ELGEMS

Test Report

Subject MG-ATC SOURCE HOLDER TEMP. TEST

Product MG-ATC **Department** Mechanical

Approved by	Yossi A.
Position	Dep. Manager
Date	24/5/99
Signature	

Performed by	Yossi N.
Position	Designer
Date	24/5/99
Signature	

Contents

Appendices
(Mark Relevant Box)

☐ Raw Material

☐ Additional:

Test Equipment

Instrument	Manufacturer / Model	Serial No.	Last Cal. Date
Temperature Meter	COX	2342055C	Good for One Time Use
Temperature Indicator	THERMINDEX / Irreversible Temperature Indicators, Series eight, Interval A	N.A	Good for One Time Use

☐ See additional Test Equipment list

Test Purpose:

We need to prove that the fixture of the source which is glued, using 3M #2216 epoxy, in its holder is stable and reliable and under normal operating conditions the source won't break loose from its holder and endanger the operator nor the patient by uncontrolled radiation.

Test Plan:

We will compare the measured temperature on the source holder during an estimated one day operation of the option at the clinic to the temperature, defined by the supplier of the source and source holder, in which the glue of the source to the holder will **start** to chemically break down.

Test Set-Up:

We estimate that in one-day operation of the option, ten patients are being scanned. Each scan consists of 32 period and each period consists one opening and one closing of the solenoid which is the only part that might get warm in the rod during the operation and effect the temperature of the source holder.
If we calculate, we'll get 320 solenoid periods in one day operation of the option, so to be on the safe side, we execute 500 solenoid periods and we did it continuously without letting the source holder cool down, if at all, between patients as in real clinic operation.
While operating the solenoid, the rod itself remain static without moving
In order to measure the temperature on the source holder we will glue temperature indicators on the middle and both ends of the holder. This indicator behaves as a "fuse" and once it reaches the temperature its color change from white to black for good. Each indicator contains eight "fuses" starting with 40°c and with equal steps up to 71°c, which give us a delta of 4°c between the "fuses".
Once the test is over, we simply have to pull out the source holder and check out which "fuses" have changed their color from white to black.. The maximum temperature that has been reached is the specific temperature of highest "fuse" plus the delta of 4°c till the next "fuse" which has not burned.
Since the test referring to interior of the rod, the rod itself can remain fixed without any movement.
Another temperature meter, positioned near the gantry, will measure the ambient temperature.

Test Results:

In none of the locations did any of the "fuses" changed color, which indicates that the 40°c temperature has not been reached!
The ambient temperature during the test was 23°c.

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Results Analysis & Conclusions:

According to the glue data sheet (3M #2216 epoxy), the glue can stand a shear force of at least 2.8N/mm^2 at a temperature of up to 82°c. Since we know that the self weight of the source, which is the only force acting on it, is approximately 23.5gr, that gives us self shear force of approximately 0.1N/mm^2.
We found out that the source holder does not reaches 40°c so we can conclude that under normal operating conditions, the glue won't chemically break down and the source won't break loose from its holder.

ELGEMS MG ATC

Test Report

test No. 453-3201-0005

Subject: MG ATC Rod shutter – Radiation Safety & Reliability

Division: R&D **Product:** MG ATC Option

Approved by	Shmuel Beach	**Performed by**	Sergio Steinfeld
Position	Project Manager	**Position**	System Engineer
Date	5/99	**Date**	5/99
Signature		**Signature**	

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Test Equipment

Camera	MG CSE Camera with ATC Option proto #2

See additional Test Equipment List

Test Purpose

The purpose of the test is to check the circuitry design of the shutter mechanism from the radiation safety stand of view and the reliability of the mechanism .

General

Power Failure , Collision detection, Emergency Stop

The shutter mechanism is normally closed. It is equipped with a spring solenoid which remains closed when the source is not in use or when the power is lost to the MG ATC Rod unit or when detecting potential failures.
Therefore, at power failure the shutter is by default closed.

When collision detection is activated (physical touch between the patient body or other object with the detector head collimator), the shutter is closed and the study is paused.

When the Emergency Stop (red button on gantry and bed aside.) is activated, the shutter is closed and the study is paused.

The source shutter mechanism is tested by sensing the position of two slotted optical switches mechanical attached to the Tungsten rod shutter which reports whether the shutter is open or close. A yellow Led is electrical connected to the slotted optical switch which changes status according to the Tungsten rod position.

Reliability

The shutter reliability pass criteria was defined to be one year of use without failure. The shutter is tested for approximately 100,000 open/close cycles without failure, the equivalent of one year of use. The test consists of checking the status of both slotted opto device switches while changing from open to close and vice versa and verifying , after completing the open/close cycles, that no leakage radiation is exposed when the shutter is closed.

Test	Description	Results	pass	fail
1	**Communication with controller** **Solenoid control : Open/Close** **Shutter opto device sensing** **Led Activation**			
	Verify that the shutter is closed, the mechanical Lever change position to CLOSE ("O") position and the Yellow Led is OFF.	The mechanical Lever change position to CLOSE ("O") position and the Yellow Led is OFF.	✓	
	Enter the system as Service Mode to directory c:/usr/service/io			
	Then type *apimate input_stage.prg*			
	verify the resulting value : Hex-14 which represents the status of the opto device sensors Open/Close sensor → Close FullyOpen/not FullyOpen → not F.O.	Resulting value : Hex-14	✓	
	Then type **apimate open.prg**			
	Verify that the shutter was opened, the mechanical Lever change position to OPEN ("I") position and the Yellow Led is ON.	The mechanical Lever change position to OPEN ("I") position and the Yellow Led is ON.	✓	
	Then type *apimate input_stage.prg*			
	verify the resulting value : Hex-C which represents the status of the opto device sensors Open/Close sensor → Open FullyOpen/not FullyOpen → F.O.	Resulting value : Hex-C	✓	
	Then type **apimate close.prg**			
	Verify that the shutter was closed, the mechanical Lever change position to CLOSE ("O") position and the Yellow Led is OFF.	The mechanical Lever change position to CLOSE ("O") position and the Yellow Led is OFF.	✓	
	Then type			

	apimate input_stage.prg verify the resulting value : Hex-14 which represents the status of the opto device sensors Open/Close sensor → Close FullyOpen/not FullyOpen → not F.O.	Resulting value : Hex-14	✓	
2	**Radiation Safety** **Power off fail- safe**			
	Active nominal standard TOMO acquisition w/AC (Attenuation Correction Option) from AUI (Acquisition User Interface) While the rod performs Transmission line motion, disconnect the gantry power input plug from the main voltage electrical box	1) The motion is stopped and the shutter is closed immediately. 2) The led is turned off	✓ ✓	
3	**Radiation Safety** **Power off fail- safe**			
	Active nominal standard TOMO acquisition w/AC (Attenuation Correction Option) from AUI (Acquisition User Interface) While the rod performs Transmission line motion, disconnect the D-type plug of the rod .	1) the shutter is closed immediately. 2) The Led is turned off. 3) An error message is displayed	✓ ✓ ✓	
4	**Radiation Safety** **Nominal operation** **Malfunction in the motion**			
	Active nominal standard TOMO acquisition w/AC(Attenuation Correction Option) from AUI. While the rod performs Transmission line motion, disconnect the motor cable. Then, after the error is displayed, reconnect and resumed.	1) After completing the transmission stage (max. 5 seconds), the shutter is closed and the study is stopped displaying an error message. 2) The Led is turned off. 3) After reconnecting power to the motor , the study is resumed and the frame is repeated.	✓ ✓ ✓	

5	**Radiation Safety** **Nominal Operation** **E Stop**			
	Active nominal standard TOMO acquisition w/AC (Attenuation Correction Option) from AUI While the rod performs Transmission line motion, press E-STOP (Emergency Stop, Red Mushroom Button) Then, after the error is displayed, reconnect and resumed.	1) The motion is stopped and the shutter is closed immediately. An error message will be displayed. 2) The led is turned Off. 3) After reconnecting, the study is resumed and the frame is repeated.	✓ ✓ ✓	
6	**Radiation Safety** **Nominal Operation** **Collision Detection**			
	Active nominal standard TOMO acquisition w/AC (Attenuation Correction Option). While the rod performs Transmission line motion , press collision detection in the collimator. Then, after the message is displayed, release the collision pressure and resumed.	1)The motion is stopped and the shutter is closed immediately. An error message will be displayed. 2)The led is turned Off. 3. After reconnecting, the study is resumed and the frame is repeated.	✓ ✓ ✓	
7	**Radiation Safety** **Nominal Operation** **Unexpected Open Shutter**			
	While system in IDLE state (no acquisition active) open the shutter manually (with the mechanical Lever) A error message is displayed in the status area on the acquisition station. Repeat this action for the following acquisition modalities : a) During an AWB (Body Scan) acquisition. b) During a Tomo acquisition c) In the middle of a Static acquisition. d) During the emission stage of a Tomo .	1) The led is turned On 2) Error message is displayed. a) → Error message is displayed b) → Error message is displayed c) → Error message is displayed d) → Error message is	✓ ✓ ✓ ✓ ✓ ✓	

		displayed		
8	**Radiation Safety** **RS-232 comunication problem**			
	Active nominal standard TOMO acquisition w/AC (Attenuation Correction Option) from AUI While the rod performs Transmission line motion, disconnect the RS 232 cable between the acquisition station and the AC control board. A h/w watch-dog will sense the communication problem and stopped the acquisition.	→ The motion is stopped and the shutter is closed immediately. The led is turned Off. An error message will be displayed.	✓	
9	**Radiation Safety** **Reliability Tests**			
	Enter the system as Service Mode to directory c:/usr/service/io Then type *apimate move.prg* Both rods should move to the middle of the scanning range. Bring the gantry to Head#2 = 0° Then type *Shutter_test report.test 25,000* The test will open/close the shutter for 25,.000 open/close cycles (3 seconds approximately period time between cycles) The test displays the number of the current cycle. The test records in file *report.test* the status of the slotted opto devices after open/close the shutter for each cycle. **Test Status** After completing the test verify the right status report of the slotted opto devices .	Both rods should move to the middle of the scanning range.	✓	

	Type *Cat report.test | grep –v14 | grep –v c* → no mismatch should be found Repeat the test for the followings Head#2 angles: 90° , 180° , 270 ° The test completes 100,000 cycles **Leakage Radiation Measurement** Use a radiation dosimeter with energy range 40-200 Kev and sensitivity of 0.01 mR/hr. The radiation leakage measurement should be < 0.1mR/h – 5cm form external surface of the rods.	→ no mismatch should be found **< 0.1mR/h /5cmm**	✓ ✓	

