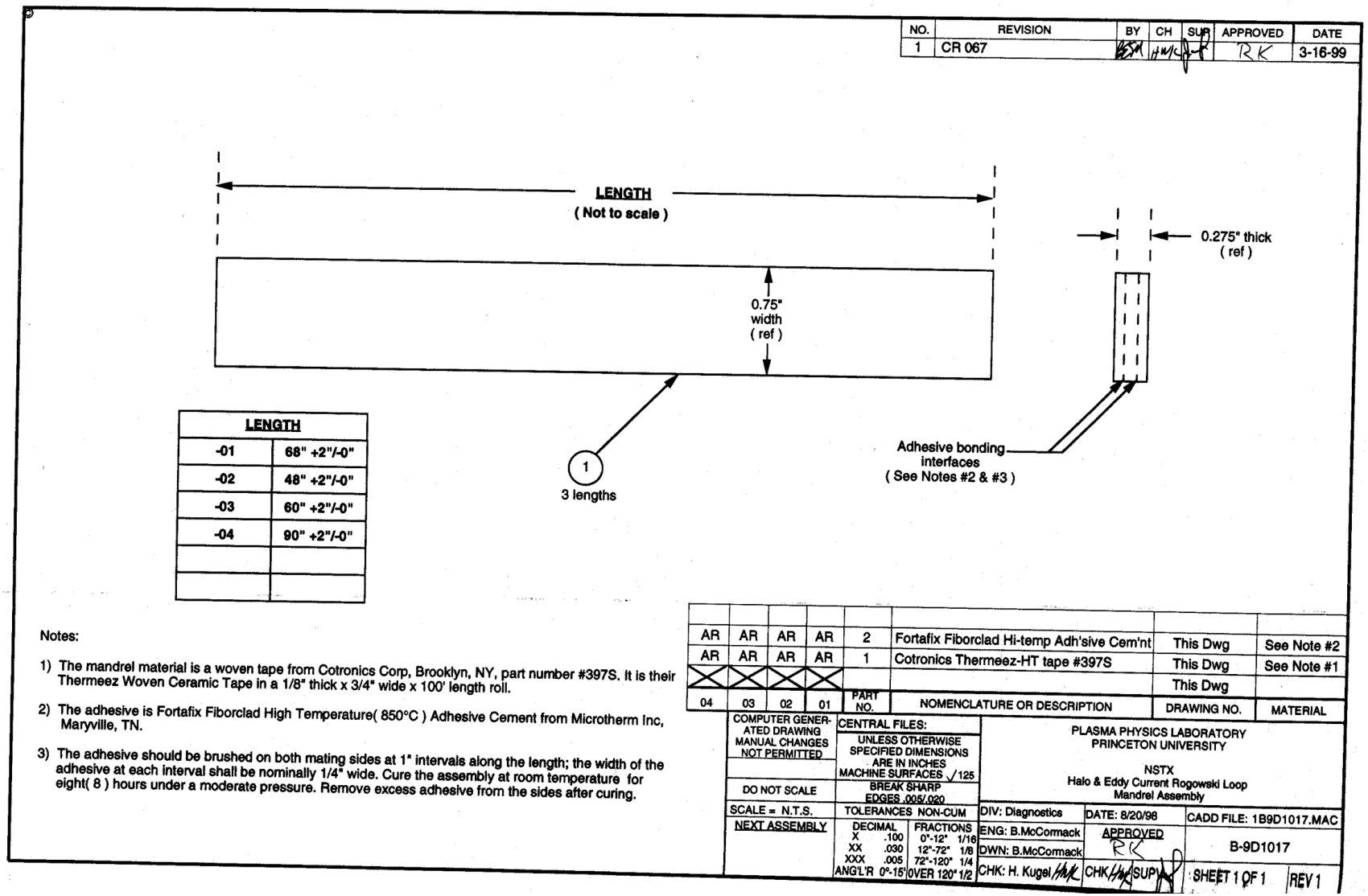
Mirnov/Pickup Coil Summary (continued)

- Status (continued)
  - Impact of upgrade on diagnostic
    - No temperature issues:
      - Bare copper wire melts at 1083 °C
      - Wound on MACOR mandrel rated at 800 °C continuous
      - “Potted” with Fortafix high temperature adhesive with maximum rating of 850 °C
    - No mechanical issues: Sensors and wires held in place by tiles

