Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

Engineering & Technical Services Division

DISCLAIMER

LAWRENCE BERKELEY LABORATORY - UNIVERSITY OF CALIFORNIA

ENGINEERING NOTE

CODE	SERIAL	PAGE
P40406	M5651	1 of 9

AUTHOR	DEPARTMENT	LOCATION	DATE
Fred Perry	Mechanical Department	Berkeley	5 Feb 1981

PROGRAM — PROJECT — JOB

PEP-4

FIELD CAGES

TITLE

SMALL RADIUS COARSE FIELD CAGE

This note is a summary of the problems that were encountered and corrective action taken in the construction of the small radius coarse field cage at Lawrence Berkeley Laboratory. For insulation work done at Sheldahl see Engineering Note P40406 M-5653, Drawing No., Engineering Notes and pictures that pertain are listed below and sketchs are at the end of this text.

Engineering Notes:
P40406 M5425B
P40406 M5510

Mandrel	19Q2804
Sheldahl Ins Assy	19Q2784
S.R.C.F.C. P.C. Board Assy	20C0046
S.R.C.F.C. Machine Detail	20C0316
Membrane Support	20C0886
Anti tracking Shields	20C1426B
Special resistors & Spark Gaps Assy	20C4496
S.R.C.F.C Assy	20C0446
Pictures	X100 Print Room B90 Rm. 2004

(1) The insulator arrived from Sheldahl @ Bldg.77 Feb 6, 1980. After opening shipping container inspection revealed slight damage @ one end of insulator. This was caused by a weak mandrel support block in shipping container. It was determmined that the damage was minor and most of it would be trimed off in machining insulator to length.

(2) The machine shop @ Bldg.77 machined the insulator to length according to drawing 20C3106 and Engineering Note P40406 M5425B.

(3) Assy. Shop Bldg.77 prepared insulator according to Engineering Note P40406 M5425B and epoxy glued on printed circuit boards which were aligned on insulator using aligning bar 20C6214.

(4) What appeared to be air bubbles trapped between the 0.001 kapton layer that was glued on @ Sheldahl & P.C. Boards, was noticed after cure. Holes were drilled through P.C. Boards just to kapton layer and filled with epoxy to eliminate air bubbles. After approximately two days of no success it was determined that the P.C. Boards adhered to the 0.001 kapton but the kapton had lifted from the mylar insulator. The P.C. Boards along with the kapton layer were removed from the insulation. Physics department latter determined that the kapton layer would be detrimental to the insulator anyway. So, one set P.C. boards

had to be scraped because the kapton could not be removed from the boards.

(5) A second set of P.C. Boards were glued on as above. (No kapton) Tined copper wire No. .26 gage 0.016 dia was wound on a frame @ the proper spacing using assembly shop Bldg.77 wire winding machine. The copper wire was then transfered from the frame to the insulator. The 5 mm spacing of wires were kept from moving by using quick set epoxy on each wire approximately every 15° arround the cylinder. The spacing of wires was checked and then soldered to printed circuit boards and proceeded as to Engineering Note - P40406 M5425B.

(6) The insulator was wraped with 0.012 x 12" wide fiber glass tape to a total of 3/16 thick and then placed in casting cylinder drawing 20C0516 and proceeded according to Engineering Note P40406 M5425B.

NOTE Many epoxy casting compounds were tested in the test chamber in Bldg.80. They all poisoned the gas to some degree. It was decided to use the tonox mixture that assembly shop Bldg 77 was accustomed to using and latter seal it off from the gas by using two layers of kapton over the epoxy casting.

After the casting had cured inspection revealed a large void midway on the cylinder it was hoped that it would clean up in machining the O.D.

But it was nonviable. It was determined that we could eliminate the void by recasting. The brass tubes were recaped and the insulator was placed back into the casting cylinder and recast. After removal from the casting cylinder and machining it looked perfect but under close inspection the ends had delaminated from insulator approximately 4 to 6 inches.

(7) It was decided to remove the mandrel. A serious problem arose in that no provision was made on the mandrel to drop the central key (the mandrel was designed by Sheldahl) the key was finally removed using crow bars and luckly no damage was accrued to the insulator. (Thanks to the highly skilled assy shop technicians.)