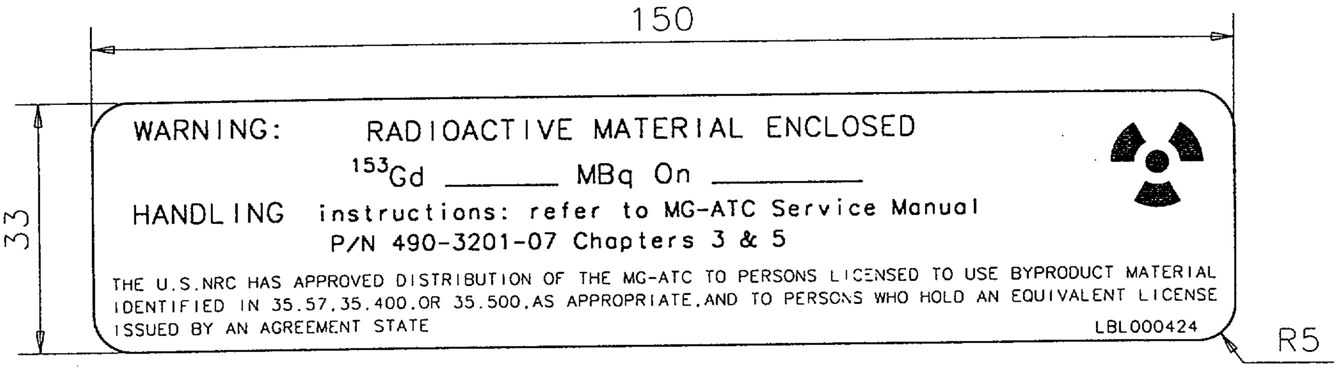
Results Analysis and Conclusions

The results analysis concludes that the shutter circuit responds to the planned criteria . The tests shows and verifies as well, the power fail -safe mechanism and safety guards of the shutter in case of collision detection, Emergency stop, unexpected opening and motion malfunction.
The shutter passes the reliability test criteria of 100,000 cycles ,equivalent to one year of life .

Appendix D

Engineering Drawings & Data Sheets

ZONE	DESCRIPTION	APPR.	DATE	REV	CHANGE ORD.
	NEW DOCUMENT			*0*	



1. MATERIAL - LEXAN 0.3 MM

2. FONT - DARK GRAY PANTONE 446

3. BACKGROUND LIGHT GRAY PANTONE 427

4. [crosshatched box] - TRANSPARENT

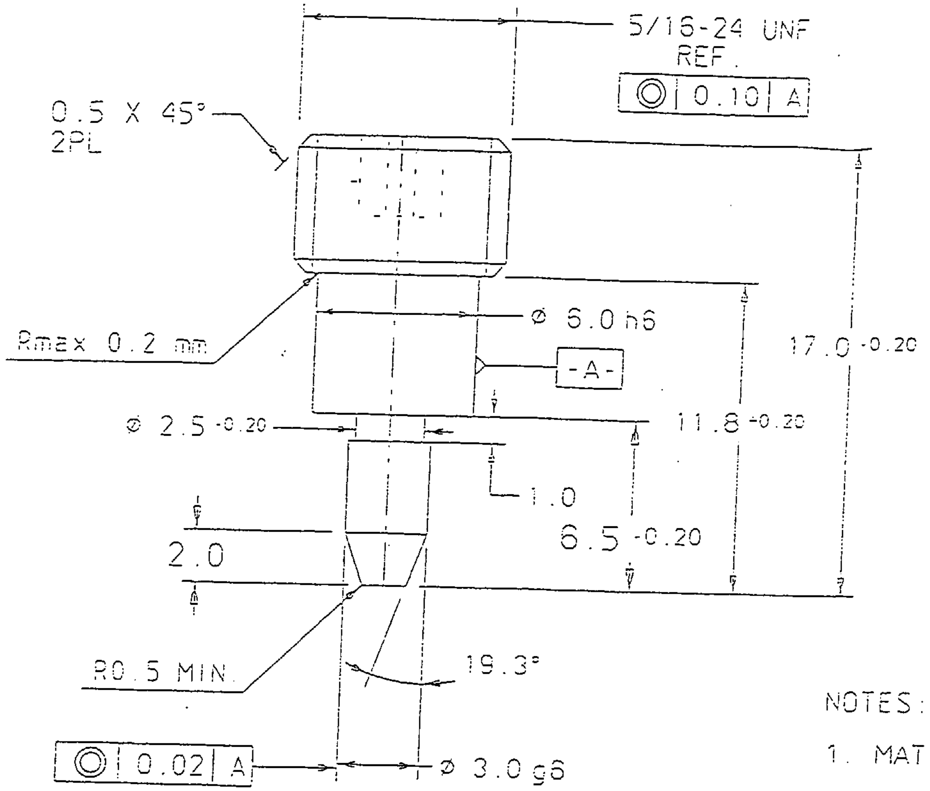
5 ADHESIVE: MAC-TAC COVER BY PAPER

Q.C.

TESTS OF 15 SECONDS RUBBING WITH WATER, ISO-PROPANOL AND METHANOL AFTER ADHESION INSPECT THAT THE TEXT IS READABLE AND CLEAR AND THAT THE BORDERS OF THE LABEL ARE NOT FOLDED

	NAME	DATE		
DESIGNER	DANY A.	11.05.99	FINISH	EQUIPMENT MG-ATC
DESIGN CONTROL	DANY A.	11.05.99		ASSEMBLY NAME No.
CHECKER	BAR ILAN			SCALE 1.0:1.0
APPROVAL	YOSSI H.		TOL. NOT SPECIFIED :	NAME WARNING LABEL

	1	DWG. SIZE 1	DRAWING No. LBL-000424-
<	1		VERSION
LAST OP.			SHEET 1 OF 1
NEXT OP.			Old Part number :



NOTES:

1. MATERIAL: SET SCREW 5/16-24 UNF, GRADE 12.9.

HEAT TREATMENT	FINAL TREATMENT	MATERIAL	QTY
	BLACK OXIDE	SEE NOTE 1.	1

IDEA
Machine Development, Design & Production Ltd.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN mm.
GEN. TOL'S: ±0.2
ANGLES: ±0°15
REMOVE ALL SHARP EDGES 0.5X45°

PROJECT NAME V-TRANSACT
FILE NUMBER/NAME \ELS\ROD\L-056
PART NAME ROD BOLT POSITION
DIMENSION

	NAME	DATE	SIGN
DESIGN	BORIS	18/08/97	
DRAWN	ALEX M	05/10/97	
CHECK	SHLOMO		
APPRD	SHLOMO		

FINISH N8 (∇)
A 3 SCALE: 5 : 1
SHEET OF
DWG NO: -- 119040006 REV: A

DO NOT MEASURE FROM THE DRAWING.

ECO	REV	DATE	APPR	DESCRIPTION
P9852025	0	7.4.98	[signature]	NEW DOCUMENT

ELGEMS
RM: HS- 0533- 0516F QTY: 1
Page 1 of 1 NOT TO SCALE P/N: 56031021100

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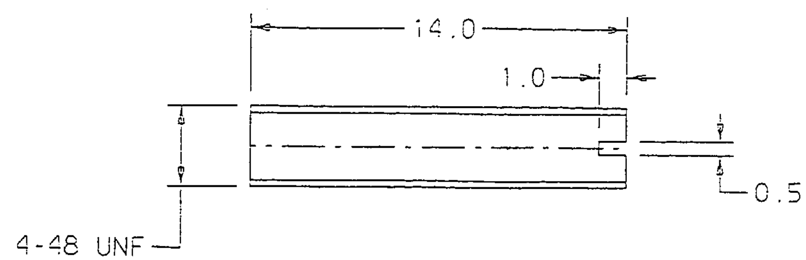
OLD NUMBER



HEAT TREATMENT	FINAL TREATMENT	MATERIAL	QTY
		Ø3 ST.ST.303	

IDEA
Machine Development, Design & Production Ltd.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN mm.
GEN. TOL'S: ±0.2
ANGLES: ±0°15
REMOVE ALL SHARP EDGES 0.5X45°

PROJECT NAME V-TRANSACT
FILE NUMBER/NAME \ELS\ROD\L-108
PART NAME
ROD SHUTER ACTUATOR SCREW
DIMENSION

	NAME	DATE	SIGN
DESIGN	BORIS	12/08/97	
DRAWN	GABI	24/02/98	
CHECK	SHLOMO		
APPRD	SHLOMO		

FINISH N8 (NO-)

A 3 SCALE: 5:1 SHEET OF 1

DWG NO: 119040047 REV:

DO NOT MEASURE FROM THE DRAWING.

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ECO	REV	DATE	APPR	DESCRIPTION

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	Page 1 of 1	NOT TO SCALE	P/N: 56231022908

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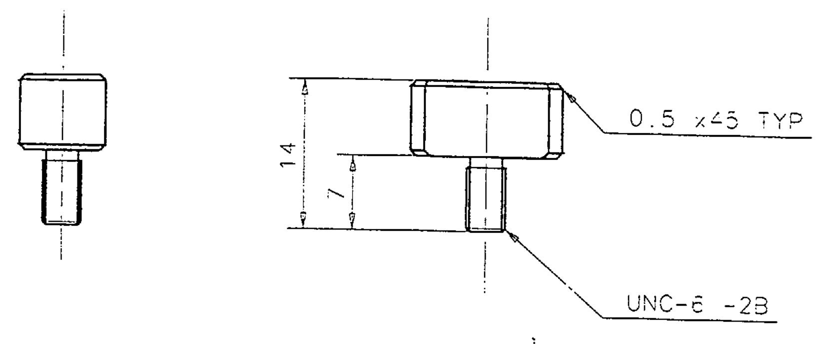
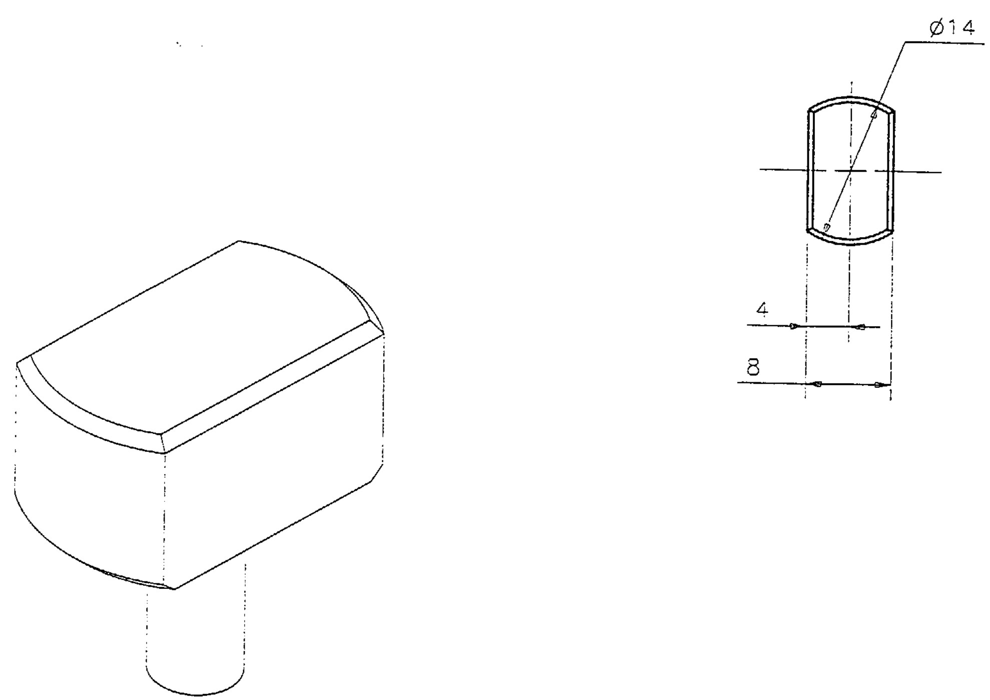
	NEW DOCUMENT		17.03.1998	0	P9852001





