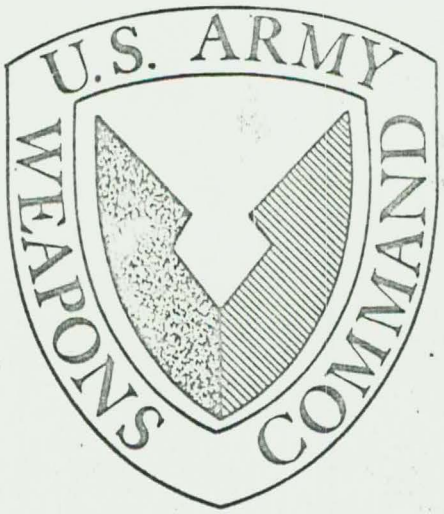
# REPORT OF EVALUATION ON NAVY CONVERSION OF RIFLE, U.S. CAL. .30, M1 TO FIRE 7.62 MM AMMUNITION BY MODIFICATION TO THE BARREL.




SPRINGFIELD ARMORY
SPRINGFIELD, MASS.

30 OCTOBER 1964

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# REPORT OF EVALUATION ON NAVY CONVERSION OF RIFLE, U. S. CAL .30, M1 TO FIRE 7.62MM AMMUNITION BY MODIFICATION TO THE BARREL

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Engineering Branch
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30 October 1964

# REPORT OF EVALUATION ON NAVY CONVERSION OF RIFLE, U. S. CAL .30, M1 TO FIRE 7.62MM AMMUNITION BY MODIFICATION TO THE BARREL

## I. OBJECTIVE

The primary purpose of this investigation was to evaluate and determine the feasibility and practicability of modifying rebuilt Rifle, U. S. Cal .30, M1 to fire 7.62MM ammunition utilizing a Navy design steel bushing assembled in the barrel chamber employing the Navy assembly procedure. This modification was primarily intended to be a simple and quick economical field conversion.

## II. CONCLUSIONS

1. There is no positive method of assuring that the bushing will be retained in the barrel chamber during life of barrel.

2. The M1 Rifle converted to fire 7.62MM ammunition is considered unsafe for launching grenades because of excessively high bolt recoil velocities.

3. The M1E14 Rifle has a large muzzle flash. The use of a flash hider will eliminate flash; but addition of a flash hider will increase weight, cost and supply problems.

4. Results of limited firing tests conducted in connection with the study indicate that there will be a tendency for a greater frequency of feed type malfunctions than is normally associated with the M1 Rifle.

5. The M1E14 Rifle conversion is not considered to be a quick economical field conversion.

III. RECOMMENDATIONS

1. In the event of adoption of the M1E14 Rifle, it is recommended that the solid barrel with 7.62MM chamber be required instead of M1 Rifle barrels converted by means of a separate bushing to avoid potential unsafe conditions.

2. The M1E14 Rifle should not be used for grenade launching.

3. A flash hider should be used with the converted M1 Rifles.

4. A spacer similar to the Navy version or the Rifle, Cal .30 T35 version should be used with the converted rifle to aid in guiding the shorter 7.62MM cartridge into the chamber, and also prevent the loading of a clip filled with Cal .30 ammunition.

IV. PROGRAM

1. As directed by Headquarters AWC during a 3 June 1964 meeting at Springfield Armory, a program was outlined to evaluate the Navy conversion of rebuilt M1 Rifles to fire 7.62MM ammunition by assembly of a Navy Bushing, Drawing 2256892, Rev B4, dated Oct 24, 1963 (see Appendix A) into an M1 Rifle barrel chamber.

2. On 13 August 1964, Springfield Armory was funded and authorized to proceed with the program. During an 8 October 1964 meeting relative to reviewing the status of the program at Springfield Armory, representatives from Headquarters AMC and AWC requested the Armory complete and submit a report including conclusions and recommendations on certain phases of the original program. These phases pertained to engineering studies, kinematic tests and preparation of a suitable bushing design including refinements based on results of engineering study.

V. DESIGN EVALUATION AND RESULTS

1. The design evaluation described in the above program is outlined and the results summarized as follows:

a. Review of M1 Rifle barrel drawings to identify design changes released during mass production, for effect on bushing retention.

A review was made of M1 Rifle drawings used in connection with production of M1 barrel. Two chamber requirements affecting pre-1942 manufactured barrels at the front neck diameter and location of second shoulder were found which could significantly affect assembleability of bushing. These dimensions are shown in sketch number 2.

b. Review of all barrel deviations authorized for effect on retention of the bushing.

