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BNWL-1376
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CHEMICAL-MECHANICAL CLEANING
OF SMALL-DIAMETER TUBING

R. R. Studer

May 1970



AEC RESEARCH & DEVELOPMENT REPORT

	P.R. NO.	LOCATION	FILE-ROUTE DATE

BNWL-1376

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BNWL-1376
UC-37, Instruments

CHEMICAL-MECHANICAL CLEANING
OF SMALL-DIAMETER TUBING

By

R. R. Studer

FFTF Fuel Department
FFTF Division

May 1970

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CHEMICAL-MECHANICAL CLEANING OF SMALL-DIAMETER TUBING

R. R. Studer

INTRODUCTION

Assuring internal cleanliness of small-diameter tubing has been a continuing problem. One effective cleaning method requires prolonged, vigorous brushing. A machine was designed to perform this operation.

SUMMARY

One requirement of FTR fuel cladding tubes is freedom from contaminating substances, particularly on internal surfaces. Other technical requirements of the tubes can only be met by tube manufacturing methods which, inherently, make cleaning difficult. Visual or mechanical examination of small-diameter tubes to determine presence or absence of gross soils is uncertain and may be damaging. The best assurance of uniform cleanliness is a completely effective cleaning operation. Such an operation has been developed, and a brushing/rinsing machine has been designed to make it practical. The machine was designed to give maximum protection to the tube being cleaned.

DISCUSSION

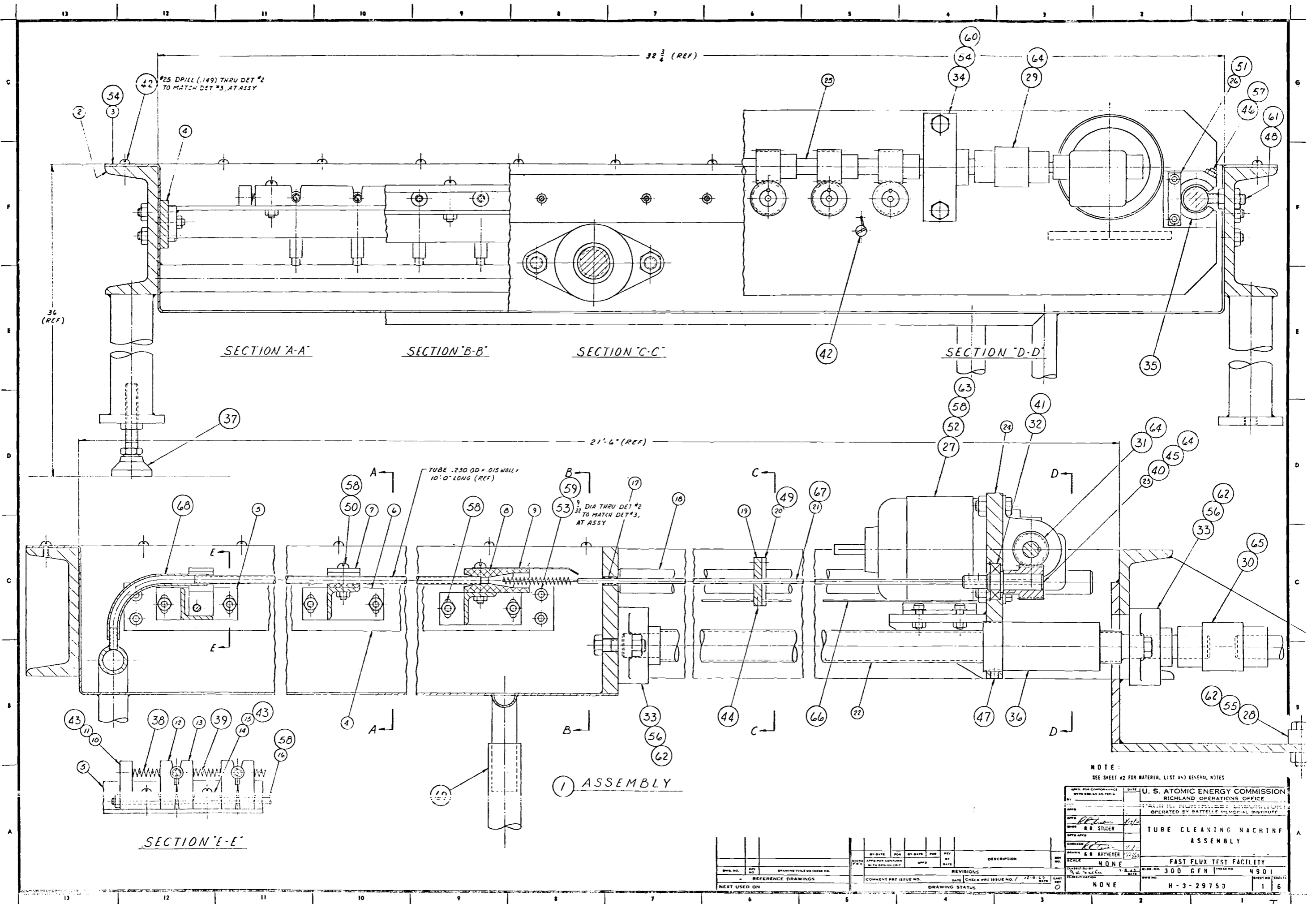
FTR fuel cladding is furnished as small-diameter, 300-series stainless steel tubing. The tubing is finished and used in the 20% cold-drawn condition. Dimensional requirements make free-sink drawing to final size impractical. Mandrel drawing is likewise impractical because reeling to free the mandrel induces dimensional and residual stress changes in the tube which compromise the validity of ultrasonic and eddy current nondestructive testing results.

All quantity production of FTR developmental fuel cladding has employed fixed plug drawing to achieve the final 20% cold-worked condition. Plug drawing is capable of producing dimensionally accurate and metallurgically sound tubes, but suffers as a production operation from the extreme demands it places on lubricants, particularly when drawing small-diameter tubing. Industry has developed complex lubricant systems which can function satisfactorily under the severe temperature and pressure conditions existing at the plug-tube interface. Unfortunately, the tenacity which makes the lubricants effective also complicates their removal.

The lubricants are typically based on chlorinated polymers and chlorinated oils. Known and demonstrated effects of both chlorine and carbon contamination on the integrity of FTR fuel cladding makes complete removal of lubricants mandatory. The lubricants are uncommonly resistant to the action of common solvent and emulsifying cleaners, and the small bore of the tubes further inhibits their effective use. The usual inspection methods are incapable of determining presence or absence of lubricants and their decomposition products. The only assurance of having clean tubes at the fuel pin assembly operation lies in the development of a completely effective cleaning procedure. The most successful sequence of operations for removing lubricants, their decomposition products, and shop soils from the bore of small diameter tubing combines soaking in a (proprietary) cleaner with subsequent vigorous brushing. The cleaner has both solvent and emulsifying action and loosens the most adherent soils, but vigorous brushing under running water is required to obtain clean rinsing. The brushing/rinsing machine, detailed in Drawings H-3-29753, Sheets 1 through 6, makes the use of the described cleaning method practical for cleaning production quantities of tubing.