ASSY NAME	NO.
ROD ASSY LEFT	47331020207
ROD ASSY RIGHT	47331020603

REMARKS or DWG.NO.	UNITS	QUANTITY	U/M	CATALOG NO.	NAME	NO.
	m	0.02	10	701[illegible]0610196	SS 303 ROUND 15MM	1

	NAME	DATE
DESIGNER	DANY A.	17.03.98
DESIGN CONTROL	DANY A.	17.03.98
CHECKER	BENNY H.	18.03.98
APPROVAL	I. SHAKED	18.03.98

EUROPEAN PROJECTION. DEFAULT DIMENSIONS : MM.

FINISH

√63

TOL. NOT SPECIFIED : 0.2 / ∠ 0.5

EQUIPMENT: V-TRANSACT

ASSEMBLY NAME: SEE TABLE

No.

SCALE: 1.0:1.0

NAME: LOCKER SCREW

DWG. SIZE: 2

DRAWING No. 562-3102-0605

SHEET OF 1

VERS. CHK. REV.

LAST OP.

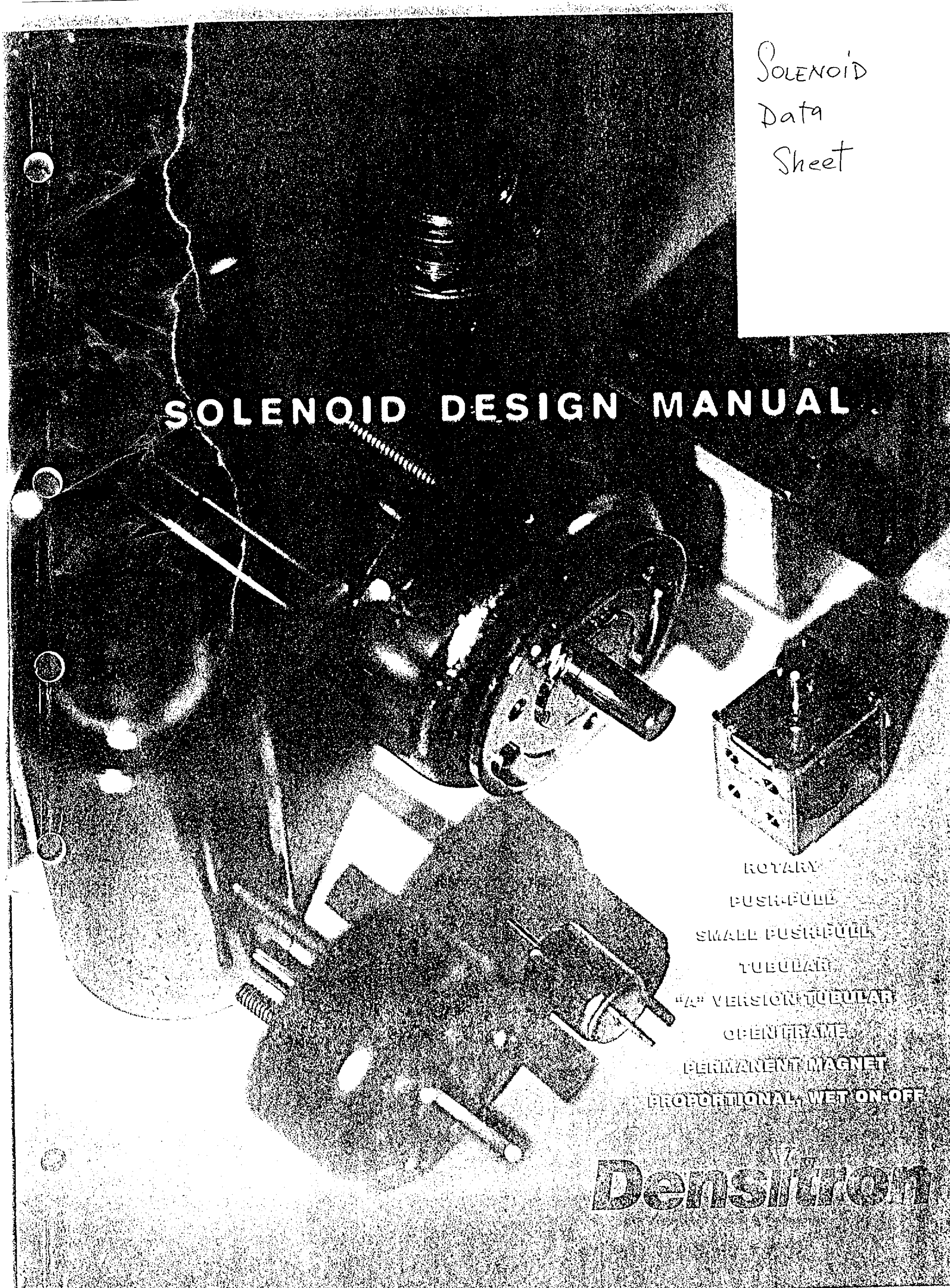
NEXT OP.

ELGEMS Ltd.
POB 170
Tirat Hacarmel 30200 ISRAEL

Project : R9852001. Item : 56231020605.00g. 17-Mar-98 18:16

Solenoid Data Sheet

SOLENOID DESIGN MANUAL



ROTARY

PUSH-PULL

SMALL PUSH-PULL

TUBULAR

"A" VERSION TUBULAR

OPEN FRAME

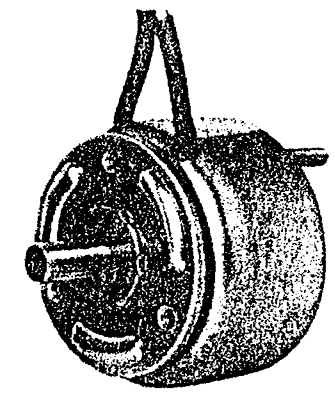
PERMANENT MAGNET

PROPORTIONAL, WET ON-OFF

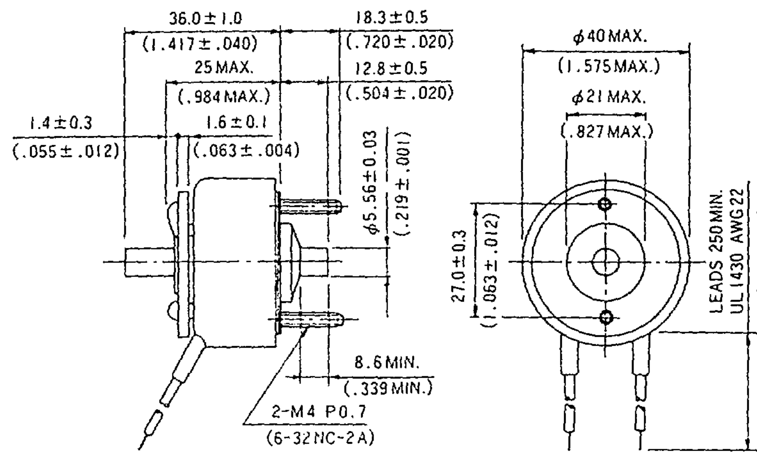
Densitron

SIZE 401 ROTARY SOLENOID

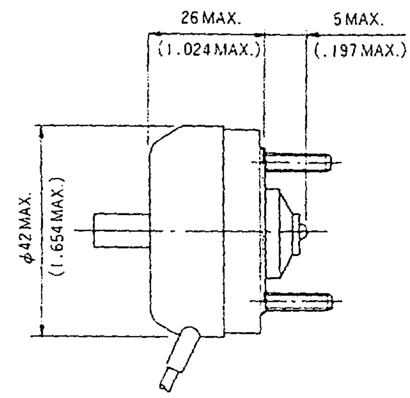
UNIT: mm (inch)
SHOWN DE ENERGIZED, RIGHT HAND ROTATION



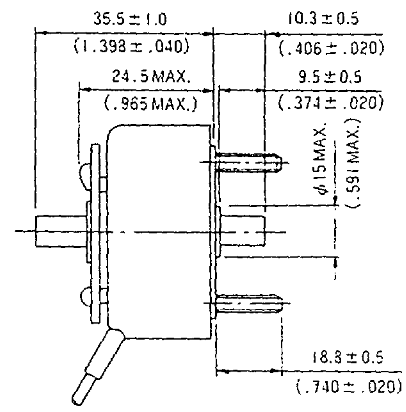
WEIGHT(ABD&R) : 200g



WITH A,B&R

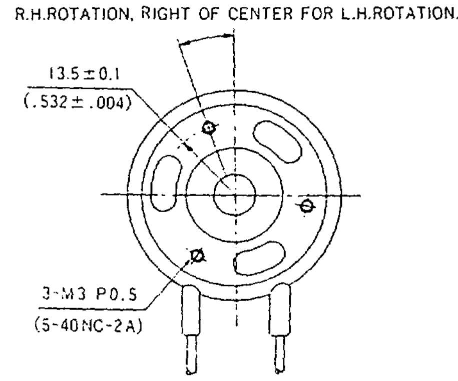


WITH A,D&R



WITH A&B

½ ROTATION ANGLE ±3° TO LEFT OF CENTER FOR R.H.ROTATION, RIGHT OF CENTER FOR L.H.ROTATION.