With the insulator demandreled the I.D. was measured for shrinkage and it was found that it had shrunk approx. 0.024 on the diameter. The outer Fiber glass cylinder which was delaminating was closely watched. After two days the delamination had reached midway of the insulation. The outer fiber glass cylinder was subsequently striped from the insulator. It was then noticed that some of the mylar insulator had delaminated and approx 3 1/2 layers of mylar were also removed. It was assumed that the reason for mylar delamination was caused at Sheldahl due to method or proceedures which had not

been perfected. A discussion arose if it would be feasible through heat and pressure to relaminate. A test was made on a sample see Engineering Note P40406 M5510.

(8) The test proved without a doubt that we could not improve the integraty of the insulator in this manner.

(9) On April 4, 1980 a meeting was held to decide how to proceed with small radius insulator. Attendees were: Allen Bross, Larry Brown, Owen Chamberlain, Otto Draeger, Ron Madaras, Jay Mark, Dave Nygren and Fred Perry.

It was decided at this meeting that we would use the insulator as is and try again. It was determined that if the mylar insulator did no further delamination the insulator would meet physics requirements.

The following additional steps were taken:

A. The 2 mm gap between the end of the insulator and the stainless steel end ring will be ventilated to the 10 atmosphere gas volume, and will not be filled with epoxy.

B. A wet lay-up will be done to make a new G-10 cylinder around the insulator.

C. A new Small-Radius Insulator will be made. The plans for this should proceed with minimum cost.

D. The following steps will be taken with the present Small-Radius Insulator in order to complete it:

1. Try to roll out the voids near the ends.

2. Sand off the bump on one end.

3. Measure ellipticity of the insulator, both inside and outside. Engineering to prepare a written status report.

4. Install a new hub assembly.

5. Depending on the results of step (1), vacuum pump on both ends simultaneously (either at step 1 ? or after the wet lay-up).

6. Paint ends with silver paint (radial stripes covering 50% of the area).

7. Determine azimuthal and longitudinal orientations.

8. Paint on central silver stripe and measure total central stripe resistance.

9. Epoxy on G-10 printed circuit boards. Check continuity and hi-pot.

10. Solder copper wires to printed circuit boards.

11. Solder in pins. Check continuity and hi-pot.

12. Seal ends temporarily with weather striping.

13. Wet lay-up. Using versimad 140 EPON 820.

14. Grind cylinder with distilled water. BLOCK OFF ENDS so that water does not come in contact with the ends of the insulator.

15. Check continuity and hi-pot.

16. Continue with the standard procedure (M5425B by Fred Perry) at this point.

(10) The Insulator was mounted on a spider. Drawing No. 20C7006 and the same procedure as previous had to be repeated. Printed circuit boards wires etc. A epoxy versimad 140 EPON 820 wet lay up of fiber glass cloth was used this time instead of a casting. This also solved the problem of poisoning the gas. No sealing off with kapton would be required. Fiber glass cloth could not be obtained in width required so it was sewed together. Dona Jones did the sewing.

I would like to mention here the dedication and craftmanship of assembly and machine shop personnel at Bldg.77 to meet the rigid schedule and seemingly impossible task of constructing this product.

(11) The O.D. of cylinder was rough turned and finished by grinding within ±.002. Deionized water obtained from Bldg.70 was used for the coolant in machining which is the purist water to be found at L.B.L. great care was taken that no water entered the mylar insulation through the ends. After machining was completed, the insulator was returned to assembly shop were it was thoroughly dryed out inspected and prepared for glueing on kapton anti-tracking sheilds.

(12) A problem arose with the anti tracking shields Drawing No. 20C1426B and punching template 20C1676C the anti tracking shields were already completed as designed but the printed circuit boards were now at a different depth than original

design. This was caused by the 3 1/2 mylar layers that were previously removed from the insulator which in turn changed the radial distance. In any case the copper pads and prepunched holes no longer lined up with the holes in insulator. Solution: the holes were elongated on anti tracking sheilds by hand using a razor blade and electrical connection was made by using small strips of copper wire and bridge soldered to pins. Note: anti tracking shields Drawing No. 20C1426B and punching template 20C1676C will require a dimensional check if another S.R.C.F.C. is constructed.