The machine incorporates a manifold to introduce a constant supply of clean rinse water to the bore of the tube while the rotating brushes are advanced and retracted under the control of timing and travel limit switches. One end of the tube-handling mechanism serves to guide the brushes into the tube bore, and traveling shaft supports prevent whipping or deflection of the brush shafts as they rotate at approximately 100 rpm. The shafts themselves are covered with heat-shrinkable Teflon to protect the inner surface of the tubes. All parts of the machine contacting the tubes are of plastics.

The electrical controls are adjustable for cycle time and for length of stroke to 10 feet maximum. Operator labor is reduced to loading and unloading the machine. An added advantage of mechanical brushing and rinsing is the assurance that every tube receives an adequate cleaning.



#25 DRILL (.149) THRU DET #2 TO MATCH DET #3, AT ASSY

TUBE .230 OD x .015 WALL 10'-0" LONG (REF)

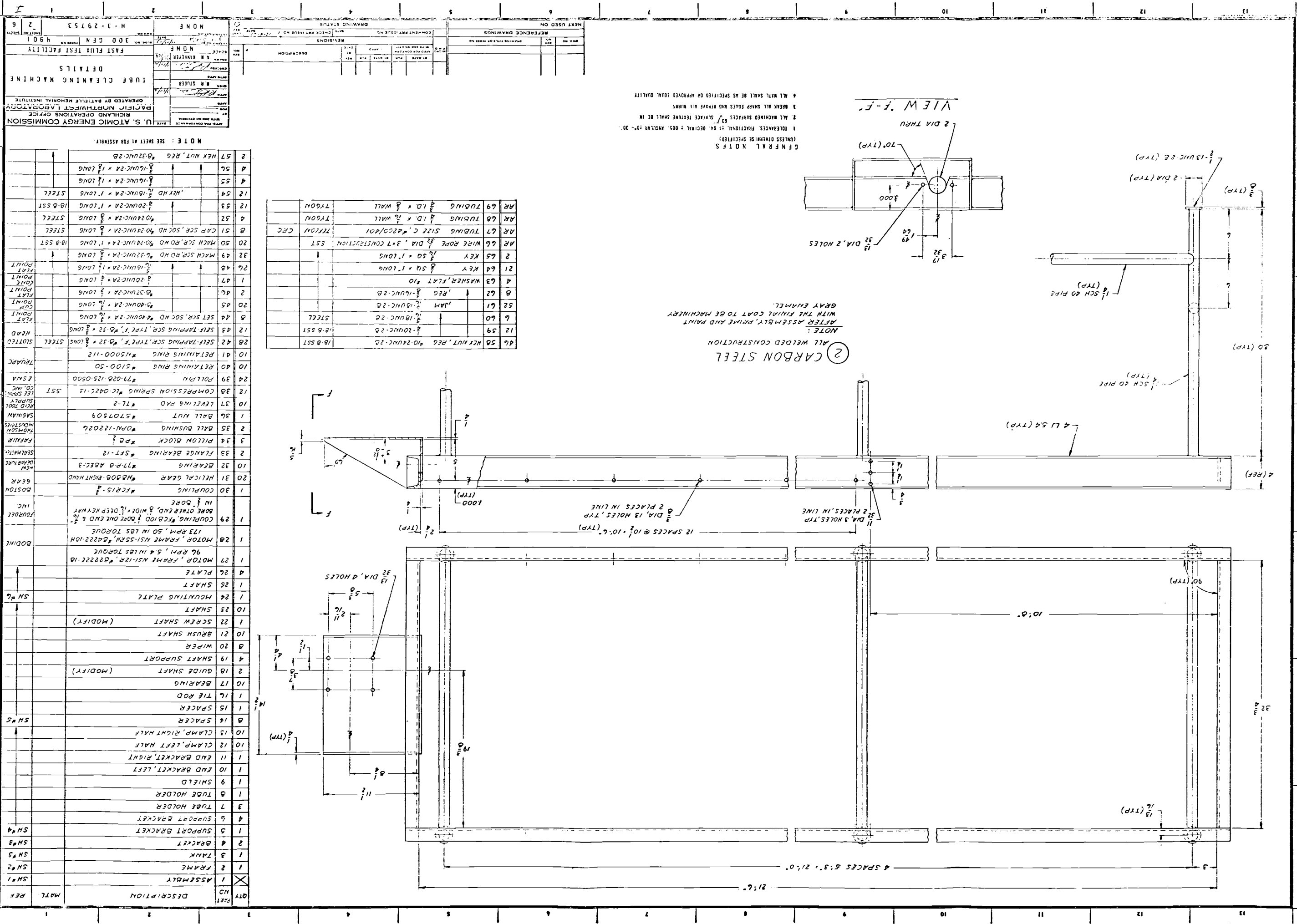
3/32 DIA THRU DET #2 TO MATCH DET #3, AT ASSY

1 ASSEMBLY

NOTE:
SEE SHEET #2 FOR MATERIAL LIST AND GENERAL NOTES

APPROVED FOR CONFORMANCE WITH DESIGN CRITERIA	DATE	U. S. ATOMIC ENERGY COMMISSION
BY		RICHLAND OPERATIONS OFFICE
APP'D		OPERATED BY BATTELLE MEMORIAL INSTITUTE
DRWR		TUBE CLEANING MACHINE ASSEMBLY
DATE		FAST FLUX TEST FACILITY
CHECKED		SCALE NONE
BY		BLDG. NO. 300 GFN
DATE		INDEX NO. 4901
CLASSIFICATION		SHEET NO. 1
		TOTAL SHEETS 6
		H-3-29753