WITH T

COIL DATA

Heat sink : 160×160×3mm aluminum   Return spring torque : 0.0165~0.024 N·m

duty cycle = "on" time / ("on" time + "off" time) ×100%			100% continuous	75% or less	50% or less	25% or less	10% or less
MAX. "on" time in seconds			∞	108	100	36	9
watts at 20°C			12.5	16.5	25	50	125
ampere-turns at 20°C			714	825	1000	1425	2250
gross starting torque at 20°C (N·m)		25°	0.104	0.138	0.195	0.355	0.52
		35°	0.069	0.092	0.127	0.23	0.355
		45°	0.035	0.058	0.092	0.16	0.276
		67.5°	0.022	0.035	0.046	0.092	0.185
		95°	0.012	0.022	0.035	0.058	0.115
AWG no.	resistance Ω±10%(at 20°C)	no. turns	volts DC				
25	3.5	384	6.6	7.8	9.5	13	21
26	5.67	486	8.4	9.7	12	17	27
27	8.76	600	11	13	16	22	35
28	13.8	748	13	15	18	26	42
29	22.6	975	17	19	23	33	52
30	34.8	1190	21	25	30	42	67
31	56.7	1520	27	31	38	54	85
32	88.3	1908	35	41	49	70	110
33	138	2360	43	50	60	86	138
34	216	2904	53	61	75	106	168
35	351	3725	67	78	95	132	213
36	480	4000	85	98	119	169	268
37	720	4950	105	121	147	210	332
38	1150	6200	132	153	185	264	—
39	1920	8350	166	191	232	332	—
40	3000	10000	210	250	300	—	—

1. Design and Features

The rotary solenoid's design starts from a standard flat face push-pull solenoid. The rotary solenoid then incorporates the mechanical design principle of an inclined plane to convert linear motion to rotary motion. There are three uniform inclined planes (spiral grooves) that are stamped into both the case and the armature, called "ball races." The "ball races" provide both a means of converting linear motion to rotary motion and a secondary bearing system to support this rotary motion. (Fig. 1)

- The ball races are specially designed and provide a constant torque output over the complete angle of rotation at 25% duty cycle.
- The rotary solenoid uses an enclosed coil and therefore provides maximum magnetic efficiency.
- The magnetic circuit is very short, so high efficiencies in terms of torque output can be obtained, and energization/response times are very quick.

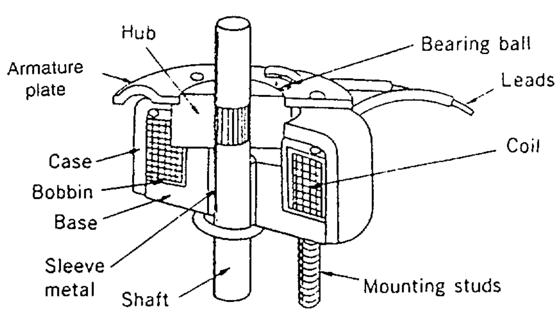


Fig. 1

2. Starting Torque

The starting torque shown in the catalog is the gross value output at 20°C. With the addition of the return spring, the solenoid's net output is the gross starting torque minus the return spring torque.

3. Rotation Angle Direction of Rotation

A) Use of an External Stopper (Fig.2)

The angle and direction of rotation are predetermined (and fixed) by the manufacturing process of the three ball races that are in the case and armature. The degree of rotation can be reduced (example: a 35 deg RH rotation solenoid reduced to 30 deg RH rotation) by the use of an external stopper. However, to assure that the solenoid operates properly, it is imperative that the solenoid armature always be allowed to return to 0 deg. or unenergized position.

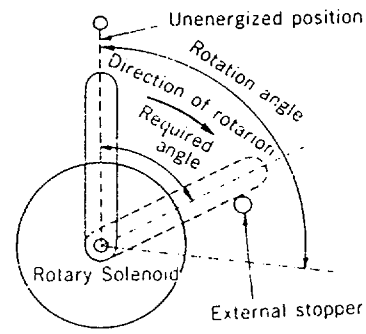


Fig. 2

B) Direction of Rotation (Fig.3)

The normally accepted convention to describe the rotation of the rotary solenoid is that the direction of rotation is viewed from the armature plate (top) of the solenoid. Clockwise rotation is right-hand (RH) rotation, and counter clockwise rotation is left-hand (LH) rotation.

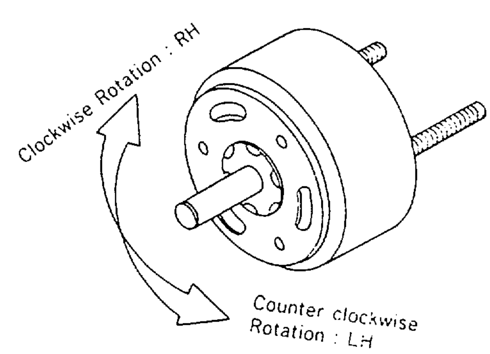


Fig. 3

C) Rotation Angle Available

The rotation angles are available as follows:

Table 1

SIZE 301	25°, 35°, 45°	RH and LH
SIZE 341	25°, 35°, 45°, 67.5°	RH and LH
SIZE 401	25°, 35°, 45°, 67.5°, 95°	RH and LH
SIZE 490, 491		
SIZE 590, 591		
SIZE 700		
SIZE 870		

4. Axial Travel

In this design of the rotary solenoid the rotary motion is created by converting linear motion into rotary motion. The use of the inclined plane (ball races) also generate a small axial stroke (about 0.7 to 2.6mm depending upon the amount of rotation and the size of the solenoid).

Table 2

SIZE	301	341	401	490.491	590, 591	700	870, 874
Axial travel (mm), approx.	0.7	0.9	1.2	1.5	1.6	2.3	2.6

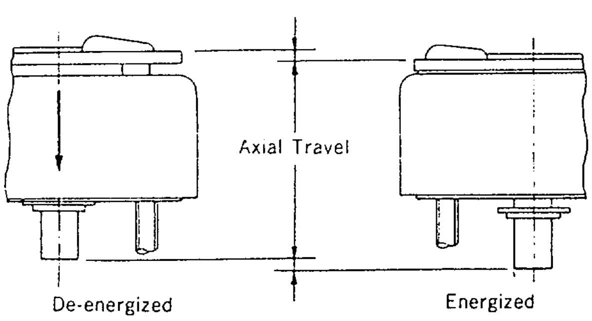
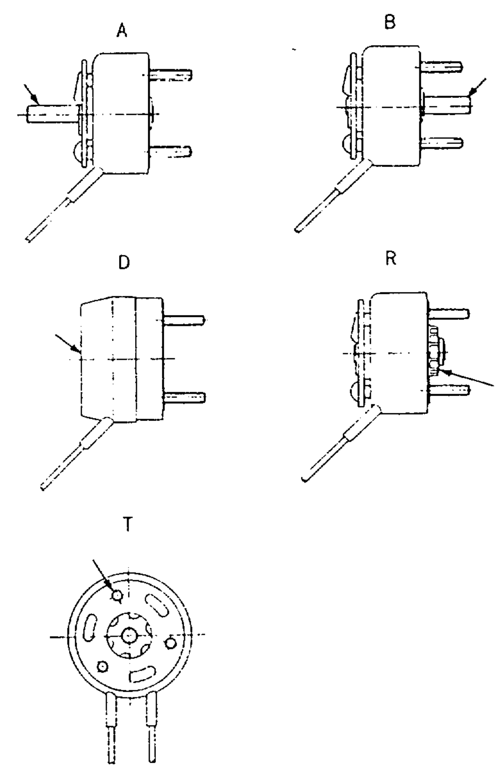


Fig. 4

5. Standard Available Accessories

The standard rotary solenoid is available with different accessories to meet your application requirements.



A: Shaft extension on the armature plate
B: Shaft extension on the base side
D: Dust cover over armature plate
R: Return spring provided
T: Tapped holes in armature plate

6. Operational Considerations

A) Temperature

The coil data of rotary solenoids shows the values at ambient temperature 20°C and with a standard heat sink. When a solenoid is used at the ratings mentioned in the coil data, it is designed so that the coil temperature rises and reaches equilibrium at approximately 85°C. In applications where the ambient temperature is higher than 20°C or the heat sink is smaller than indicated in the catalog, possible thermal damage can occur. Temperature rise tests should be performed by the customer to assure that the coil does not reach 120°C. Coils can be constructed to operate at temperatures higher than 120°C without thermal damage. Please consult the factory for details.

B) Shaft Modifications

It is not recommended that the customer modify the shaft, as the shafts are fabricated before assembly. Any special configurations can be supplied. Please consult the factory for details.

C) How to Use The "T" (tapped armature plate) Feature

As noted above, the rotary solenoid does have axial movement in the armature plate position during energization and de-energization. When directly attaching a mechanism to the armature plate, the load must allow for free movement in the axial direction. Also, the attaching screws can not be longer than the thickness of the armature plate or interference in the rotary motion will occur.

7. General Characteristics

Insulation class	Class E (120°C) Lead wire class A (105°)
Dielectric strength	AC 1000V 50/60 Hz 1 min. (at normal temperature and normal humidity)
Insulation resistance	More than 100 Mohm at DC 500 V megger (At normal temperature and normal humidity)
Expected life	Standard life: 2 million cycles Extended life: 10 million cycles Long life: 50 million cycles

(Solenoid cycle life is very dependent upon side load, frequency of use, and environmental conditions. Cycle life tests should be performed by the customer.)

8. How to Select a Rotary Solenoid

Before selecting a rotary solenoid, the following information must be determined.

A) Torque
The actual torque required in the application should be increased using a safety factor multiplier of 1.5 to arrive at the torque value that should be used in your specification.

B) Duty Cycle
Use the aforementioned formula to calculate duty cycle. Also note the maximum on time. (See Page 2)

C) Rotation Angle
Rotation angle is determined by application requirements.

D) Rotation Direction
Rotation direction is determined by application requirements (note direction of armature plate).

E) Operating Voltage
Operating DC voltage is determined by the application and voltage available.

After determining these specifications, one can find the correct size solenoid for the application, using the torque characteristics tables. The coil data is also shown for different sizes of magnet wire. If the exact operating voltage is not in the coil data table, use the nearest voltage shown in the table.

NOTE: When the operating voltage falls between 2 coil sizes, always us the higher AWG numbered coil so as to prevent potential thermal damage.