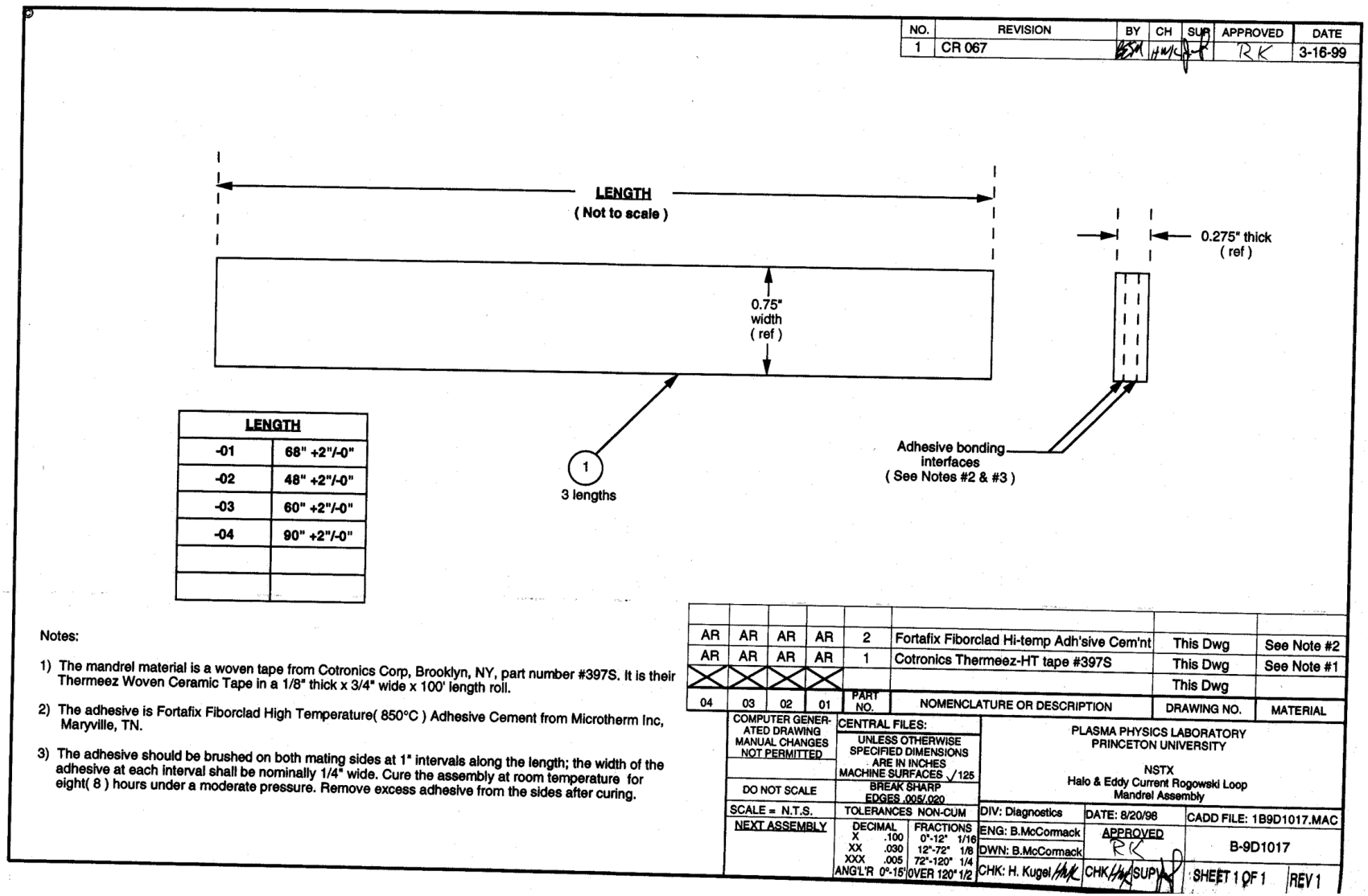
Halo Current Rogowski Coil Summary

- Summary
  - Locations
    - Specified in detail since August 13, 2009 peer review
    - Includes additional coils in “horizontal” sections of divertor regions
  - Design
    - Essentially unchanged for “vertical sections”
    - May need to change width for “horizontal” sections (depending on tile thickness)
  - Documentation
    - Drawings available from archived NSTX engineering drawings
    - Statement of Work for winding available (Airex Corporation)
    - Installation procedure needs modification to accommodate new tile design (channels for cable routing and means for securing heavier gauge cables to sensors)