REV. NO.	REV.	DATE	DESCRIPTION	BY	CHKD.	DATE
1	REFERENCE DRAWINGS					
REVISIONS						
DRAWING STATUS						



QTY	PART NO.	DESCRIPTION	MATL
1	SM#1	ASSEMBLY	
1	SM#2	FRAME	
1	SM#3	TANK	
2	SM#4	BRACKET	
1	SM#5	SUPPORT BRACKET	
4	SM#6	SUPPORT BRACKET	
3	SM#7	TUBE HOLDER	
1	SM#8	TUBE HOLDER	
1	SM#9	SHIELD	
1	SM#10	END BRACKET, LEFT	
1	SM#11	END BRACKET, RIGHT	
10	SM#12	CLAMP, LEFT HALF	
10	SM#13	CLAMP, RIGHT HALF	
14	SM#14	SPACER	
1	SM#15	TIE ROD	
10	SM#17	BEARING	
2	SM#18	GUIDE SHAFT (MODIFY)	
4	SM#19	SHAFT SUPPORT	
1	SM#20	WIPER	
10	SM#21	BRUSH SHAFT	
1	SM#22	SCREW SHAFT (MODIFY)	
10	SM#23	SHAFT	
1	SM#24	MOUNTING PLATE	
1	SM#25	SHAFT	
4	SM#26	PLATE	
1	SM#27	MOTOR, FRAME NSI-12R, B2222C-18	
1	SM#28	MOTOR, FRAME NSI-55RH, B2222-10H	
1	SM#29	COUPLING, FCD100, BORE OTHER END, 1/2 DEEP KEYWAY IN 1/2 BORE	
1	SM#30	COUPLING, FCR15-3	
1	SM#31	HELICAL GEAR, #HB008-RIGHT HAND	
10	SM#32	BEARING	
2	SM#33	FLANGE BEARING #ST-12	
3	SM#34	PILLOW BLOCK #PB-3	
2	SM#35	BALL BUSHING #OPN-12026	
1	SM#36	BALL NUT #5707509	
10	SM#37	LEVELING PAD #TL-2	
12	SM#38	COMPRESSION SPRING #C-042C-12	
24	SM#39	FOLLY #79-028-125-0500	
10	SM#40	RETAINING RING #S100-50	
10	SM#41	RETAINING RING #N500-112	
28	SM#42	SELF-TAPPING SCR, TYPE F, #8-32 x 1/2 LONG	STEEL
12	SM#43	SELF-TAPPING SCR, TYPE F, #8-32 x 1/2 LONG	18-8 SST
6	SM#44	JAM #10UNC-28	STEEL
2	SM#45	WASHER, FLAT #10	
21	SM#46	KEY 3/4 x 1/2 x 1/2	
2	SM#47	KEY 1/2 x 1/2 x 1/2	
26	SM#48	MACH SCR, RHD #8-32UNC-24 x 1/2 LONG	
32	SM#49	MACH SCR, RHD #8-32UNC-24 x 1/2 LONG	
20	SM#50	MACH SCR, RHD #8-32UNC-24 x 1/2 LONG	18-8 SST
8	SM#51	CAP SCR, SOC HD #8-32UNC-24 x 1/2 LONG	STEEL
4	SM#52	TUBING SIZE C, #200/101	TITANIUM CRC
AR	SM#53	TUBING 1/2 ID x 1/2 WALL	TYGON
AR	SM#54	TUBING 3/4 ID x 1/2 WALL	TYGON
69	SM#55	TUBING 1/2 ID x 1/2 WALL	TYGON

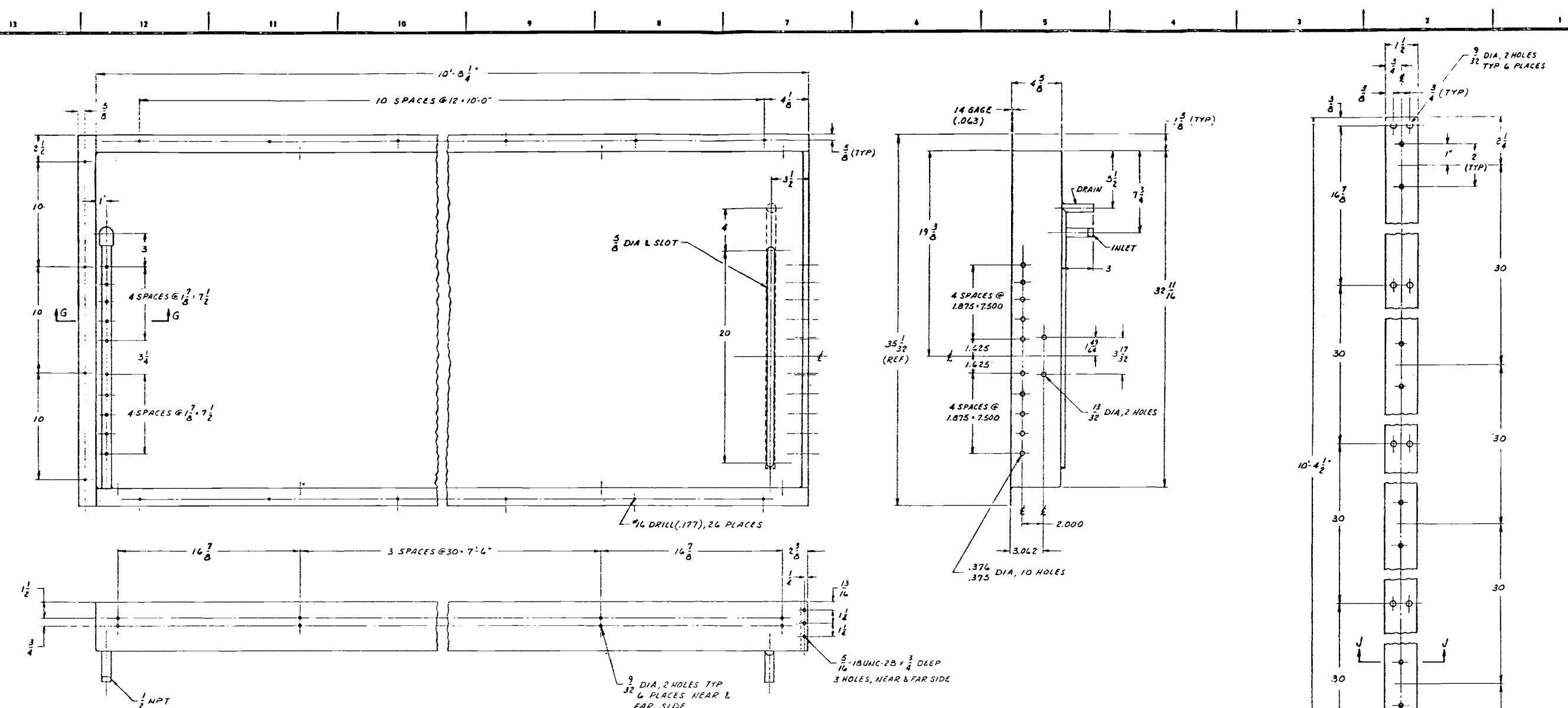
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12	SM#59	10-24UNC-28	18-8 SST
6	SM#60	10-24UNC-28	STEEL
52	SM#61	JAM #10UNC-28	STEEL
8	SM#62	REG #10UNC-28	
4	SM#63	WASHER, FLAT #10	
21	SM#64	KEY 3/4 x 1/2 x 1/2	
2	SM#65	KEY 1/2 x 1/2 x 1/2	
AR	SM#66	WIRE ROPE 3/8 DIA, 3-7 CONSTRUCTION	SST
AR	SM#67	TUBING SIZE C, #200/101	TITANIUM CRC
AR	SM#68	TUBING 1/2 ID x 1/2 WALL	TYGON
AR	SM#69	TUBING 3/4 ID x 1/2 WALL	TYGON

NO.	REV.	DESCRIPTION
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2		REVISED TO SHOW CHANGES

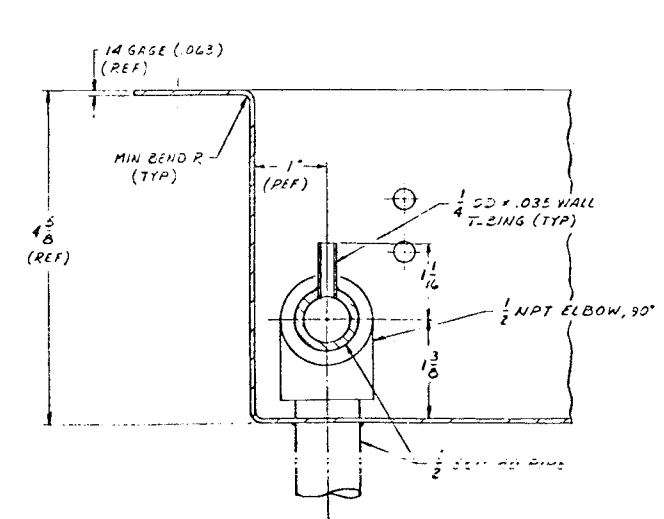
NOTE: SEE SHEET #1 FOR ASSEMBLY

GENERAL NOTES:
 1. TOLERANCES, FRACTIONAL: .125 DECIMAL: .005 ANGLE: .02° .20°
 2. ALL MACHINED SURFACES .03 SURFACE TEXTURE SHALL BE IN
 3. BREAK ALL SHARP EDGES AND REMOVE ALL BURRS
 4. ALL MATL SHALL BE AS SPECIFIED OR APPROVED EQUAL QUALITY