A review of authorized deviations relative to M1 barrel chamber dimensional requirements indicated that the deviations would not adversely affect assembleability and retention of the bushing in barrel chamber.

c. Conduct dimensional studies of the interelationship between the M1 Rifle bolt assembly, headspace condition, 7.62MM cartridge case and the bushing in the M1 Rifle barrel chamber.

(1) Study showed that there can be a resultant diametral interference of .008 inch between the chamber body and the mating surface of the 7.62MM cartridge case as shown in Sketch Number 3. This would necessitate modification to M1 Rifle barrel chamber body to eliminate cartridge case interference.

Headquarters AWC authorized the Armory during early phase of the program to design a special reamer to remove the interference after the bushing was seated by firing two M80 Ball rounds.

(2) The Navy drawing 2256892 Rev B4, dated 24 Oct 1963, required phosphate coating of the bushing. This would affect retention of bushing in barrel chamber, since the coefficient of friction between phosphated surfaces and steel is less than that of steel on steel. The bushing should be free of any protective finish.

Note: Midway through the program the phosphate coating requirement was deleted.

(3) The fit between the bushing diameter and mating barrel chamber diameter (Sketch Number 4) and the front neck can result in an interference of .0015 with current barrel requirements and .0019 with pre-1942 barrel requirements. An interference can result at the second shoulder of the barrel involving length A, Sketch No. 2. This study takes into consideration the resultant shortening of dimensions based on extremes of tolerances relative to receiver, barrel and bolt, with barrel shoulder crush and maximum stock removed from the first shoulder of the barrel during the headspacing operation of the rebuilt M1 Rifle. Sketch Number 5 illustrates that the front portion of the bushing can strike the second shoulder of the chamber and prevent the bushing from seating because of a .0015 interference (current barrel design) to .0105

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NOTE: Sketch Number 1 illustrates barrel chamber nomenclature used throughout this report.

interference (pre-1942 barrel design).

(4) The 34° angle on bushing is different than the 34° 26' angle at second shoulder of barrel (Sketch Number 6). An interference will result between the .130R maximum of bushing and a permissible sharp corner at the second shoulder (Sketch Number 7). The above conditions adversely affect bushing assembleability or retention.

(5) With the bushing assembled in the barrel there may be a resultant maximum free run of bullet of .5177 inch in bullet seat area prior to engraving by the rifling (See Sketch Number 8). The maximum free travel of bullet in M1 Rifle is .065 inch. Because of length of bullet free run, greater than normal gas leakage will result in large muzzle flash. Excessive flash was observed during kinematic tests explained later in report. Gas leakage will probably accelerate erosion in bullet seat area in both original barrel and the softer bushing material. This may wear away the bushing material, affect holding force of bushing, and result in loosening or complete loss of the bushing from chamber. The bushing material does not have the erosion resisting qualities of the original barrel material. A loose bushing in barrel will disable the weapon. Complete loss of bushing can result in double feeding, one live round into another.

d. Study the dimensional relationship of eight round cartridge clip and the M1 Rifle receiver when using 7.62MM ammunition, including the review of all deviations on both receiver and clip.

(1) There are no deviations on record for either the M1 Rifle receiver or the eight round cartridge clip that would adversely

affect entry of a clip loaded with 7.62MM cartridge into the receiver.

(2) Sketch Number 9 shows the minimum clearance between a cartridge clip loaded with Cal .30 ammunition, inserted into the receiver as compared to a cartridge clip loaded with 7.62MM ammunition. The .0035 minimum clearance that may result in certain weapons with a cartridge clip filled with 7.62MM ammunition may be marginal, especially when the rifle is exposed to dust and dirt.

e. Evaluation of Navy Bushing fit in barrel.

(1) The Navy Bushing design under all conditions would not provide necessary plastic yielding of material to insure permanent assembly in barrel chamber.

(2) The minimum clearance between barrel and bushing must be sufficient so that yield of bushing beyond limit will provide plastic flow to conform to barrel chamber configuration with residual stress to result in sufficient pressure interference fit for retention of bushing.

f. Non-destructive examination of barrels in converted rifles.

In all converted test rifles in which an interference condition in first shoulder area was eliminated, X-Ray examination showed the bushings were fully seated in barrel chamber.

VI. KINEMATIC TEST PROCEDURE

1. Eight M1 Rifles selected at random that passed rebuild requirements were function fired 100 rounds each. Four rifles were then

used to obtain kinematic test data as follows:

a. Projectile velocity at 78 feet from muzzle.

b. Pressure readings inside gas cylinder.

c. Time-displacement curves using ball ammunition.

d. Time-displacement curves using cartridge, Cal .30, M3 Grenade, Rifle, and Grenade, Rifle Practice, M31 (inert).