(13) Field cage membrane support Drawing No. 20C0896 and 20C0886. At the two thin sections 0.015 thick the 0.002 copper was increased to 0.010 for rigidity this was approved by physics. The 0.193 copper clad both sides nema-G10 should be machined to 0.023 thick and then glue the 0.002 copper at these areas. The support blocks were glued in place and the I.D. was bored as a single unit 0.030 larger than the O.D. of the insulator. A fixture had to be made to support it for maching. The connector rings 19C9856 and 19C8156 I.D. were Also machined 0.030 larger. Note: The I.D. of membrane support and connectors had been left under size because we didn't know what the final O.D. of the insulator would be.

(14) Inner field cage aligning ring assy Drwaing No. 20C1586 was used to locate and hold for glueing membrane support 20C0886 and all support blocks for fine field cage. (See Small Radius Coarse Field cage assy Drawing No.20c0446.)

The method with which aligning fixture 20C1586 was employed: The aligning fixture was orientated correctly on insulator from scribe line on fixture to holes in outer cylinder. The fixture was set away from the center line so items 2 & 5 were approx. 0.030 over correct location for glueing membrane support and the fixture was clamped in place. The insulator with fixture clamped in place was taken to machine shop Bldg 77 and placed in a lathe and items 2 & 5 were machined perpendicular to the insulator and at the correct distance from end of insulator. Note: all work done on insulator. Spider support Drawing 20C7006 was used which was locked in place.

(15) After machining was complete the insulator was returned to the assy shop were membrane support Drawing No. 20C0896 was sliped over insulator glue applyed and clamped to aligning fixture. After glue had cured and fixture removed the membrane support pads were checked for being perpendicular to insulator and found to be within ±0.0005 which I thought was amazing. The fixture was also used to locate fine field cage support blocks using 0.125

dowel holes. The fixture was clamped in the right location and the appropriate block with glue applyed was then placed between dowel pins and clamped in place until cured.

(16) The North and South connectors 19C9856A, 19C8156 respectively were found to be 0.039 to thick. This was a design error which turned out to be a blessing in disguise. The connectors were set out 0.039 further and glued. They were then machined parallel and perpendicular and true position to membrane support within ±0.002.

Other work that was required on connectors was done by hand using router file drill etc. A relief for fine field cage, vent holes wiring holes etc. this work can be seen in pictures taken during construction and are shown in file number X100 Bldg. 90 Room 2004, Print Room.

(17) Electrical work resistors spark gaps, wiring, and capacitors along with a schematic for proper location were supplied by the Physics Department. The coordinators for this work were Ron Madaras, Allen Bross, and Owen Chamberlain and for further details these people should be contacted.

(18) In Conclusion to this Engineering Note, there are some basic procedures that should be followed if another small radius coarse field cage is constructed.

(A) On arrival, the insulator mandrel drawing 19Q2804 should be removed and insulator inspected for damage. Spider assy drawing 20C7006 should be installed and used for all further work.

NOTE: Mandrel key has been modified. The key has 3/8 - 16 taped holes so it can be jacked off and removed from mandrel.

(B) Deionized water should be used for coolant for all machining.

(C) Epoxy EPON 820 versimad 140 fiber glass wet lay up should be used for outer cylinder.

NOTE: Fiber glass cloth should be full width, probably will need to be sewed together, not tape. A wet lay up can also, be used on inner cylinder.