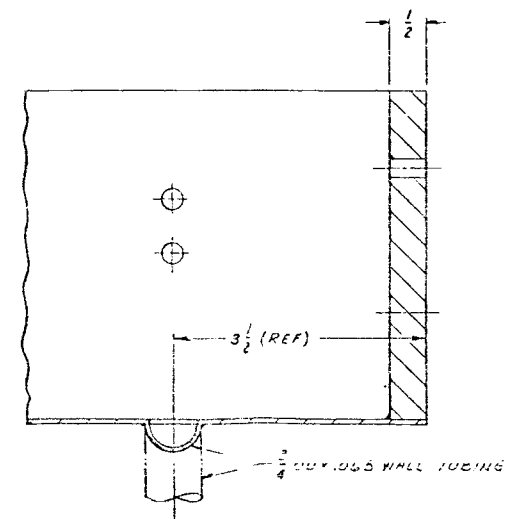
NOTE:
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 CARBON STEEL
 AFTER ASSEMBLY, PRIME AND PAINT
 WITH THE FINISH COAT TO BE MACHINERY
 GRAY ENAMEL



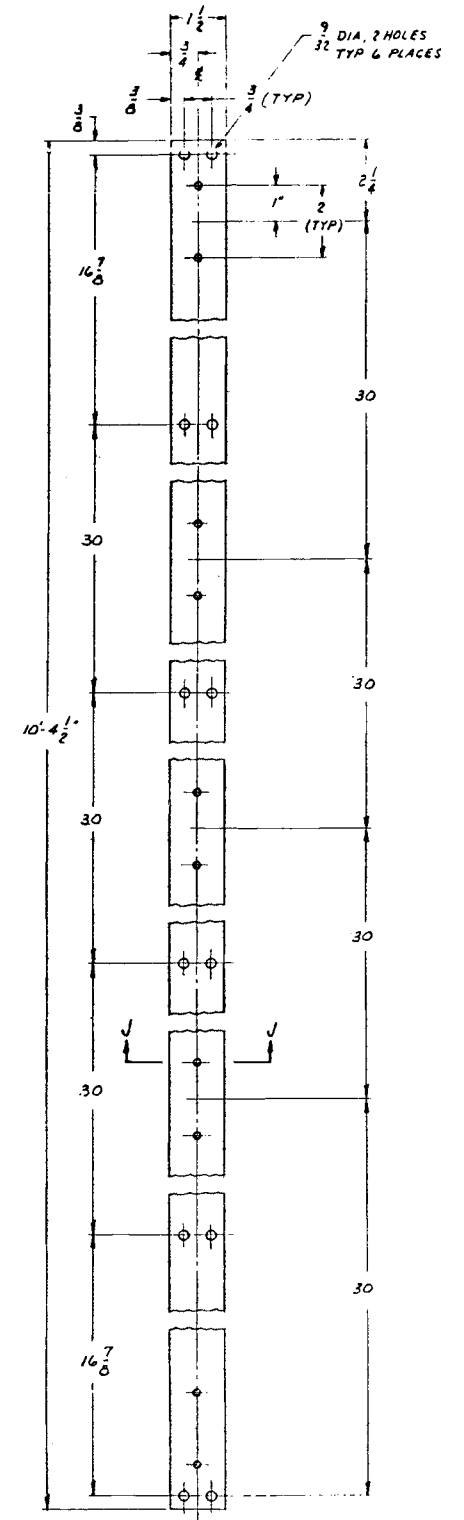
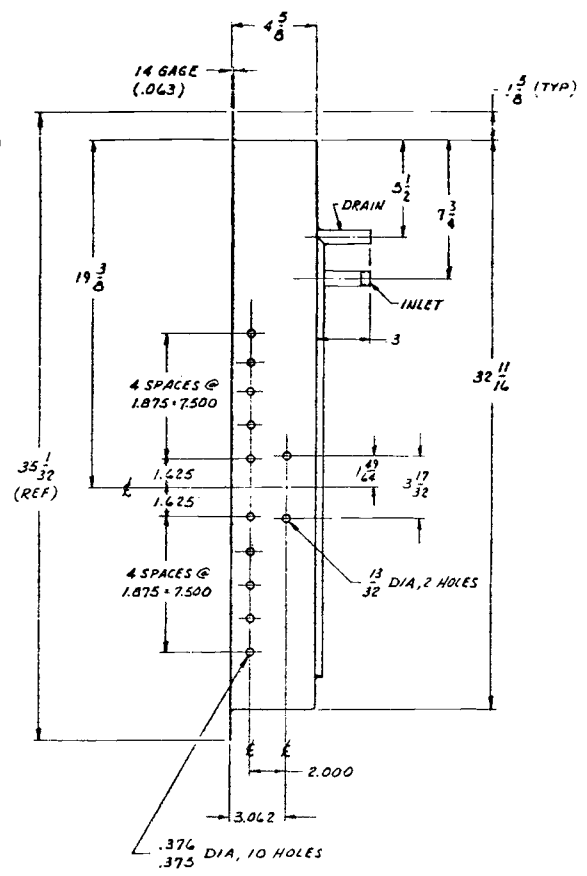
③ 6061-T6 AL
ALL WELDED CONSTRUCTION



SECTION "G-G"



SECTION "H-H"