2. The above eight rifles were converted to M1E14 configuration using the Navy design bushing except that the bushings were free of phosphate coating as follows:

a. Thoroughly clean chamber with trichloroethylene.

b. Eliminate sharp corner in first shoulder area of chamber of all rifles, using a special design reamer.

Note: This operation eliminated the interference as shown in sketch number 7 and was not included in original procedure.

c. Re-clean chamber thoroughly with trichloroethylene.

d. Insert bushing and M80 Ball round into breech, chamber, lock action and fire round. Feed a second round of M80 Ball into chamber and fire.

Note: It was necessary to hand charge the action a number of times on majority of rifles to seat the bushing and M80 Ball round in chamber. This was primarily due to interference of 7.62MM cartridge case in M1 Rifle chamber body as shown in sketch number 3.

e. After seating of the bushing, the M1 Rifle barrel chamber body configuration was re-shaped to accommodate the 7.62MM

cartridge by using another special design reamer. This also was not in the original procedure but was found necessary to preclude inordinate hand charging during subsequent testing. Excessive hand charging introduced a possible safety hazzard. The reamed area of chamber body was polished to insure ease of cartridge extraction.

f. The gas port hole diameters (.0790 + .0015) of the eight M1 Rifle barrels were enlarged to .0995 diameter on four barrels and .1065 diameter on four barrels. The eight converted rifles were then function fired 100 rounds each without utilizing a spacer.

g. Two rifles each with above barrel port diameters were selected and re-tested in accordance with par 1.

h. Still photographs were taken to record resultant flash on test weapons without and with a T-37 Hider, Flash.

VII. SUMMARY OF TEST RESULTS

1. The eight rifles were fired a total of 3100 rounds after conversion. Once the bushings were seated, there were no bushing extractions.

2. Headspace measurements of the eight M1 Rifles prior to conversion were within M1 Rifle rebuild requirements.

3. Headspace measurements of seven out of eight converted rifles were up to .0055 inch under the 1.6355 minimum headspace requirement for the M14 Rifle. This may cause difficulty in locking the Bolt in converted rifles.

4. Kinematic data and pressure readings (inside gas cylinder)

are tabulated in Chart I, II and III.

a. The peak pressures taken inside the gas cylinder and the bolt recoil velocities are lower in the converted M1E14 rifles than in M1 rebuild rifles. M1E14 rifles having the .1065 inch barrel port diameter more closely approximate the power of the M1 rebuild rifle.

b. Instrumental projectile velocities are tabulated in Chart II. Round to round variation in projectile velocities in the M1E14 rifle is greater than that recorded on rebuilt M1 Rifles, and muzzle velocities were higher in the M1E14 Rifle.

c. Data on Grenade Launcher tests are tabulated in Chart III. Bolt opening velocities were dangerously high on the converted rifles. On two rifles, the bolt recoiled violently enough to strike rear of Receiver and bounce back into battery. This condition occurred in rifles having barrels with port-hole diameters of either .0995 or .1065 inches.

5. Malfunction data are tabulated in Chart IV. There was an indication that feed type failures would be greater than the M1 Rifle.

6. Muzzle flash on the converted M1E14 Rifle was considered excessive using ball ammunition. A Hider, Flash (T37) designed for use with the M1C and M1D Snipers Rifle was used in an effort to supress flash. The T-37 Flash Hider eliminated this flash as shown in photographs taken during firing of single shots (see Appendix C).

## VIII. MODIFIED DESIGN

1. A modified bushing design and M1 Rifle barrel chamber configuration including an assembly procedure are shown on Sketch SA A28552 dated 30 Oct 64, sheets 1 through 5 (Appendix B).

2. Also included are two additional concepts as shown in alternative designs, Numbers 1 and 2 which would provide greater assurance of bushing retention in barrel chamber. These designs are considered more costly for manufacture.