9. Ordering Information

When ordering a rotary solenoid, the correct part number needs to be determined from the following combination of characteristic (1-5):

(1) M-Metric Thread
F-SAE Thread
(2) Solenoid Size (example - 490)
(3) Coil Wire Size (AWG no.)
(4) Angle of rotation, direction of rotation and accessories (Table 3)
(5) R - Standard Life Bearing
RE - Extended Life Bearing
RL - Long Life Bearing

Example of a complete part number:

(1)	(2)	(3)	(4)	(5)
F	490	26	141	R

This part number is for a solenoid with (1) SAE threads, (2) size 490, (3) 26 AWG coil wire, (4) 35 deg. right-hand rotation, with accessories of armature side shaft extension and return spring provided, and (5) standard life bearings.

10. Labeling

For rotary solenoids the part number labeling is as follows:

A) Standard Solenoid (no modifications).

The solenoid label will have the part number and the date code (which identifies the year and week of manufacture).

Example: F 490 26 141 R 9801

- SAE Thread — F
- Solenoid Size — 490
- Coil Wire AWG — 26
- Rotation & Accessories — 141
- Rotary & Bearing Life — R
- Date Code (year and week) — 9801

B) Special Configuration (required for any modification to a standard design).

Any change from the standard catalog design requires that a custom part number be assigned, which also include the date code of manufacture.

Example: F94123R 9801

- Special Part Number — F94123R
- Date Code (year and week) — 9801

11. Accessories Definition Table

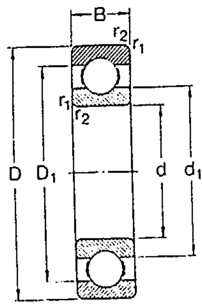
When ordering a rotary solenoid, the correct number for the angle of rotation, direction of rotation and accessories needs to be determined from the following table.

Table 3

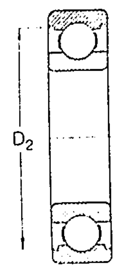
Accessories	Clockwise Rotation(RH)					Counter Clockwise Rotation(LH)				
	25°	35°	45°	67.5°	95°	25°	35°	45°	67.5°	95°
A	070	071	072	073	074	075	076	077	078	079
A T	100	101	102	103	104	105	106	107	108	109
A T R	110	111	112	113	114	115	116	117	118	119
A D	120	121	122	123	124	125	126	127	128	129
A D R	130	131	132	133	134	135	136	137	138	139
A R	140	141	142	143	144	145	146	147	148	149
T	170	171	172	173	174	175	176	177	178	179
T R	180	181	182	183	184	185	186	187	188	189
B	220	221	222	223	224	225	226	227	228	229
A B	230	231	232	233	234	235	236	237	238	239
A B T	260	261	262	263	264	265	266	267	268	269
A B T R	280	281	282	283	284	285	286	287	288	289
A B D	290	291	292	293	294	295	296	297	298	299
A B D R	300	301	302	303	304	305	306	307	308	309
A B R	310	311	312	313	314	315	316	317	318	319
B T	340	341	342	343	344	345	346	347	348	349
B T R	360	361	362	363	364	365	366	367	368	369
B D	370	371	372	373	374	375	376	377	378	379
B D R	380	381	382	383	384	385	386	387	388	389
B R	390	391	392	393	394	395	396	397	398	399

Ball Bearing Data sheet

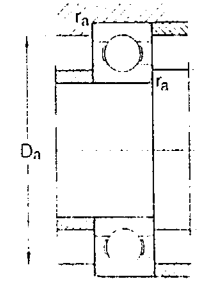
Deep groove ball bearings
single row
d 2,5–12 mm



With full outer ring shoulders

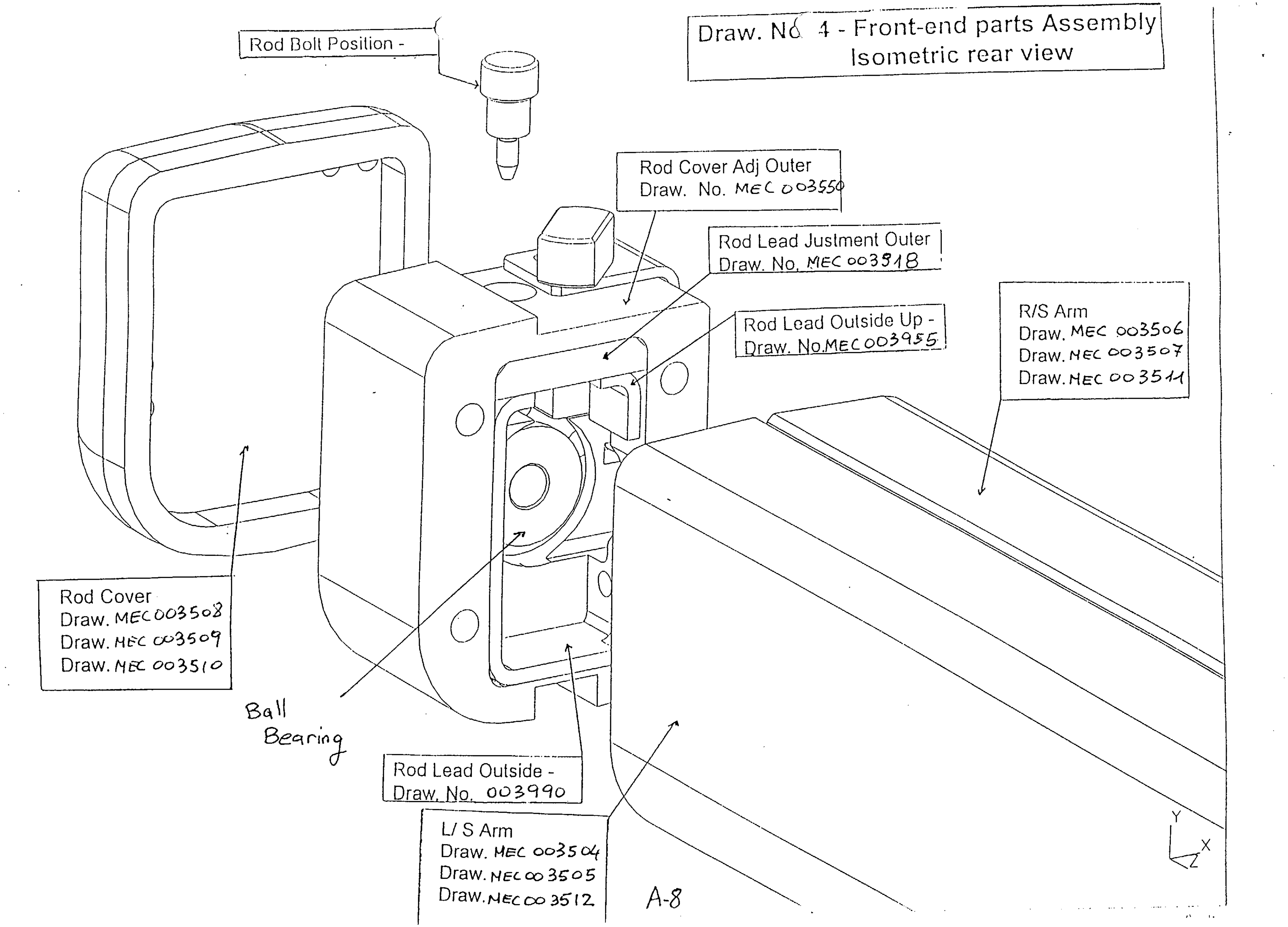


With recessed outer ring shoulders



Principal dimensions			Basic load ratings		Fatigue load limit	Speed ratings		Mass	Designation
			dynamic	static		Lubrication grease	oil		
d	D	B	C	C_0	P_u				
mm			N		N	r/min		kg	–
2,5	8	2,8	319	106	4	67 000	80 000	0,0007	60/2.5
3	10	4	488	146	6	60 000	70 000	0,0015	623
4	9	2,5	540	180	7	63 000	75 000	0,0007	618/4
	12	4	806	280	12	53 000	63 000	0,0022	604
	13	5	975	305	14	48 000	56 000	0,0031	624
	16	5	1 110	380	16	43 000	50 000	0,0054	634
5	11	3	637	255	11	53 000	63 000	0,0012	618/5
	16	5	1 110	380	16	43 000	50 000	0,0050	625
	19	6	1 720	620	26	36 000	43 000	0,0090	635
6	13	3,5	884	345	15	48 000	56 000	0,0020	618/6
	19	6	1 720	620	25	36 000	43 000	0,0084	626
7	14	3,5	956	400	17	45 000	53 000	0,0022	618/7
	19	6	1 720	620	26	38 000	45 000	0,0075	607
	22	7	3 250	1 370	57	32 000	38 000	0,013	627
8	16	4	1 330	570	24	40 000	48 000	0,0030	618/8
	22	7	3 250	1 370	57	36 000	43 000	0,012	608
9	17	4	1 430	640	27	38 000	45 000	0,0034	618/9
	24	7	3 710	1 660	71	32 000	38 000	0,014	609
	26	8	4 620	1 960	83	28 000	34 000	0,020	629
10	19	5	1 380	585	25	36 000	43 000	0,0055	61800
	22	6	1 950	750	32	34 000	40 000	0,010	61900
	26	8	4 620	1 960	83	30 000	36 000	0,019	6000
	28	8	4 620	1 960	83	28 000	34 000	0,022	16100
	30	9	5 070	2 360	100	24 000	30 000	0,032	6200
	35	11	8 060	3 400	143	20 000	26 000	0,053	6300
12	21	5	1 430	670	28	32 000	38 000	0,0063	61801
	24	6	2 250	980	43	30 000	36 000	0,011	61901
	28	8	5 070	2 360	100	26 000	32 000	0,022	6001
	30	8	5 070	2 360	100	26 000	32 000	0,023	16101
	32	10	6 890	3 100	132	22 000	28 000	0,037	6201
	37	12	9 750	4 150	176	19 000	24 000	0,060	6301