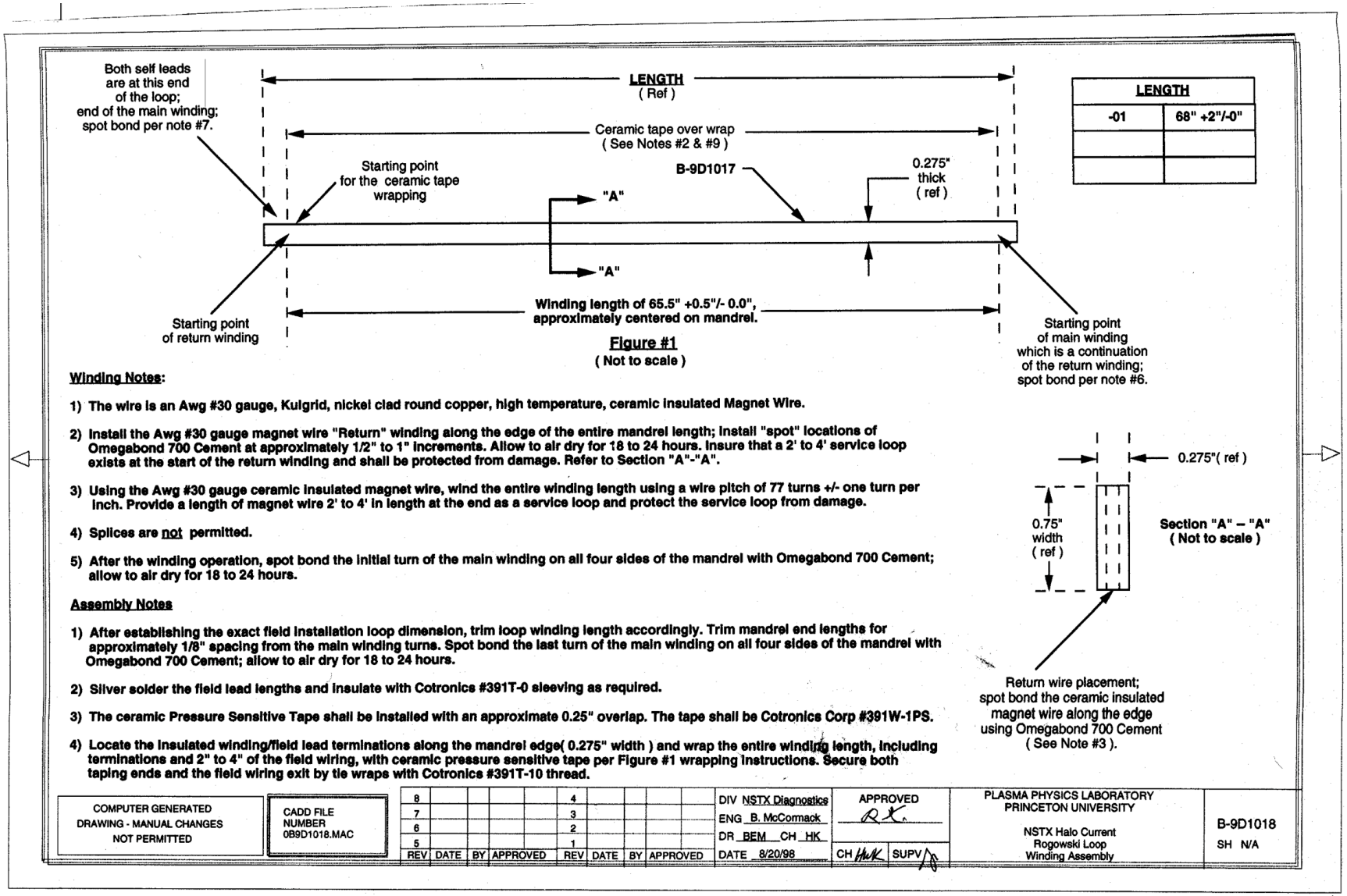
Halo Current Rogowski Mandrel Drawing



Halo Current Rogowski Mandrel Drawing