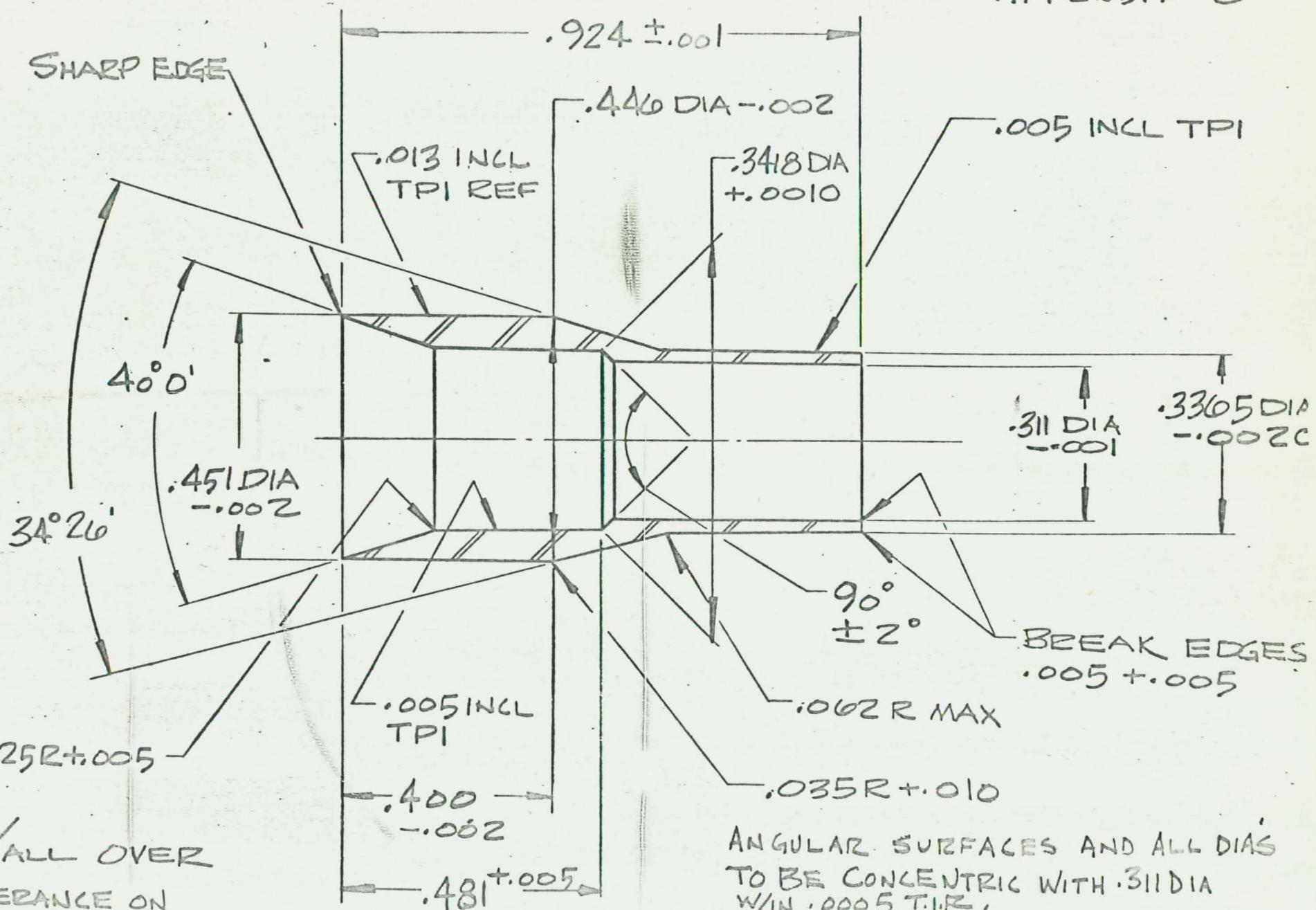
3. It should be recognized that further effort to design, test and evaluate the above designs will be required before any decision on adoption.

IX

COMPARATIVE ANALYSIS OF M1 RIFLE BARREL WITH BUSHING VS NEW BARREL WITH 7.62MM CHAMBER

| | BARREL WITH BUSHING | | NEW BARREL WITH 7.62MM CHAMBER |
|---|---|---|---|
| 1. | Bushing conversion less costly. | 1. | Cost greater than bushing. |
| 2. | Life questionable. | 2. | Barrel life should be equal to M1 Barrel. |
| 3. | Poorer accuracy, especially at longer ranges. | 3. | Accuracy equal to that of M1 Rifle. |
| 4. | No economical means of inspection of bushing in barrel. No positive assurance bushing will remain in chamber. | 4. | No problem. |
| 5. | Free run of bullet approximately 9 times that of M1 or M14 barrels. | 5. | Free run controlled to minimum by barrel design. |
| 6. | Bushing may become loose presenting a safety hazard. | 6. | No hazard. |
| 7. | Barrel bullet seat erosion accelerated. | 7. | Erosion should be comparable to that experienced in the M1 barrel. |
| 8. | Muzzle flash greater due to greater gas leakage. | 8. | Flash will be less due to control of free run of bullet. |
| 9. | 7.62MM M80 Ball ammunition not designed for compatibility with M1 Rifle rifling twist. | 9. | Barrel can be manufactured with 1 turn in 12 inches rifling twist. |
| 10. | Mechanical properties of bushing material do not match barrel steel. More susceptible to wear. | 10. | No problem. |
| 11. | Possibility of damaging or removal of bushing by use of a ruptured cartridge extractor and chamber cleaning equipment. | 11. | No problem. |
| 12. | Grenade launching results in a hazardous condition. | 12. | Grenade launching results in a hazardous condition. |