Dimensions					Abutment and fillet dimensions		
d	d_1	D_1	D_2	$r_{1,2}$ min	d_a min	D_a max	r_a max
mm					mm		
2,5	4,6	6,4	–	0,15	3,7	6,8	0,1
3	5,2	7,5	8,2	0,15	4,2	8,8	0,1
4	5,2	7,5	–	0,1	5,2	7,8	0,1
	6,4	9,6	–	0,2	5,6	10,4	0,2
	6,7	10,3	11,2	0,2	5,6	11,4	0,2
	8,4	12	13,3	0,3	6	14	0,3
5	6,8	9,3	–	0,15	6,2	9,8	0,1
	8,4	12	13,3	0,3	7	14	0,3
	10,7	15,3	16,5	0,3	7	17	0,3
6	7,9	11,2	–	0,15	7,2	11,8	0,1
	10,7	15,3	16,5	0,3	8	17	0,3
7	8,9	12,2	–	0,15	8,2	12,8	0,1
	10,7	15,3	16,5	0,3	9	17	0,3
	11,8	17,6	19	0,3	9	20	0,3
8	10,1	14	–	0,2	9,6	14,4	0,2
	11,8	17,6	19	0,3	10	20	0,3
9	11,1	15	–	0,2	10,6	15,4	0,2
	14,2	19,8	21,2	0,3	11	22	0,3
	14,4	21,4	22,6	0,3	11	24	0,3
10	12,6	16,4	–	0,3	12	17	0,3
	13	18,1	–	0,3	12	20	0,3
	14,4	21,4	22,6	0,3	12	24	0,3
	16,7	23,4	24,8	0,3	12	26	0,3
	16,7	23,4	24,8	0,6	14	26	0,6
	17,5	27,1	28,7	0,6	14	31	0,6
12	15	18,2	–	0,3	14	19	0,3
	15,5	20,6	–	0,3	14	22	0,3
	16,7	23,4	24,8	0,3	14	26	0,3
	16,7	23,4	24,8	0,3	14	28	0,3
	18,2	25,9	27,4	0,6	16	28	0,6
	19,5	29,7	31,5	1	17	32	1



Draw. No 4 - Front-end parts Assembly
Isometric rear view
Rod Bolt Position -
Rod Cover Adj Outer
Draw. No. MEC 003550
Rod Lead Justment Outer
Draw. No. MEC 003518
Rod Lead Outside Up -
Draw. No.MEC 003955
R/S Arm
Draw. MEC 003506
Draw. MEC 003507
Draw. MEC 003511
Rod Cover
Draw. MEC 003508
Draw. MEC 003509
Draw. MEC 003510
Ball Bearing
Rod Lead Outside -
Draw. No. 003990
L/ S Arm
Draw. MEC 003504
Draw. MEC 003505
Draw. MEC 003512
Y
X
Z

Appendix E

Mil – C – 13924 Class Standard

H-13-07

MIL-C-13924C
AMENDMENT 1
30 September 1987

MILITARY SPECIFICATION

COATING, OXIDE, BLACK, FOR FERROUS METALS

This amendment forms a part of Military Specification MIL-C-13924C, dated 9 June 1980, and is approved for use by all Departments and Agencies of the Department of Defense.

PAGE 1

Paragraph 1.2 Classification. Line 2: Delete "see 6.4" and substitute "see 6.3.2".

Paragraph 1.2 Classification. Reinstate "Class 2 - Alkaline - chromate oxidizing process (for use on certain corrosion resistant steel alloys which are tempered at less than 900°F (482°C).

Paragraph 1.2 Classification. Line 7 and 8: Delete "Class 4 - Alkaline oxidizing process (for 300 series corrosion resistant steel alloys only)"; substitute "Class 4 - Alkaline oxidizing process (for other corrosion resistant steel alloys)".

PAGE 3

Paragraph 3.4 Alkaline oxidizing solutions (class 1).

Changes to read as follows:

"3.4 Alkaline oxidizing solutions (classes 1 and 2). Classes 1 and 2 oxide coatings shall be formed from a boiling alkaline-oxidizing or alkaline-chromate-oxidizing solution, respectively."

AMSC N/A

/AREA MFFP/

DISTRIBUTION STATEMENT A Approved for public release; distribution unlimited.

THIS DOCUMENT CONTAINS 3 PAGES.

Paragraph 3.4.1 Rinsing. Line 1: Rewrite line one as follows:

"3.4.1 Rinsing. All classes of black oxide coated pieces shall be rinsed."

PAGE 4

Paragraph 3.7 Coverage and color. Line 1: Insert "2" between 1 and 3, so that line one now will read as follows:

"3.7 Coverage and color. Class 1, 2, 3, and 4 coatings (see 1.2) shall"

Paragraph 3.8, lines 1 and 2

Change the first two lines to read as follows:

"3.8 Quality coating (oxalic acid spot test for classes 1, 2, and 3).

The black oxide coatings of classes 1, 2, and 3, prior to the application of a preservative,"

PAGE 5

Paragraph 4.3.2 Sampling of destructive tests. Line 4: Delete "1.0 percent defective" and substitute "4.0 percent defective."

PAGE 6

Paragraph 4.4.2, lines 1 and 2.

Change the first two lines of this paragraph to read as follows:

"4.4.2 Oxalic acid spot test (class 1, 2, and 3). The black oxide coated pieces of classes 1, 2, and 3 only, prior to the application of a preservative,"

PAGE 8

Paragraph 6.3.2 Processing. Line 4. The following guidance statement is to be inserted as the second to the last sentence of the paragraph as clarification for selection of which class is needed to process the different types of corrosion resistant steels.

Add the following sentence:

"Class 2 is used to process the 4XX series corrosion resisting steels, class 3 is used for 3XX and 4XX series, and class 4 is used to process those 300 series corrosion resisting steels which can meet the special salt spray test criteria and for those 4XX series corrosion resisting steels which do not have any special salt spray test criteria.

Paragraph 6.3.2 Processing. Table I - add: an additional row between 1 and 3 for class 2 as follows:

Class	Applicability ferrous metals	Process and possible chemicals	Approximate processing temperature	Approximate immersion time
2	Certain corrosion resistant steel alloys which are tempered at less than 482°C	Alkaline-chromate $NaOH$, $NaNO_3$, $Na_2Cr_2O_7$, Water.	250 ± 10°F (121 ± 5°C)	30 to 45 min

Paragraph 6.3.2 Processing. Table I, column 2, Applicability to ferrous metals, class 4: Delete "For 300 series corrosion resistant steel alloys only" and substitute "For corrosion resistant steel alloys."

Change paragraph 6.3.3 to read as follows:

"6.3.3 Cast and malleable irons, and certain 400 series corrosion resistant steels. Cast and malleable irons and 400 series corrosion resistant steels of the martensitic type can also be effectively treated in Class 4 proprietary baths, but will not meet the salt spray requirement of austenitic 300 series corrosion resistant steels."

Custodians:
Army - MR
Navy - OS
Air Force - 20

Review activities:
Army - AR, MI, EA, GL, AV, ME
Navy - AS
Air Force - 99

User activity:
Navy - SH
Air Force - 68

Preparing activity:
Army - MR

Project No. MFFP-0291

H-13.07

MIL-C-13924C
9 June 1980
SUPERSEDING
MIL-C-13924B
30 March 1966

MILITARY SPECIFICATION

COATING, OXIDE, BLACK, FOR FERROUS METALS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers black oxide coatings applied to ferrous metals (wrought iron, carbon, low alloy, and corrosion resistant steels). Black oxide coatings, with or without a supplementary preservative treatment (see 3.11), may be used where a black surface is required. Only very limited corrosion protection, under mildly corrosive conditions, is obtained as a result of black oxide coating (see 6.1). Black coatings are included in this specification with limitations as noted in 1.2.

1.2 Classification. Black oxide coatings covered by this specification shall be of the following classes as specified (see 6.4).

Class 1 - Alkaline oxidizing process (for wrought iron, cast and malleable irons, plain carbon, and low alloy steels).

Class 3 - Fused salt oxidizing process (for corrosion resistant steel alloys which are tempered at 900 F (482 C) or higher).

Class 4 - Alkaline oxidizing process (for 300 series corrosion resistant steel alloys only).

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

/ Area MFFP /

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMR-LS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

THIS DOCUMENT CONTAINS 10 PAGES.

P

SPECIFICATIONS

FEDERAL

TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings

VV-L-800 - Lubricating Oil, General Purpose, Preservative, (Water-Displacing, Low Temperature)

MILITARY

MIL-S-5002 - Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems

MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application

DOD-P-16232 - Phosphate Coating, Heavy, Manganese or Zinc Base (For Ferrous Metals)

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

HANDBOOKS

MILITARY

MIL-HDBK-205 - Phosphating and Black Oxide Coating of Ferrous Metals

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

B 117 - Method of Salt Spray (Fog) Testing

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 Materials. The materials for the blackening processes shall be selected by the contractor. The selected materials shall result in black coatings meeting all the applicable requirements of this specification.

3.2 Preparation of basis metal. Prior to the application of the black coatings, the basis metal shall be thoroughly cleaned as prescribed in MIL-S-5002. Cleaning materials and methods shall be at the option of the contractor. The cleaning process shall be performed without measurable abrasion or erosion. The cleaned surfaces shall be free of rust, scale, grease, oil, paint, or other foreign matter.

3.2.1 Stress relief treatment. All parts which are cold formed or which contain residual tensile stress, such as may be produced by cold straightening, shall be given a stress relief treatment in accordance with MIL-S-5002 before cleaning and coating.

3.2.2 Coating as a final process. Unless otherwise specified, the black coatings shall be applied after all machining, forming, welding, cold straightening and heat treatment have been completed.

3.3 Application of black coatings. The coating shall conform to the class specified. The specified black coating shall be applied under controlled time and temperature conditions. All equipment together with solutions or baths shall be properly maintained and kept free of dirt or possible contaminants. The selected process shall not reduce the hardness of the parts being processed or expose the parts to temperatures in the temper brittle range of the material, nor shall it cause embrittlement of the steel.

3.3.1 Surface attack. The process shall not result in any attack of the surface, either pitting or intergranular. Daily determination for this behavior shall be made using a microscopic method and examined at a magnification which will clearly establish the condition. Parts with pitted surfaces or showing intergranular attack shall be rejected.

3.4 Alkaline oxidizing solutions (class 1). Class 1 oxide coatings shall be formed from a boiling alkaline-oxidizing solution.

3.4.1 Rinsing. Class 1 black oxide coated pieces shall be rinsed immediately after processing in a stagnant warm rinse at 140 to 190 F (60 to 88 C) followed by thorough cold water rinsing to effect complete removal of blackening solution.

3.4.2 Chromic acid dip. After the cold water rinse (see 3.4.1) the pieces shall be dipped for a minimum of 30 seconds in a 0.06 percent solution (8 oz. chromic acid per 100 gallons water) of chromic acid maintained at a temperature of 150 to 190 F (66 to 88 C) and a pH of 2 to 3. After the chromic acid dip, parts shall be dried without further rinsing by using warm dry air.