Halo Current Rogowski Winding Drawing



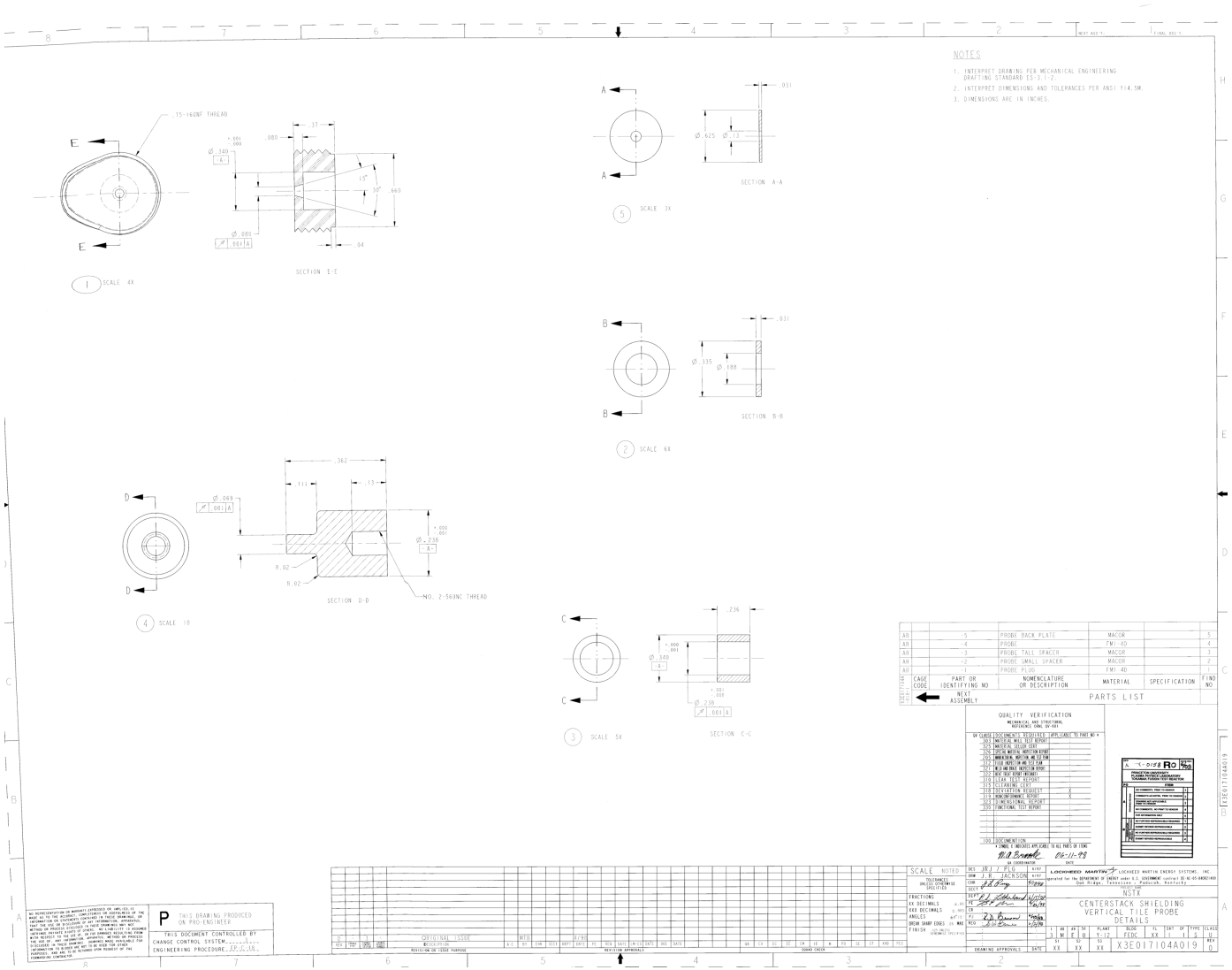
Halo Current Rogowski Coil Summary (continued)