APPENDIX B




32 √ ALL OVER

TOLERANCE ON ANGLES ±0°15' UNLESS OTHERWISE SPEC.

ANGULAR SURFACES AND ALL DIAS TO BE CONCENTRIC WITH .311 DIA W/IN .0005 T.I.R.

# BUSHING

SA-A28552 3Cr64

SN 1 OF 5

PROCESSING PROCEDURE OF M1E14 CONVERSION

1. REMOVE BARREL AND RECEIVER ASSEMBLY.

2. REMOVE BOLT FROM RECEIVER.

3. REAM CHAMBER TO NEW DIMENSIONS (.013 INCL TPI BODY TAPER, 1.955 SHOULDER DEPTH, .450 SHOULDER DIAMETER) USING SPECIAL REAMER.

4. CLEAN CHAMBER.

5. CLEAN BUSHING.

6. RE-ASSEMBLE BOLT IN RECEIVER.

7. RE-ASSEMBLE ENTIRE WEAPON.

8. INSERT PROOF ROUND (7.62MM) IN BUSHING.

9. INSERT BUSHING WITH PROOF ROUND IN CHAMBER.

10. CLOSE BOLT MAKING SURE LOCKING LUGS ARE ENGAGED IN LOCKING SURFACES OF RECEIVER.

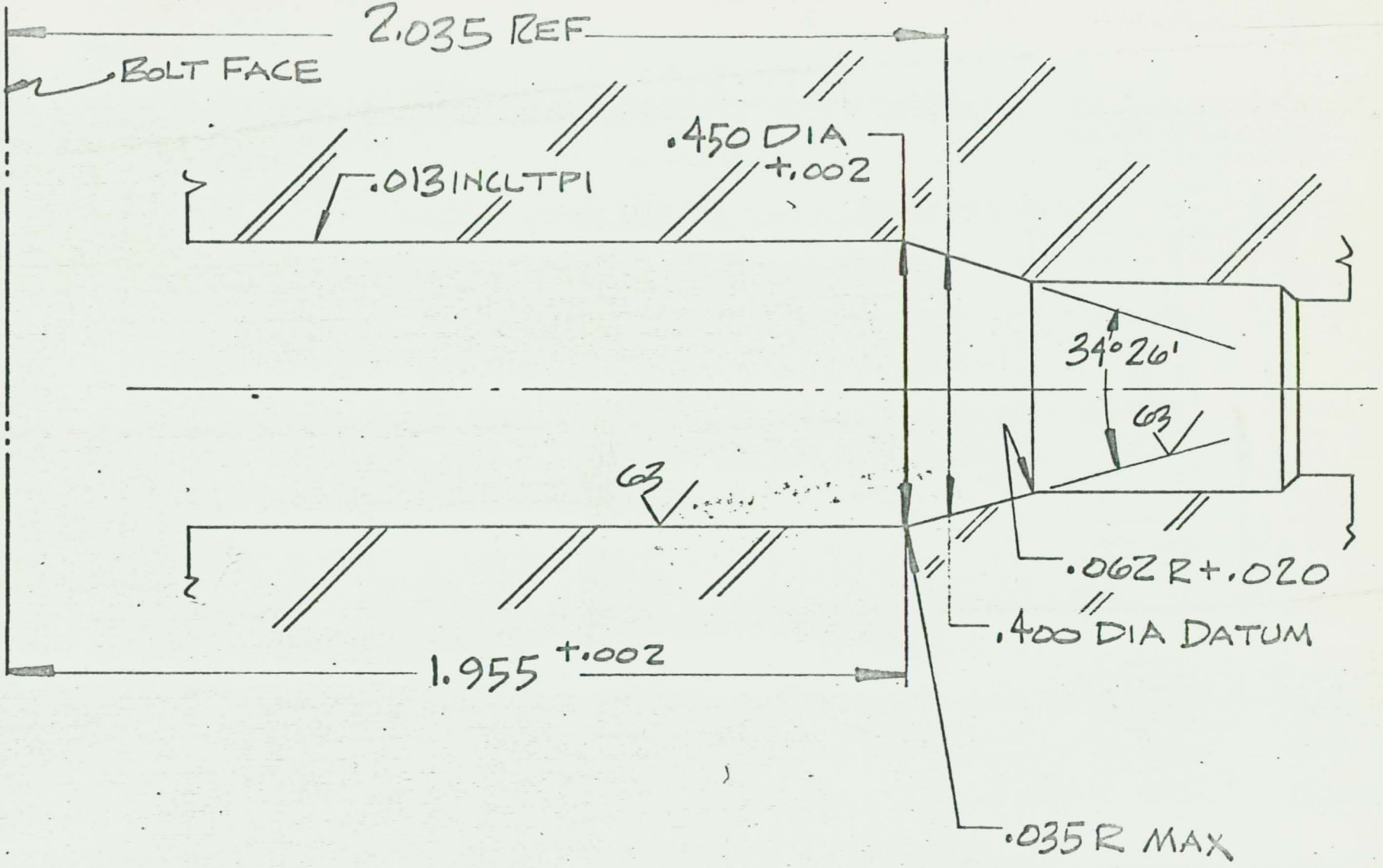
11. FIRE PROOF ROUND TO SEAT BUSHING.