④ 304 SST
1/4 THICK

NOTE:
SEE SHEET #2 FOR MATERIAL LIST AND GENERAL NOTES

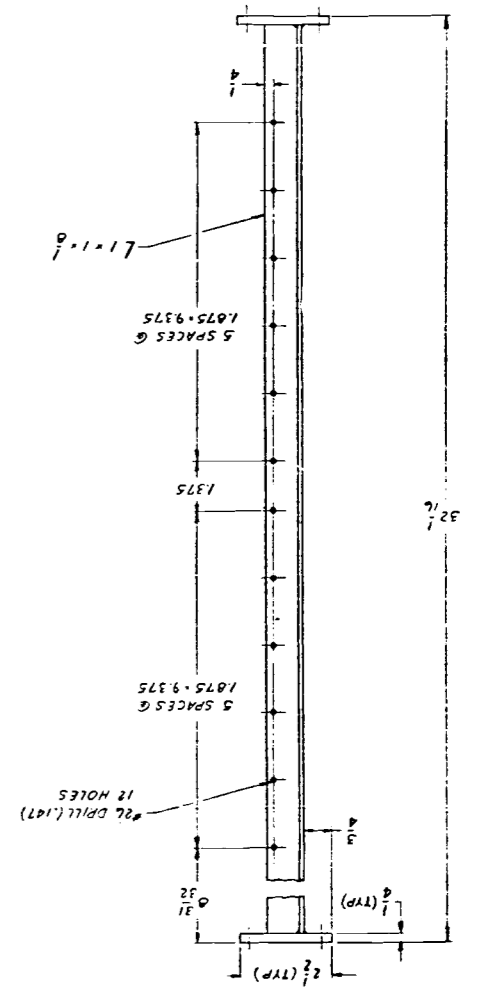
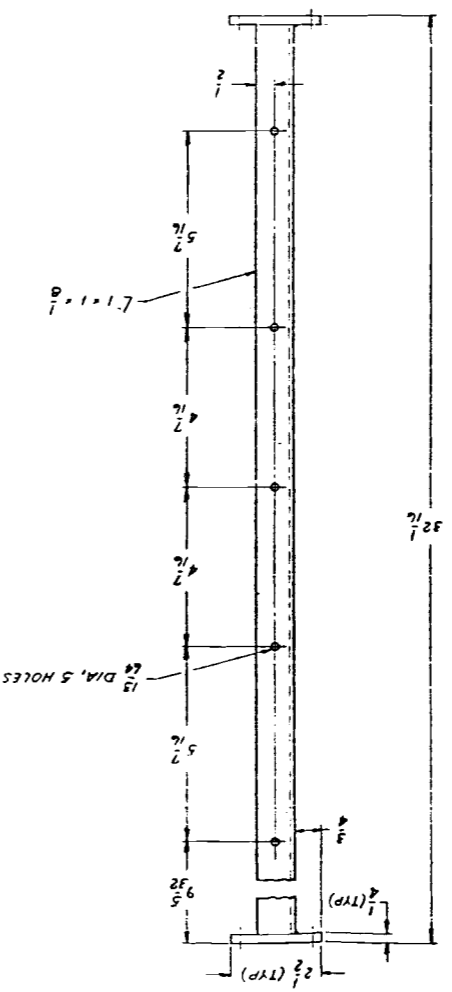
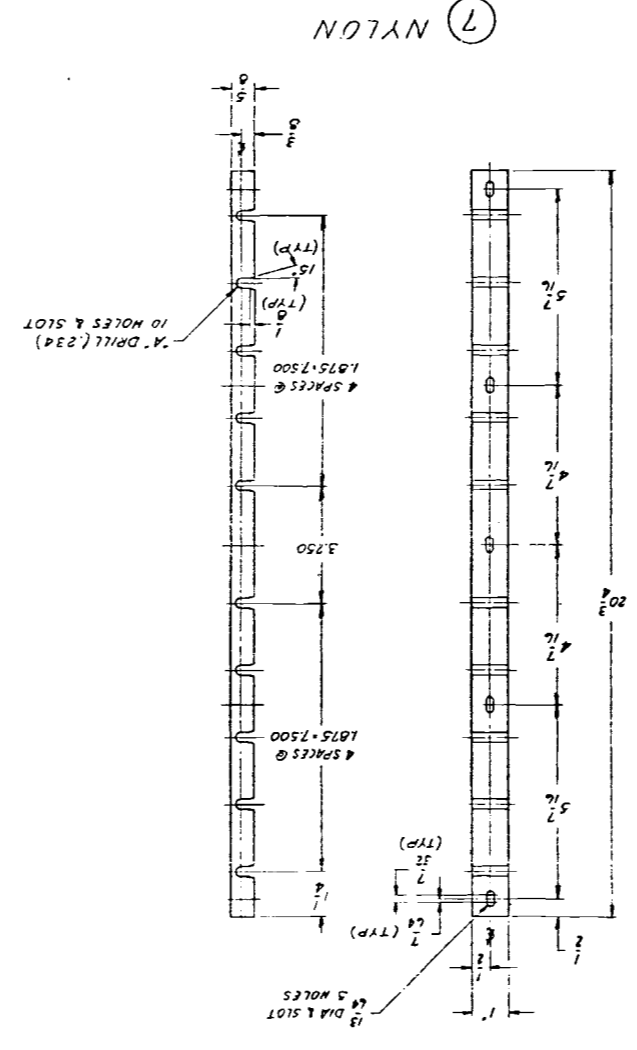
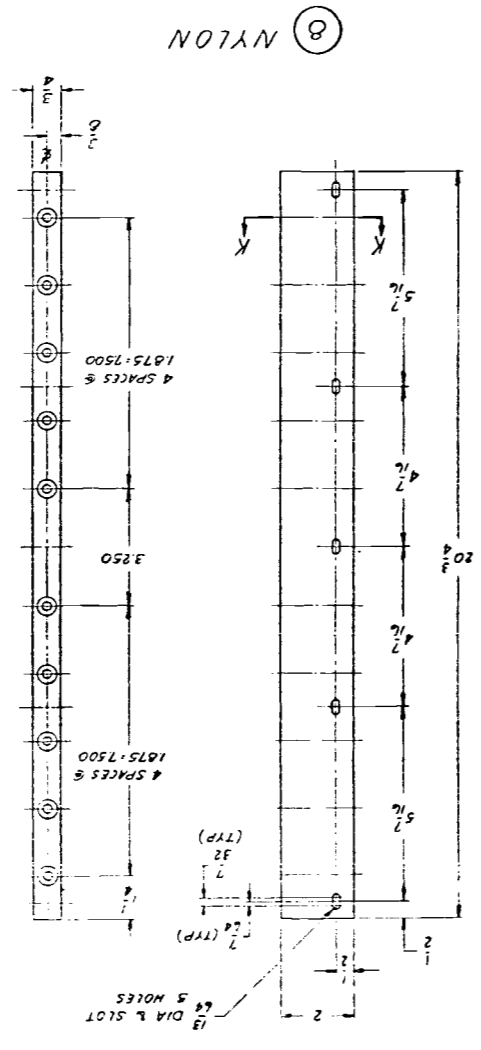
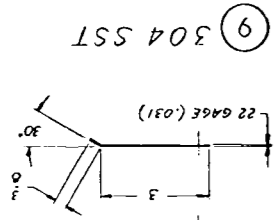
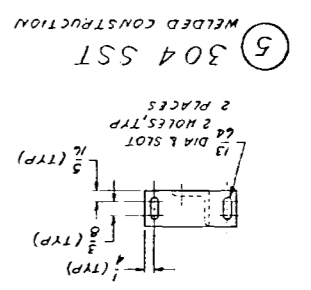
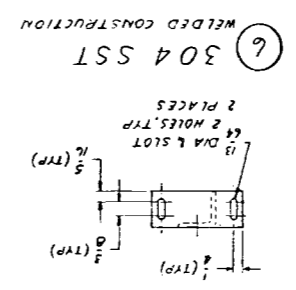
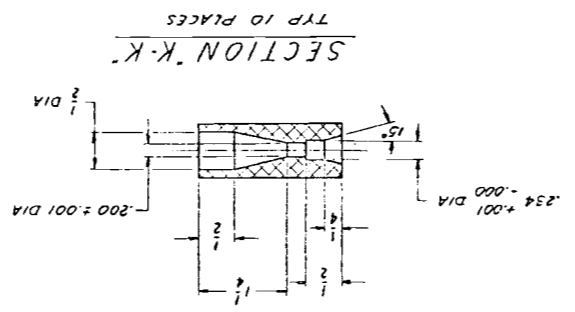
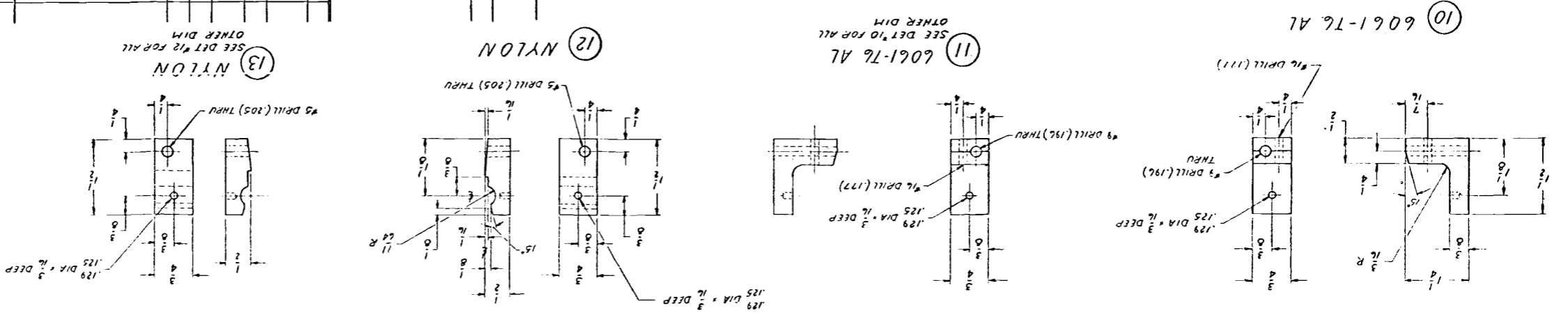
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SCALE		DATE		FAST FLUX TEST FACILITY	
CLASSIFICATION		DATE		SCALE NONE	
NEXT USED ON		DATE		BLDG. NO. 300 GEN	
REFERENCE DRAWINGS		DATE		INDEX NO. 4901	
COMMENT PRT ISSUE NO		DATE		SHEET NO. 36	
DRAWING STATUS		DATE		H-3-29753	