3.5 Fused salt oxidizing (class 3). The temperature of the molten oxidizing salt of class 3 shall not be higher than 900 F (482 C). After suitable immersion, the treated parts shall be withdrawn, cooled from eight to ten minutes and rinsed in hot water, 190 F (88 C), followed by thorough cold water rinsing to effect complete removal of blackening solution. After rinsing, the parts shall be dried by warm dry air and given a chromic acid dip as outlined in 3.4.2.

3.6 Alkaline oxidizing (class 4). The black coating of class 4 shall be processed in accordance with instructions furnished by the suppliers of the raw materials and the resulting coating shall conform to the applicable requirements of this specification.

3.7 Coverage and color. The class 1, 3, and 4 coatings (see 1.2) shall cover the basis metal completely and shall pass the smut test. The color shall be a uniform black. A slight amount of smut, which is inherent in the process, shall not be cause for rejection. There shall be no indication of any reddish-brown or green smut when tested as in 4.4.1. Smut "spottiness" shall be classified as unsatisfactory requiring reprocessing.

3.8 Quality coating (oxalic acid spot test for classes 1 and 3). The black oxide coatings of classes 1 and 3, prior to the application of a preservative, shall pass the oxalic acid spot test for a good quality coating (figure 3) as specified in 4.4.2.

3.9 Resistance to salt spray (fog) (class 4 AISI type 300 series corrosion resistant steel only). The black coating, of class 4 (300 series only), prior to the application of a prservative, shall show no signs of corrosion after 96 hours of exposure in the salt spray test (see 4.4.3).

3.10 Treatment of high strength steel. When specified, steel parts having an ultimate tensile strength of 200,000 psi (1379 MPa) or above shall be baked at 375 ± 25 F (191 ± 14 C) for three hours or more or given an equivalent embrittlement relief treatment after application of the oxide coating. Coated springs or other parts subject to flexure shall not be flexed prior to the baking operation. When specified by the procuring activity, high strength steel parts shall be tested in accordance with 4.4.4 for embrittlement relief. If an embrittlement relief bake is required, it shall follow the chromic acid rinse. The embrittlement relief precedes the supplmentary preservative treatment.

3.11 Supplementary preservative. Materials for supplementary preservative treatments and methods of application shall be in accordance with the applicable requirements of the end item specification, or as otherwise specified. Unless otherwise specified, the supplementary preservative treatment shall be applied to the clean and dry parts immediately following the hot dilute chromic acid dip.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Lot. A lot shall consist of coated parts of the same class, same basis metal, and approximately the same size and shape and coated under similar conditions. A maximum of 8 hours continuous production shall constitute a lot.

4.3 Sampling. Single sample plan for normal inspection of the classification of defects shall be in accordance with MIL-STD-105.

4.3.1 Sampling for nondestructive tests (visual inspection, coverage, color, smut, and workmanship). Samples shall be selected at random from each inspection lot in accordance with MIL-STD-105, inspection level I, and acceptable quality level (AQL) equal 1.0 percent defective.

4.3.2 Sampling for destructive tests (oxalic acid spot test, salt spray test, and embrittlement relief test). Samples shall be selected at random from each inspection lot in accordance with MIL-STD-105, inspection level S-1 and acceptable quality level (AQL) equal to 1.0 percent defective.

4.4 Test procedures.

4.4.1 Smut test. Test shall be made prior to application of corrosion preventive compound or after vapor degreasing. Each black oxide coated piece shall be inspected visually under strong light to assure a satisfactory appearance. Each sample shall also be wiped with a clean white cloth for indications of smut (see 3.7). A slight amount of smut which is inherent in the process is acceptable for all classes of coatings and shall not be cause for rejection.

4.4.2 Oxalic acid spot test (classes 1 and 3). The black oxide coated pieces of classes 1 and 3 only, prior to the application of a preservative, shall be handled with clean cotton gloves or the equivalent. Each sample shall have deposited, on one flat spot of the black oxide coated surface, three drops (0.2 ml) of a five percent solution of oxalic acid. The reaction shall be observed after 30 seconds and up to eight minutes. After eight minutes the panel shall be rinsed and compared to figures 1, 2, and 3. A light grey center with a lighter border color (figure 1) indicates a poor quality coating. A grey-black center with a light border (figure 2) indicates a borderline quality coating. The coating shall conform to the good quality coating of figure 3 to be acceptable. A black or dark brown center with a light border (figure 3) indicates a good quality coating. A good quality coating may show a light border, indicating exposure of metal around the drops. Parts shall therefore be judged only on the color and exposure of the metal under the drops.

4.4.3 Resistance to salt spray (class 4). The coated pieces of class 4 (AISI type 300 series corrosion resistant steel) shall be subjected to a 5 percent salt spray (fog) test in accordance with ASTM B 117. Exposure time for the black coatings, prior to the application of a preservative, or after vapor degreasing, shall comply with the requirements of 3.9.

4.4.4 Embrittlement relief. To test for embrittlement, the use of notched tensile samples may be used when specified. Samples selected in accordance with 4.3.2 for determining compliance with 3.10, shall be subjected to a sustained tensile test as specified by the procuring activity, or using loads applicable to the parts as contained herein. The articles or parts shall be held under the load for at least 200 hours unless otherwise specified, and then examined for cracks. The lot shall be rejected if any coated part develops cracks or fails by fracture.

4.4.4.1 Fasteners. Parts such as steel fasteners, threaded or not threaded, which are used for mechanical joining of metal shall be subjected to a sustained tensile loading not less than 75 percent of the material specification minimum ultimate tensile strength.

4.4.4.2 Spring pins, lock rings, etc. Parts such as spring pins, lock rings, etc., which are installed in holes as rods shall be similarly assembled using the applicable parts specification as drawing tolerances which impose the maximum sustained tensile stress on the coated parts.

4.4.4.3 Other parts. Other parts, that will be subjected to a sustained static tensile load in excess of 25 percent of the material specification minimum tensile yield strength in service use, shall be subjected to a sustained tensile load equal to 75 percent of the material specification minimum tensile yield strength.

5. PACKAGING

5.1 Preparation for delivery is not applicable to this specification.

6. NOTES

6.1 Intended use. Black oxide coatings are particularly suited for moving parts that cannot tolerate the dimensional build-up of a more corrosion-resistant finish. They are not recommended on parts going into long-term storage. Sometimes, long term storage is required and a protective preservative fluid is recommended or a desiccated package is utilized. The coatings present a pleasing black appearance frequently employed for decorative purposes or decrease in light reflection. A supplementary water displacing preservative coating such as MIL-C-16173, grade 3 or VV-L-800 or comparable material which will provide equal or superior corrosion protection may be specified.

CAUTION: High strength steel (Rockwell C40 or greater hardness) may be subjected to "caustic embrittlement" that could lead to spontaneous cracking if under internal or applied stress during the blackening treatment.

6.1.1 Organic finishes. Black oxide coatings are not primarily used as pretreatment coatings for paint and lacquer. A phosphate base coating (TT-C-490, type I, or DOD-P-16232, type Z, class 3) gives better corrosion resistance and is preferred.

6.2 Ordering data. Purchasers should exercise any desired options offered herein, and procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Class of coating (see 1.2).

c. Embrittlement relief treatment and test, if applicable (see 3.10 and 4.4.4).

d. Supplementary preservative treatment if required (see 3.11 and 6.1).

6.3 Miscellaneous notes.

6.3.1 Dimensional change. Black oxide coatings on iron and steel should produce no appreciable dimensional change of the treated piece. The dimensions shown on the drawings are, therefore, the dimensions after the application of the coatings.

6.3.2 Processing. Contractors may employ one of a number of trade-name black-finishing oxidizing materials or prepared chemical mixtures to apply the black oxide coating. The processing details should conform to MIL-HDBK-205, or as recommended by the raw material supplier. Table I provides an outline of the various processes.

TABLE I. Materials and processing procedures.

Class	Applicability to ferrous metals	Process and possible chemicals	Approximate processing temperature	Approximate immersion time
1	Carbon steels, low alloy steels, wrought irons, cast and malleable irons	Alkaline oxidizing, NaOH, $NaNO_3$, water	1 or 2 tanks boiling at 285 - 305 F (141 - 152 C)	5 to 60 min
3	For corrosion resistant steel alloys which are tempered at 900 F (482 C) or higher	Fuzed salt oxidizing $Na_2Cr_2O_7$ and/or $K_2Cr_2O_7$	Molten bath 750 - 850 F (399 - 454 C)	30 min
4	For 300 series corrosion resistant steel alloys, only	Alkaline oxidizing, proprietary compounds plus water.	250 - 265 F (121 - 130 C)	15 to 30 min

6.3.3 Cast and malleable irons. Cast and malleable irons may be more effectively treated in class 4 proprietary baths. They have not been included in table I because of the class 4 salt spray requirement.

6.3.4 Class 4 coatings. Corrosion resisting steels of minimum composition 17 Cr - 7 Ni can be effectively blackened by this process.

6.3.5 Rinsing. In order to obtain effective removal of blackening solution and ensure thorough rinsing, a combination of spray rinses with tank rinses or a properly operated double counterflow rinse operation may be advantageous. Use of such a system may help reduce the amount of water required to obtain a desired rinsing criterion and facilitate meeting the EPA standard.