12. USING PILOTED AND ADJUSTABLE REAMER, FINISH HEAD SPACE AND CLEAN BODY.

13. CLEAN CHAMBER.

14. CHECK FOR HEADSPACE REQUIREMENT.

15. FUNCTION FIRE 16 ROUNDS.



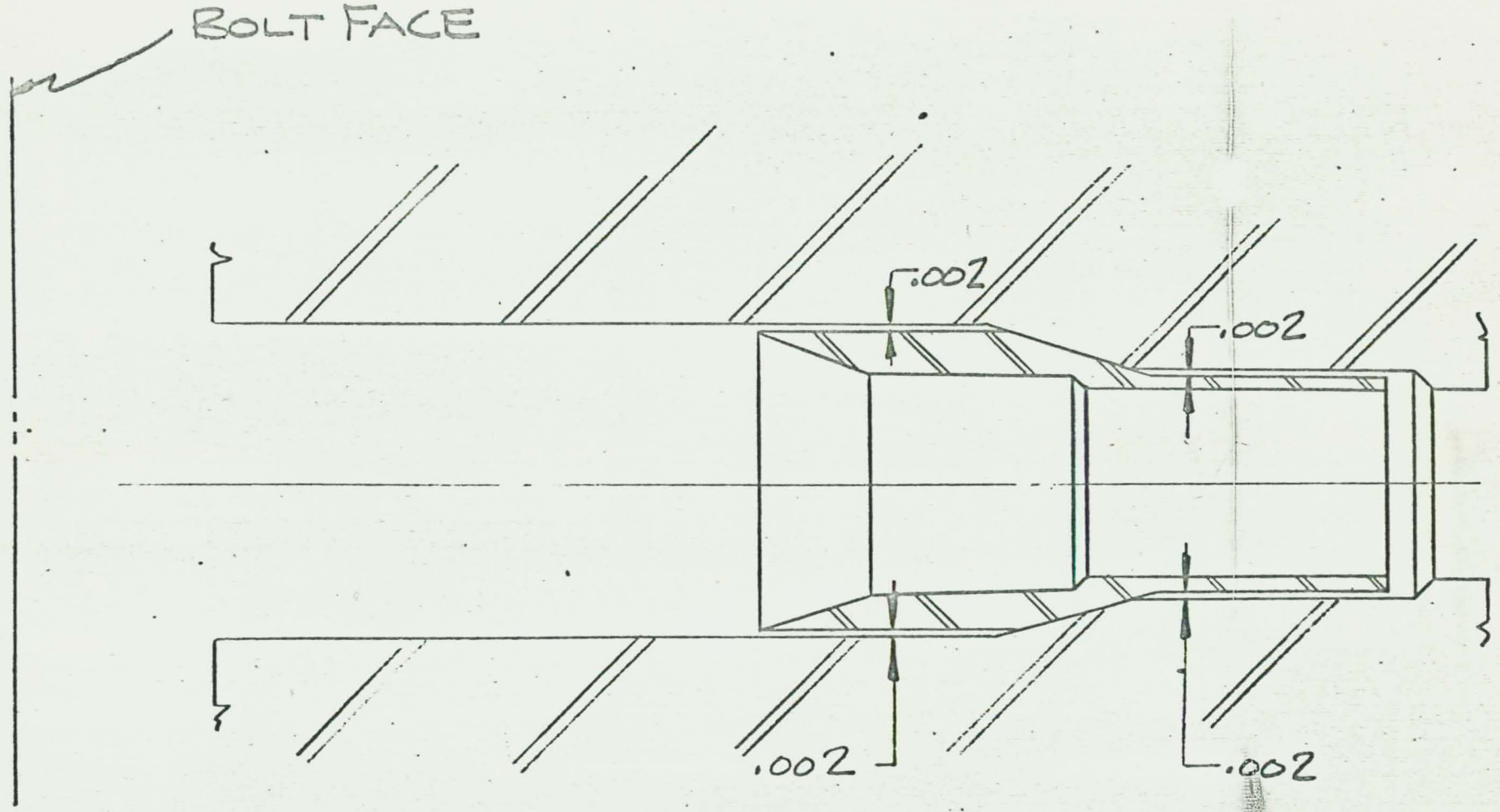

MODIFIED M1 BARREL CHAMBER REQUIREMENTS

30 Oct 64