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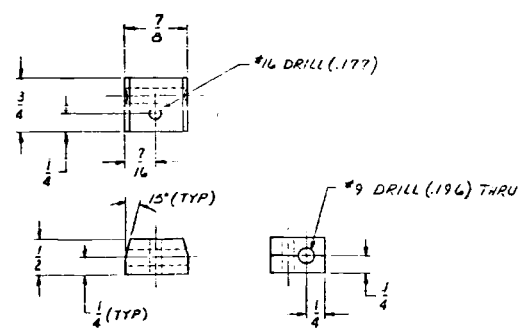
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5	SECTION M-M	5	SECTION M-M
6	SECTION N-N	6	SECTION N-N
7	SECTION O-O	7	SECTION O-O
8	SECTION P-P	8	SECTION P-P
9	SECTION Q-Q	9	SECTION Q-Q
10	SECTION R-R	10	SECTION R-R
11	SECTION S-S	11	SECTION S-S
12	SECTION T-T	12	SECTION T-T
13	SECTION U-U	13	SECTION U-U

U. S. ATOMIC ENERGY COMMISSION RICHLAND OPERATIONS OFFICE OPERATED BY BATTELLE MEMORIAL INSTITUTE	DESIGNED BY R. M. STODEN	DATE 11/20/54
FAST FLUX TEST FACILITY	ENGINEER R. M. STODEN	SCALE AS SHOWN
300 GPN	PROJECT NO. H-3-29753	REV. NONE
FAST FLUX TEST FACILITY	NO. 4901	CLASSIFICATION SECRET

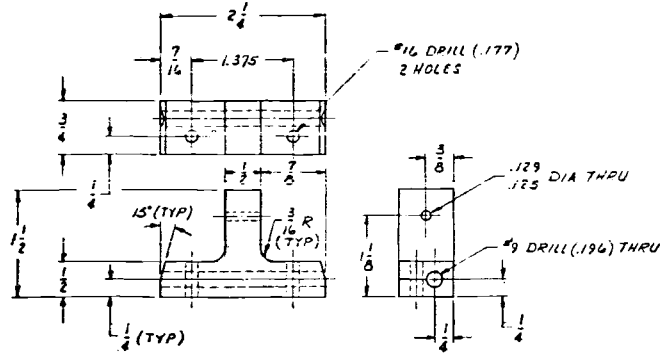
NOTE: SEE SHEET #2 FOR MATERIAL LIST AND GENERAL NOTES