Custodians:
Army - MR
Navy - OS
Air Force - 11

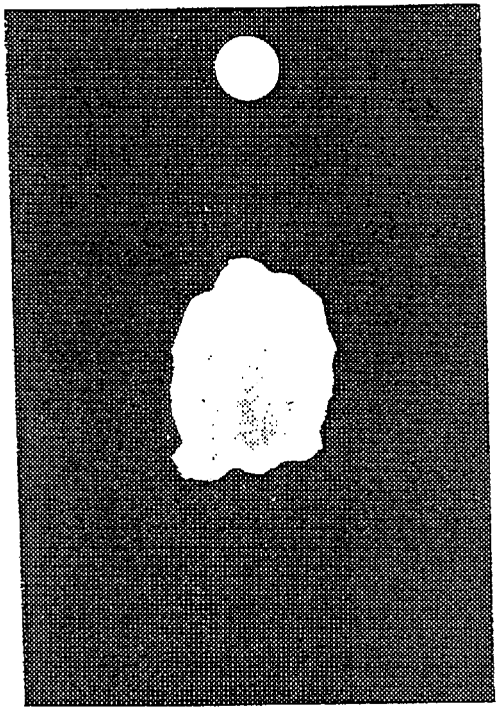
Preparing activity
Army - MR

Project No. MFFP-0147

Review activities:
Army - AR, MI, EA
Navy - AS
Air Force - 99

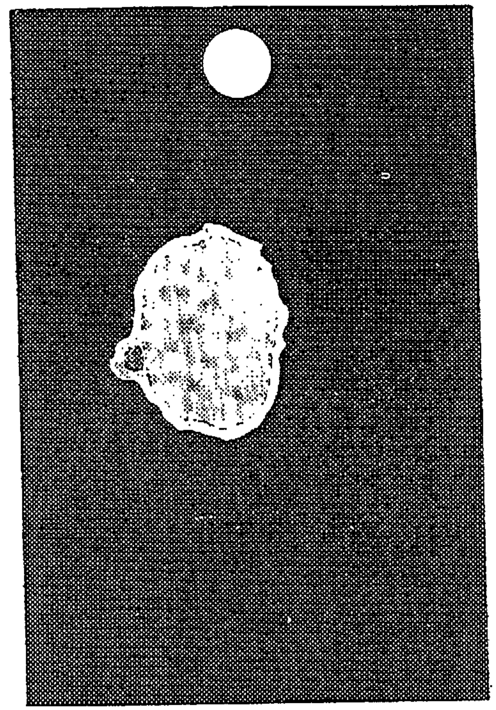
User activity:
Army - ME, AV
Navy - SH
Air Force - 68

OXALIC ACID SPOT TESTS ON BLACK OXIDE COATINGS



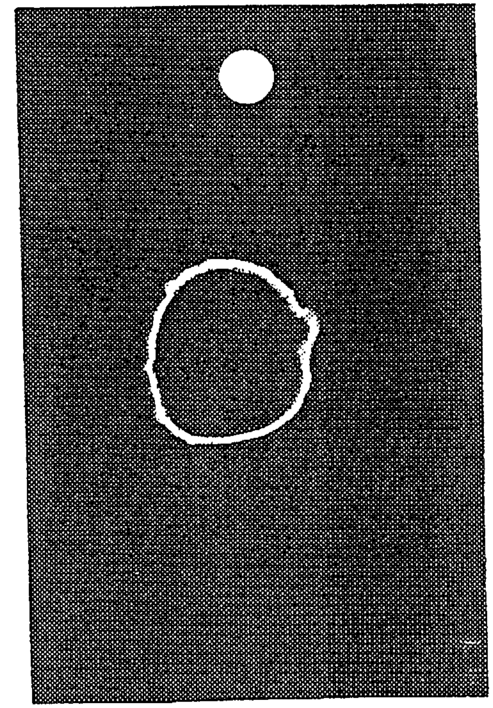
A POOR QUALITY COATING

Figure 1



A BORDERLINE QUALITY COATING

Figure 2



A GOOD QUALITY COATING

Figure 3

Appendix F

ISO 9001

SI ISO 9000
The Standards Institution of Israel
Quality Assured Firm

The Standards Institution of Israel

מתי

Certificate of Approval

This is to certify that the Quality Management System of

ELGEMS LTD.

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has been audited by SII and found to comply with the Quality Management Standard: SI ISO 9001 And EN46001

The Certificate is granted in accordance with SII's Rules for the Certification of Quality Systems (SII procedure-002). The validity of the Certificate is subject to the continuous maintenance of the Quality System according to the above standard, and the follow-up surveillance performed by SII.

scope: *DESIGN, MANUFACTURE AND SERVICE SUPPORT OF NUCLEAR MEDICINE DIAGNOSTIC IMAGING SYSTEMS.*

Accredited by

the R v A

CERTIFIED IQNet QUALITY SYSTEM

Date of initial approval: 16 . 07 . 1997
Date of issue: 01 . 01 . 1999
Date of expiration: 31 . 12 . 2001

No: 16563

Ziva Patir

ZIVA PATIR
Director General

Appendix G

NER-462 Source Window Safety Evaluation
DuPont Pharmaceuticals

NER-462 SOURCE WINDOW SAFETY EVALUATION

The Model NER-462 ^{55}Fe source has a 'window' of 2 mil thick Kapton (DuPont) type H polyimide film with ~ 300 Å of nickel evaporated on one side. The polyimide has demonstrated sufficient radiation resistance to function as an NER-462 source window. The maximum absorbed dose of an NER-462 source window for the entire ^{55}Fe decay is $\gtrsim 2\times10^7$ Grays.

SOURCE WINDOW ABSORBED DOSE

The calculation of the total radiation dose to the kapton source window has the following conservative assumptions:

1. The radiation incident on the window is 0.5 times the radiation emitted by the ^{55}Fe nuclide (2π geometry), with no allowance for self-attenuation within the ^{55}Fe deposit.
2. The energy of the Auger electrons from the ^{55}Fe decay is totally absorbed in the window because the range of the electrons is less than the window thickness of 7.2mg/cm^2.

The dose rate to the window active diameter from the 6 KeV photon of ^{55}Fe is calculated to be 0.179 Grays-cm^2/hr-mCi from the equation:

$$\text{Dose} = \{0.5\}\ \{21.3\text{x}10\ \frac{\text{Disint.-gm-Gray}}{\text{MeV-mCi-hr}}\}\ \{\frac{f\text{x}E\text{x}\mu}{\rho}\}$$

f = 0.28 Photons/disint.

E = 6×10^{-3} MeV/Photon

μ = 14.2 cm^{-1}

ρ = 1.42gm/cm^3

Table 1 Computed Photon Dose Rates to Source windows

Capsule	Window Area	Maximum Activity	Dose Rate	Maximum Absorbed Dose Rate
LE55E	0.412 cm^2	50 mCi	0.179 Grays-cm^2/hr-mCi	22 Grays/hr.
LE55F	0.894 cm^2	100 mCi	0.179 Grays-cm^2/hr-mCi	20 Grays/hr.

The dose rate to the window active diameter from the electron emission of ^{55}Fe is determined to be 0.0426 gm-Gray/mCi-hr from the equation:

$$\text{Dose} = \{0.5\}\ \{21.3\ \frac{\text{Disint/-gm-Gray}}{\text{MeV-mCi-hr}}\}\ \{\Sigma f x E\}$$

f = 0.61 and 1.39 Auger electrons/disintegration

E = 5.19×10^{-3} and 6×10^{-4} MeV/electron respectively.

Table 2 Computed Electron Dose Rates to Source Windows

Capsule	Window Mass	Maximum Activity	Dose Rate	Maximum Absorbed Dose Rate
LE55E	2.97×10^{-3} gm	50 mCi	0.0426 gm-Gray/mCi-hr	720 Grays/hr
LE55F	6.45×10^{-3} gm	100 mCi	0.0426 gm-Gray/mCi-hr	660 Grays/hr

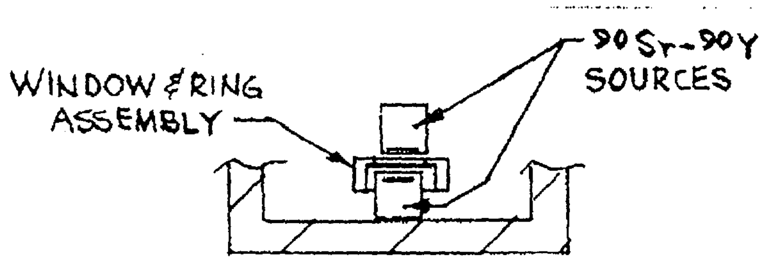
The total absorbed dose rates are 740 Grays/hr for the LE55E capsule and 680 Grays/hr for the LE55F capsule. Therefore the maximum total absorbed dose over the total decay life (~18 yrs.) of the ^{55}Fe source would be:

$$\frac{\text{Dose Rate}}{\lambda} = \frac{740\ \text{Grays/hr}}{2.93 \times 10^{-5}\ \text{hr}^{-1}} \cong 2.5 \times 10^{7}\ \text{Grays}$$

KAPTON IRRADIATION

A total of four window and ring assemblies were prepared for the prototype tests. Two of the assemblies were irradiated and two were maintained as controls for testing to indicate any differences in ultimate strength, ductility, or hermetic seal.

Each of two units were irradiated by exposure to 2.5×10^{7} Grays of ^{90}Sr-^{90}Y beta dose emitted from two sources placed on the window and ring assemblies as shown below. The contact beta dose of each source (0.19-0.21 Grays/sec each) was measured by direct comparison to an N.B.S. dose rate calibrated ^{90}Sr-^{90}Y source of identical construction. The dose rate was $\gtrsim 3.5 \times 10^{5}$ Grays/day to each polyimide window.



PROTOTYPE TESTS

The first control unit was threaded onto a fixture connected to a compressed gas cylinder. The regulator valve was opened slowly allowing the gas pressure to expand and burst the window at 400 psig. The first irradiated unit was tested in the same manner and the window burst at 350 psig. This test indicated that the irradiated unit retained most of its ultimate strength after being subjected to a radiation exposure of $\sim 2.5 \times 10^7$ Grays.
The second control unit and irradiated unit were threaded onto the fixture separately. The gas slowly expanded each window, however, the window pressures were released at 50 psig below the burst pressures recorded in the first test. As shown in Figures 1 & 2, the plastic deformations were similar, illustrating that the ductility of the Kapton material was retained after a radiation exposure of $\sim 2.5 \times 10^7$ Grays.

FIGURE 1: CONTROL UNIT

300 PSIG

FIGURE 2 IRRADIATED UNIT

The helium permeabilities of the second control unit and irradiated unit were measured and found to be 1.0 and 0.8×10^{-6} std. cc. He/sec. respectively. The higher He gas permeation of the control unit was attributed to its thinner section from greater expansion (350 vs. 300 psig) of the window. Therefore, the hermetic seals of both units were essentially the same.

SUMMARY

The prototype tests indicate that 2 mil Kapton type H polyimide film is suitable for use as an NER-462 source window. The total ^{55}Fe radiation exposure of the source window over the decay life of the source (~18 years) has little effect on the mechanical properties of the Kapton or the hermetic seal of the assembly.

Date: 6/13/80

By: John Sumares

John Sumares, Design Engineer
Nuclides and Sources Divisin

DEBBIE BEAUCHAMP/ASST MGR
GE MEDICAL SYSTEMS
3000 N GRANDVIEW BLVD
WAUKESHA WI 53188
(414)544-3839

SHIP DATE: 30JUL99
ACC # 103267080
ACTUAL WGT: 1 LBS SCALE

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UNITED STATES NUCLEAR REGULATORY CM
MATERIALS SAFETY AND INSPECTION BR.
DIVISION OF INDUSTRIAL AN MEDICAL N
WASHINGTON DC 20555-0001

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UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555-0001

Mr. Saeng Lee

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