(D) For rest of procedure follow Engineering Note P40406 M5425B

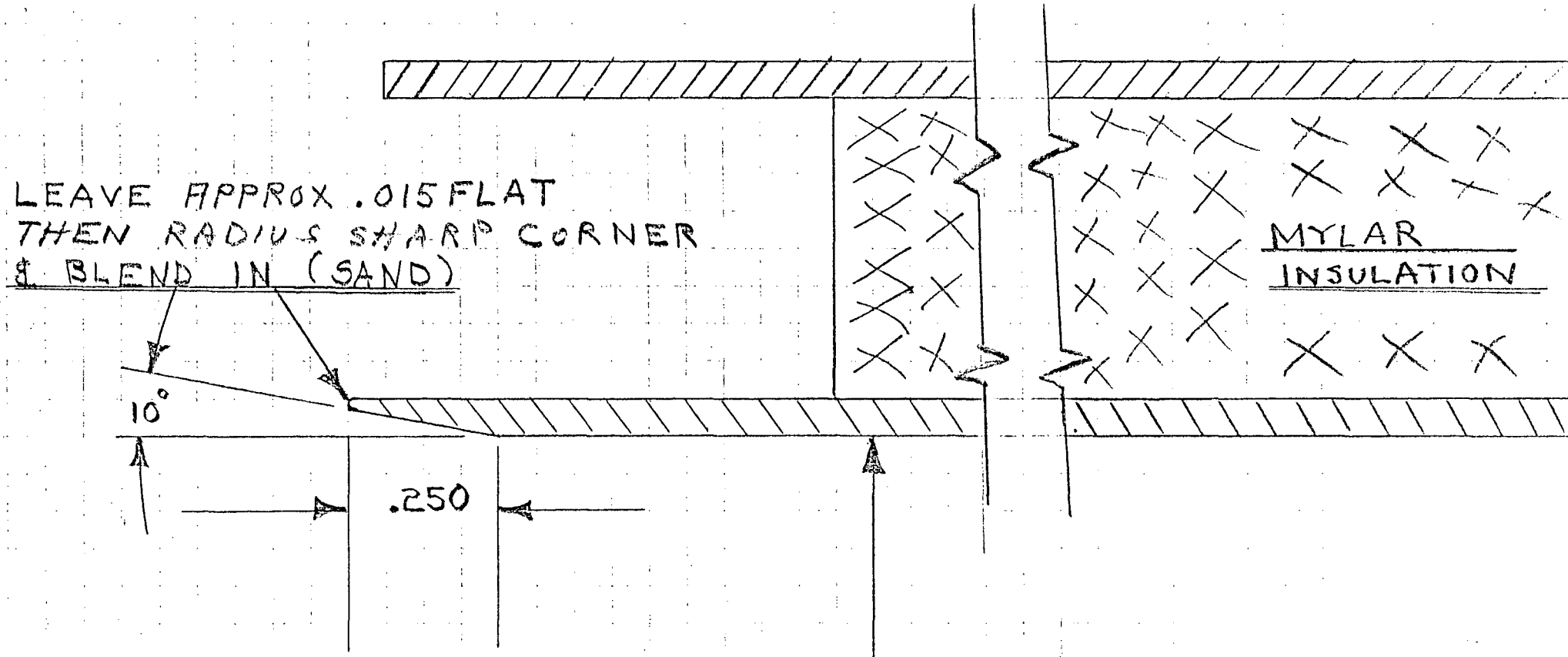
/nyc

REFER QUESTIONS
TO FRED PERRY EX-5041

SCALE - 4/1

Serial M5651

Code P40406



MACHINING DETAIL FOR CUTING ANGLE ON INNER CYLINDER SHOULD BE INCLUDED IN 20C0316 MACHINING DETAIL

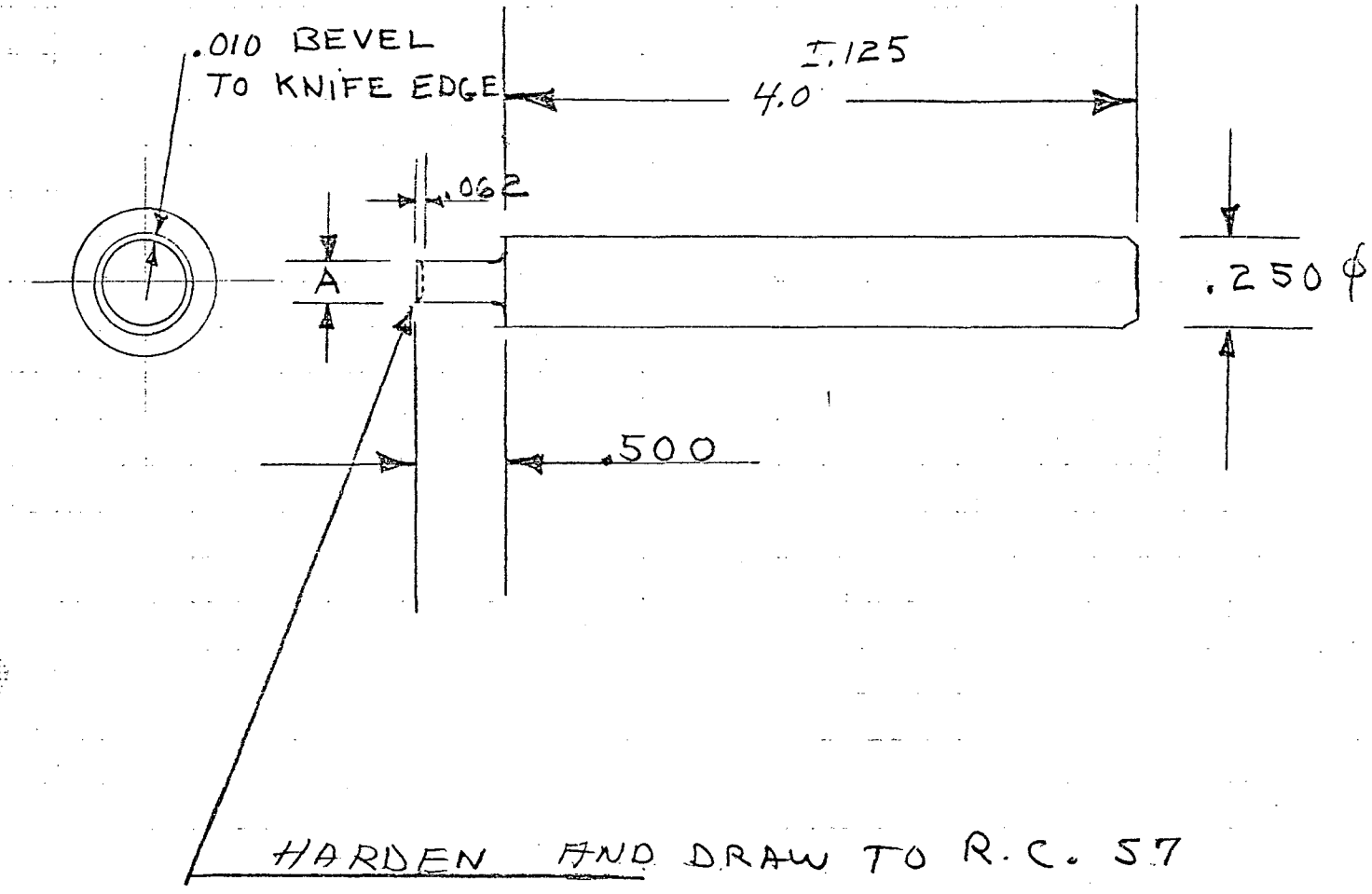