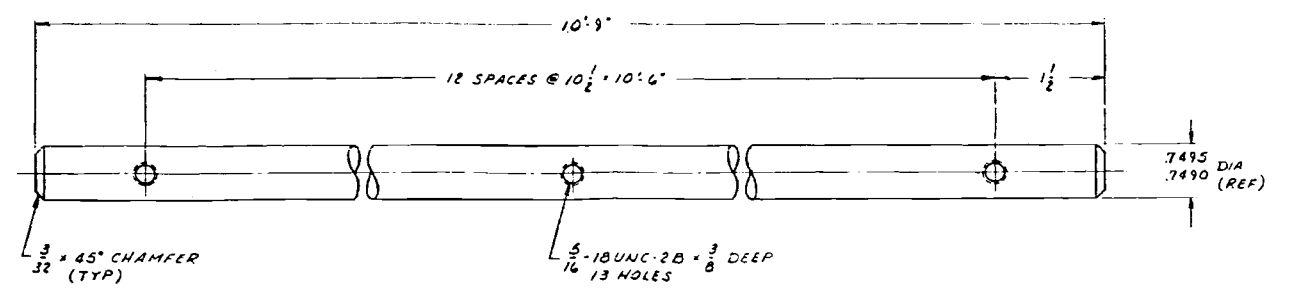
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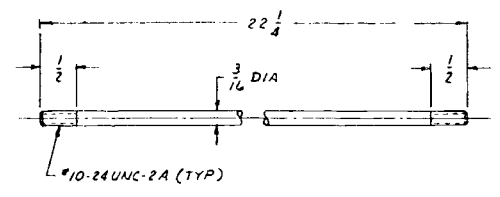
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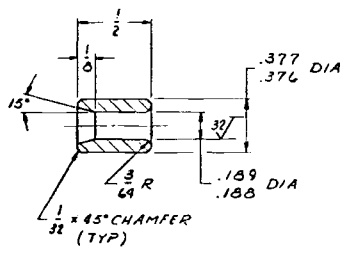
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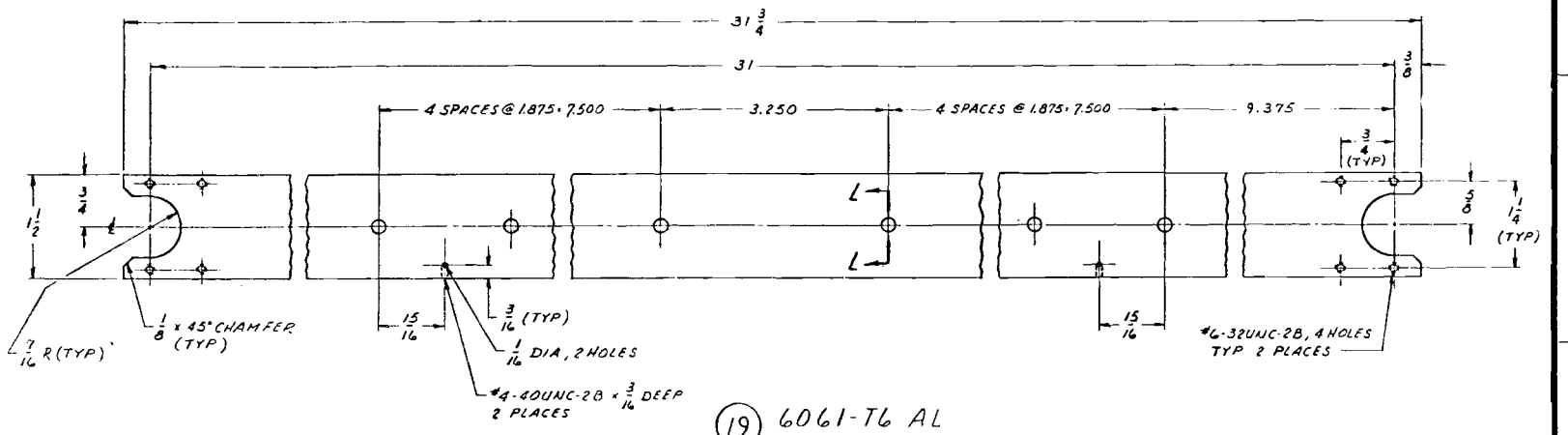
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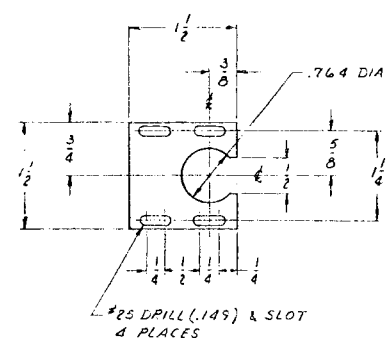
16 304 SST



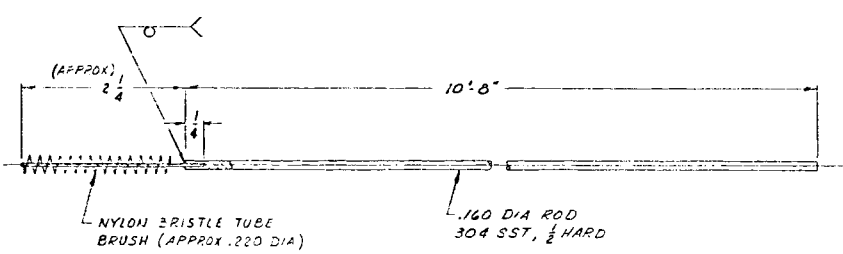
17 304 SST



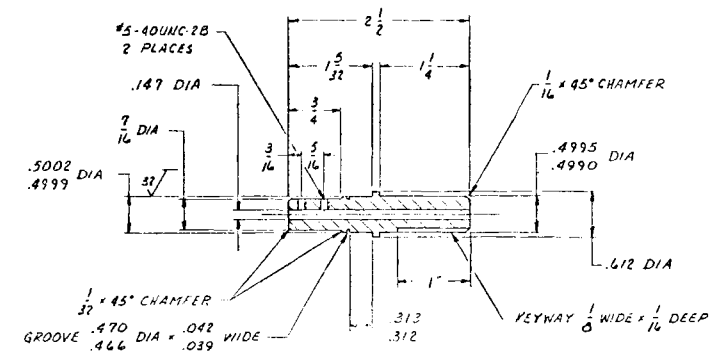
19 6061-T6 AL 1/4 THICK



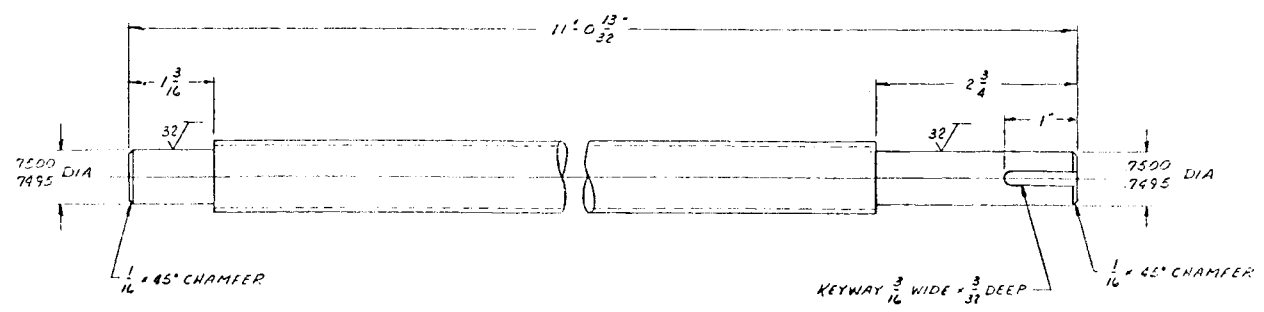
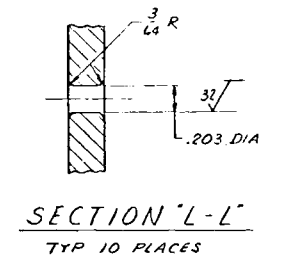
20 TEFLON 1/8 THICK