- Status (continued)
  - Remaining space allocation task
    - Halo current Rogowski coil requested on center stack midplane
      - Does not exist on present center stack
      - Planned space is 1" x 0.25" deep
        - » Need to determine if coil can be reduced from present thickness of 0.275" for mandrel plus wire and "potting"
    - No mechanical issues: Sensors and wires held in place by tiles
  - Impact of upgrade on diagnostic
    - No temperature issues:
      - Bare copper wire melts at 1083 °C
      - Wound on Cotronics ceramic woven tape mandrel rated at 1650 °C
      - "Potted" with Fortafix high temperature adhesive with maximum rating of 850 °C
    - No mechanical issues: Sensors and wires held in place by tiles

Langmuir Probe Summary

- Summary
  - Locations
    - Specified in detail since August 13, 2009 peer review
  - Design
    - Unchanged
    - Keeping present center stack arrangement of one sensor per tile
  - Documentation
    - Probe tip fabrication drawings available
    - Standard tile drawings need modification to accommodate probe tips
    - Installation procedure needs modification to accommodate new tile design (channels for cable routing and means for securing heavier gauge cables to sensors)

Langmuir Probe Tip Drawing



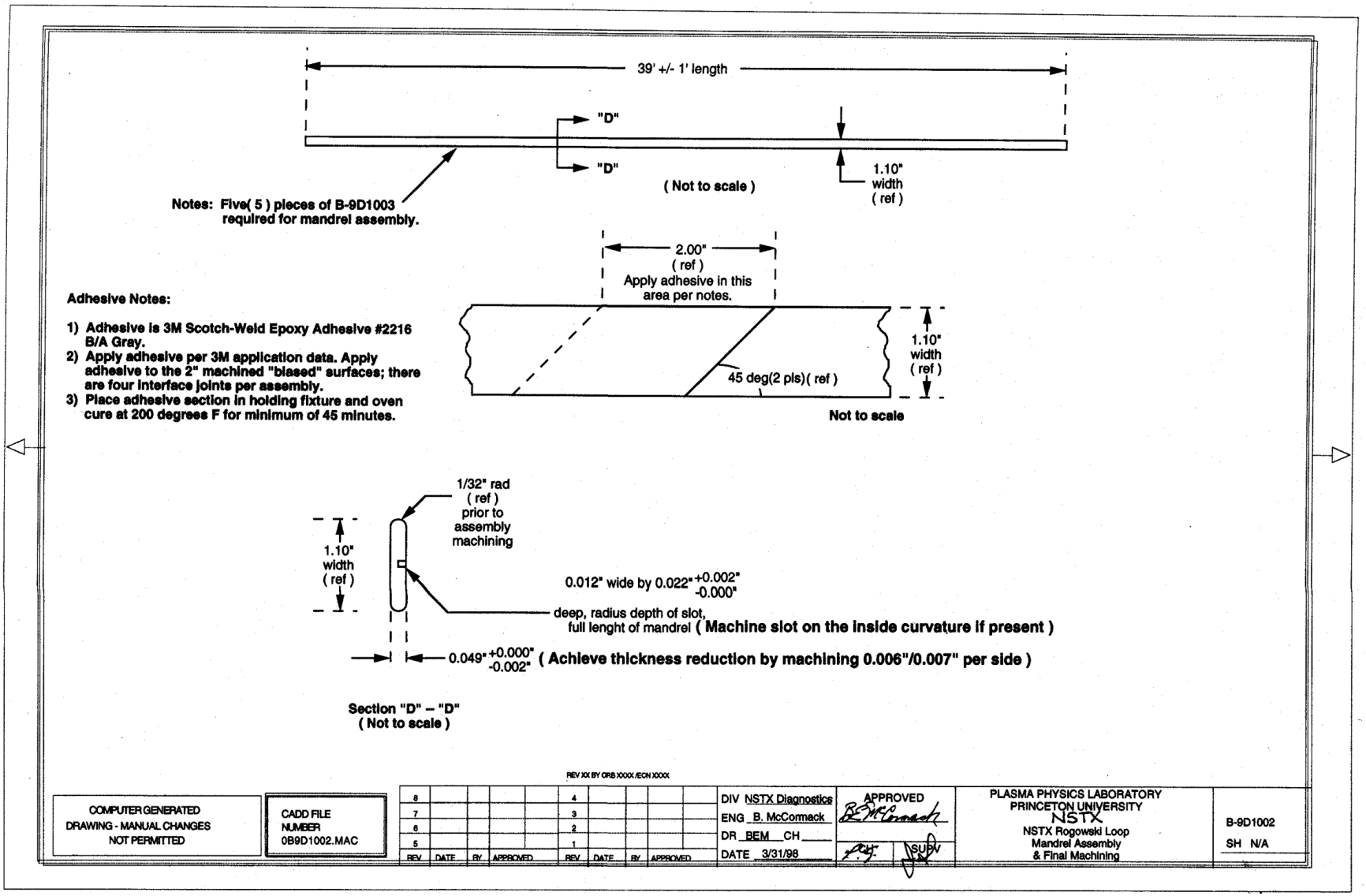
Langmuir Probe Summary (continued)