I.D. OF NEMA G10 INNER CYLINDER
15.750

FRED PERRY
EX 5041 BLDG 90/2065

037417 8 of 9
7918-41

MATERIAL TOOL OIL
HARDING STEEL

M-A	.082 +.0000 .128 -.0005	MAKE - 8 4 OF EACH DIM A

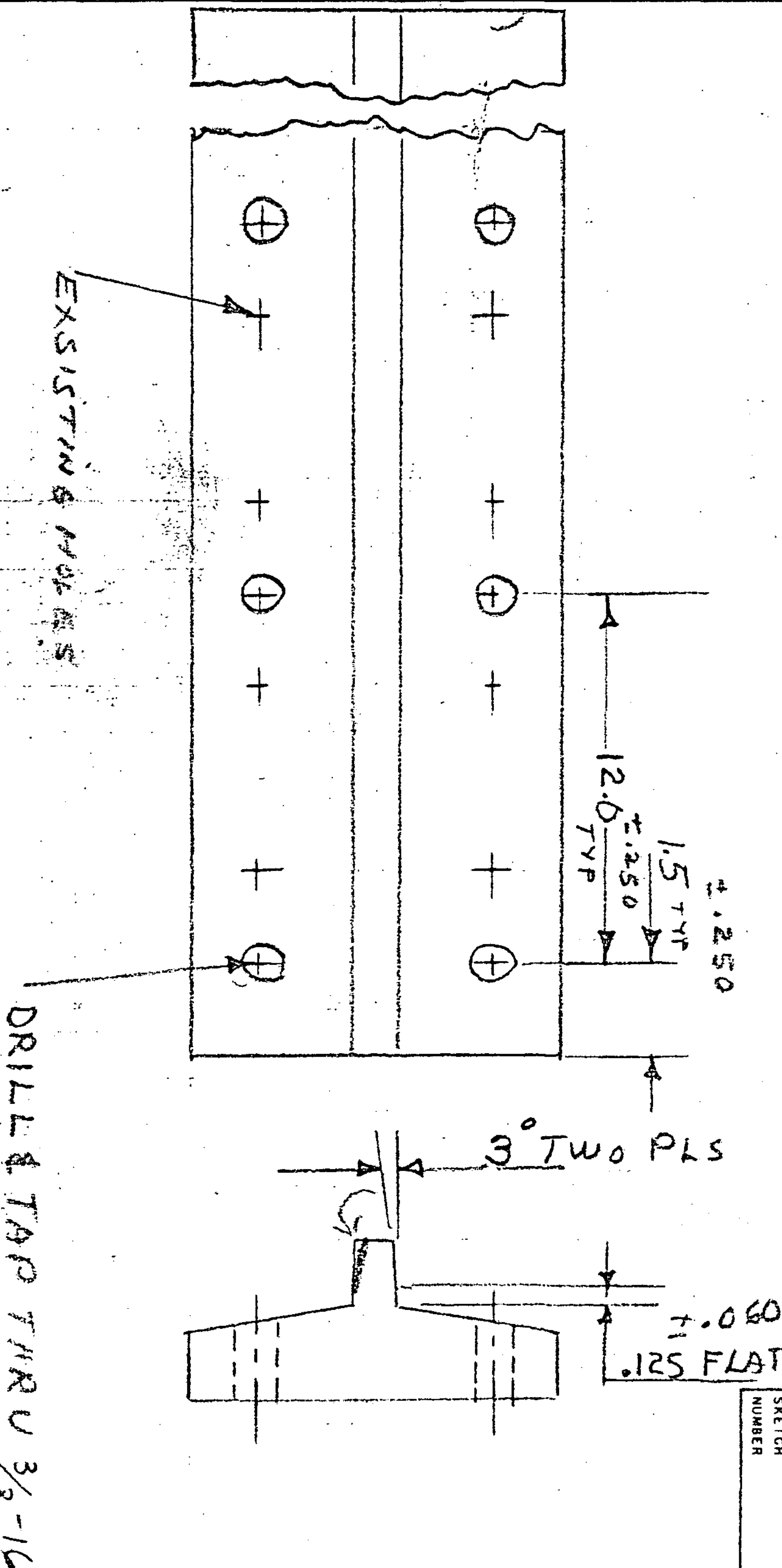


COOKY PUNCH

USED WITH KAPTON PUNCHING
TEMPLATES 20C1676C & 20C2456C

SUBJECT SMALL RADIUS FIELD CAGE MANDREL	SKETCH LAWRENCE RADIATION LABORATORY UNIVERSITY OF CALIFORNIA	JOB ORDER INFORMATION	JOB NO.	TAG NO.
DRAWN BY Fred Perry			SERIAL NO. 7918-41	NO. REQD. 1
DATE 4/4/80	BUILDING NO. ROOM NO.	APPROVED BY	DATE	DATE ISSUED SK50492 / DELIVER TO

MANDREL KEY
REF. DRAWING 19Q2804



Rework

SKETCH NUMBER

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720