21 MATERIAL NOTED



23 STEEL



22 MODIFY BALL SCREW "SAGINAW" SZE 1000-1000-SRT, #5706830

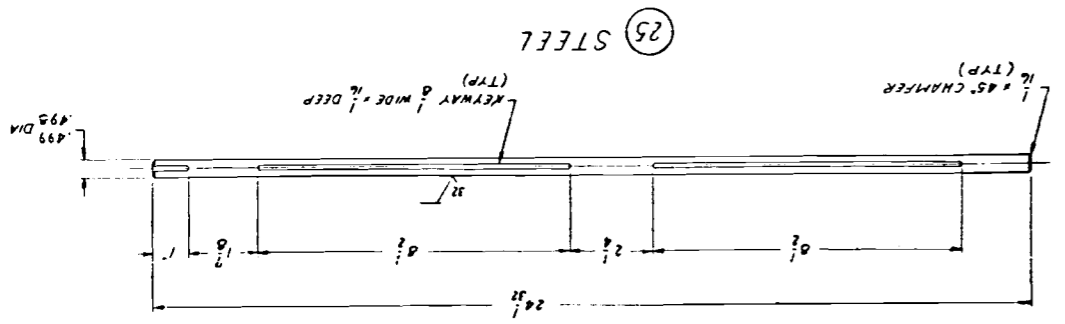
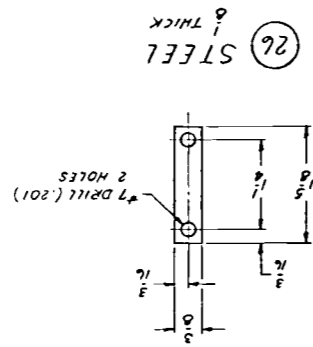
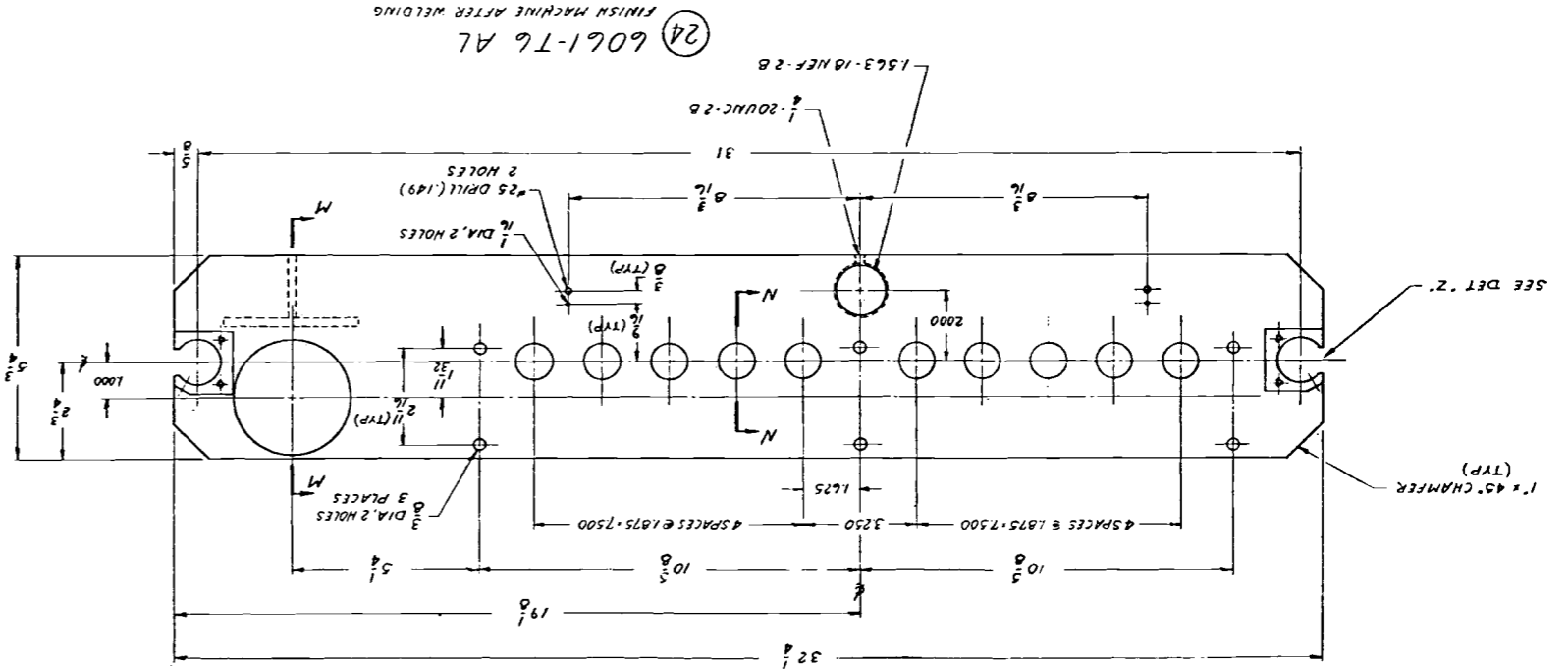
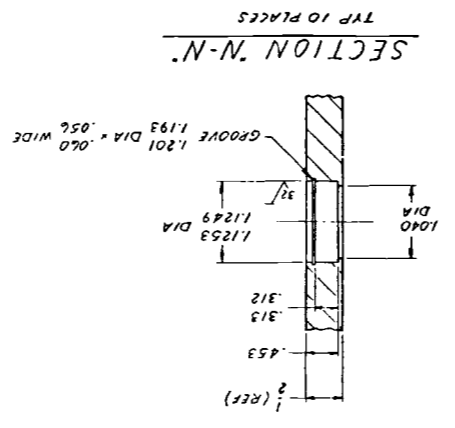
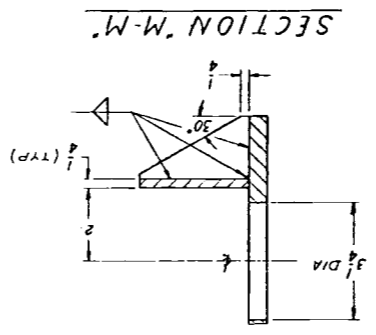
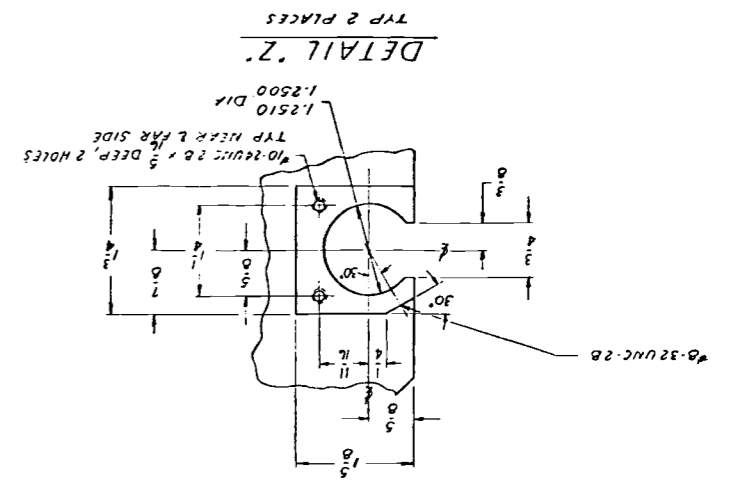
NOTE: SEE SHEET #2 FOR MATERIAL LIST AND GENERAL NOTES

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CHECKED BY: R. R. STUDER		DATE: 11/2/68		TUBE CLEANING MACHINE	
DRAWN BY: R. R. STUDER		DATE: 11/2/68		DETAILS	
SCALE: NONE		CLASSIFICATION: NONE		FAST FLUX TEST FACILITY	
REVISED BY: J. J. SULLIVAN		DATE: 11/2/68		300 GEN 4901	
NEXT USED ON		DRAWING STATUS		H-3-29753 5 6	

REV. NO.	DATE	DESCRIPTION	BY	CHKD.
1	11-2-68	ISSUED FOR FABRICATION	R. R. STUDER	R. R. STUDER
2	11-2-68	REVISED TO CORRECT DIMENSIONS	J. J. SULLIVAN	R. R. STUDER

DRAWING STATUS		DRAWING NO.		DRAWING TITLE	
DATE	BY	NO.	REV.	NO.	REV.
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DATE	BY	NO.	REV.	NO.	REV.
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DATE	BY	NO.	REV.	NO.	REV.
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 SCALE: NONE
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1 Combustion Engineering
 1000 MWe Follow-On Study
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