- Status (continued)
  - Impact of upgrade on diagnostic
    - No temperature issues:
      - Carbon components similar to tile material
      - MACOR components rated at 800 °C continuous
    - No mechanical issues: Sensors and wires held in place by tiles

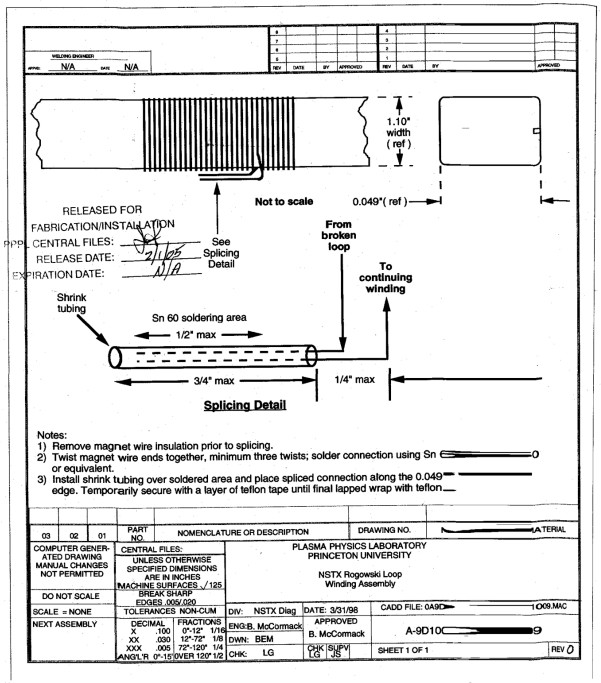
Plasma Current Rogowski Coil Summary

- Status
  - Locations
    - Similar to placement on existing center stack
    - Consider increasing number from two to three for additional redundancy
  - Design
    - Essentially unchanged
    - Need to determine if “radial build” of larger center stack can accommodate thicker Rogowski coil for ease of mandrel fabrication
  - Documentation
    - Drawings available from archived NSTX engineering drawings
    - Statement of Work for winding available (Airex Corporation)
    - Installation procedure available

Plasma Current Rogowski Coil Mandrel Drawing



Plasma Current Rogowski Coil Winding Drawing



Plasma Current Rogowski Coil Summary (continued)

- Status (continued)
  - Impact of upgrade on diagnostic
    - No temperature issues:
      - To be protected by “microtherm” insulation as on present center stack
    - No mechanical issues:
      - Coils to be held in place with Teflon tape as on present center stack

Flux Loop Summary

- Status
  - Locations
    - Similar to placement on existing center stack
  - Design
    - Two enamel-coated wires at each location for redundancy as on existing center stack
  - Documentation
    - Installation procedure available
  - Impact of upgrade on diagnostic
    - No temperature issues:
      - To be protected by “microtherm” insulation as on present center stack
    - No mechanical issues:
      - Coils to be held in place with Kapton tape as on present center stack

Acknowledgements

- S. Gerhardt
- H. Kugel (original sensor design)
- B. McCormack (original sensor design)
- V. Soukhanovskii
- K. Tresemer (center stack upgrade tile design)
- A. Jariwala (diagnostic layout on center stack)