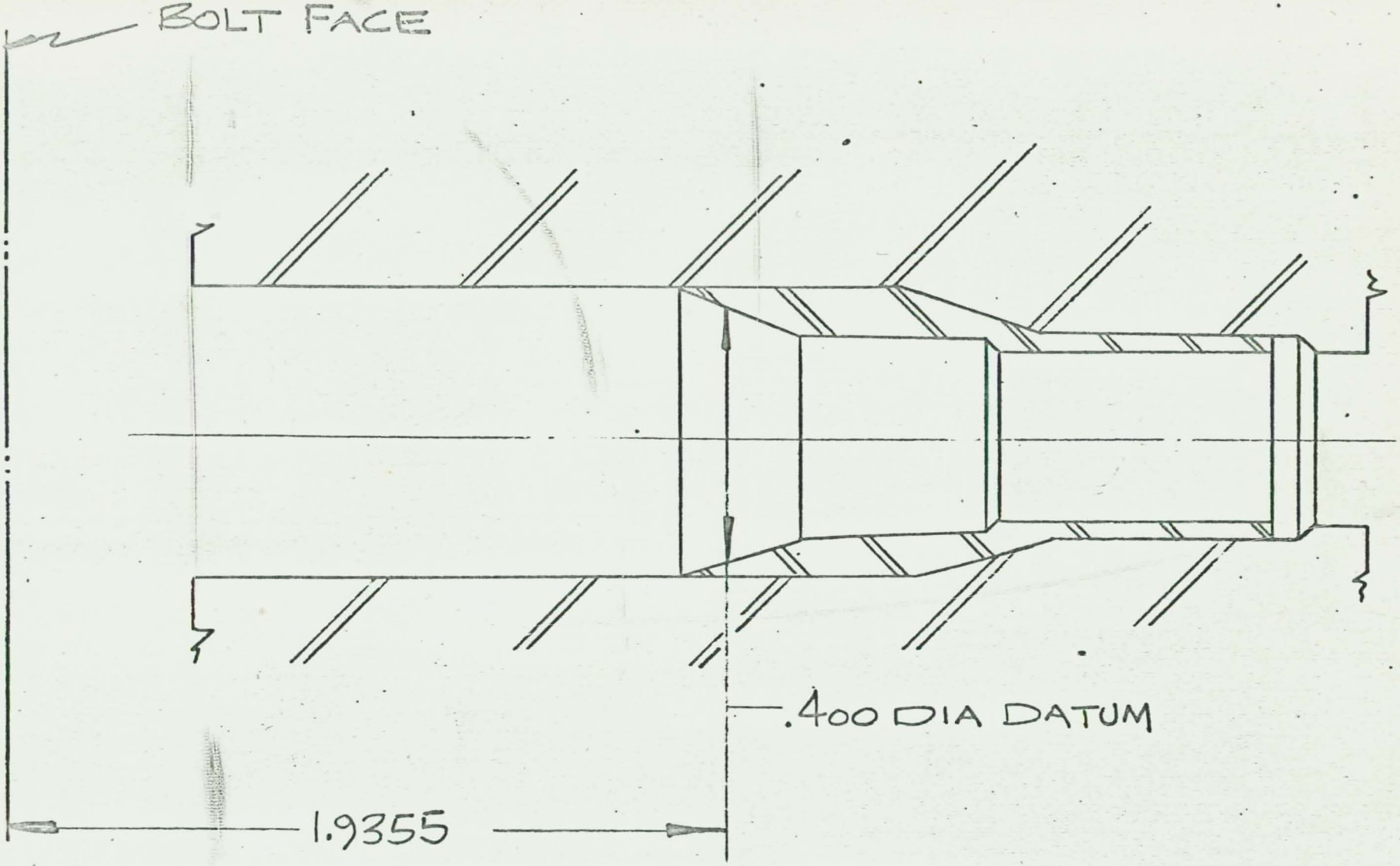
APPENDIX B

SH 3

SA-A2R557

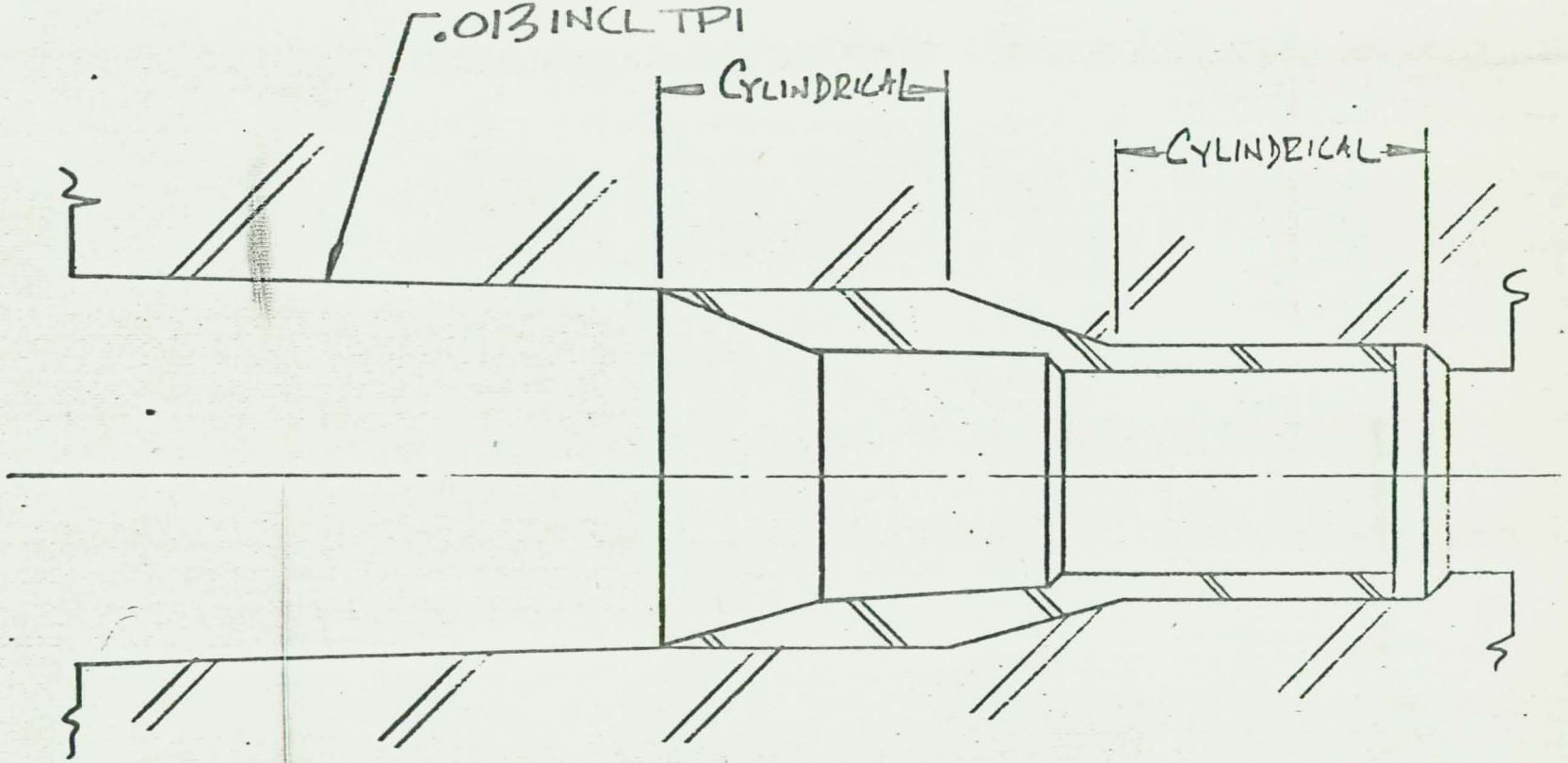



ASSEMBLY OF BUSHING IN CHAMBER



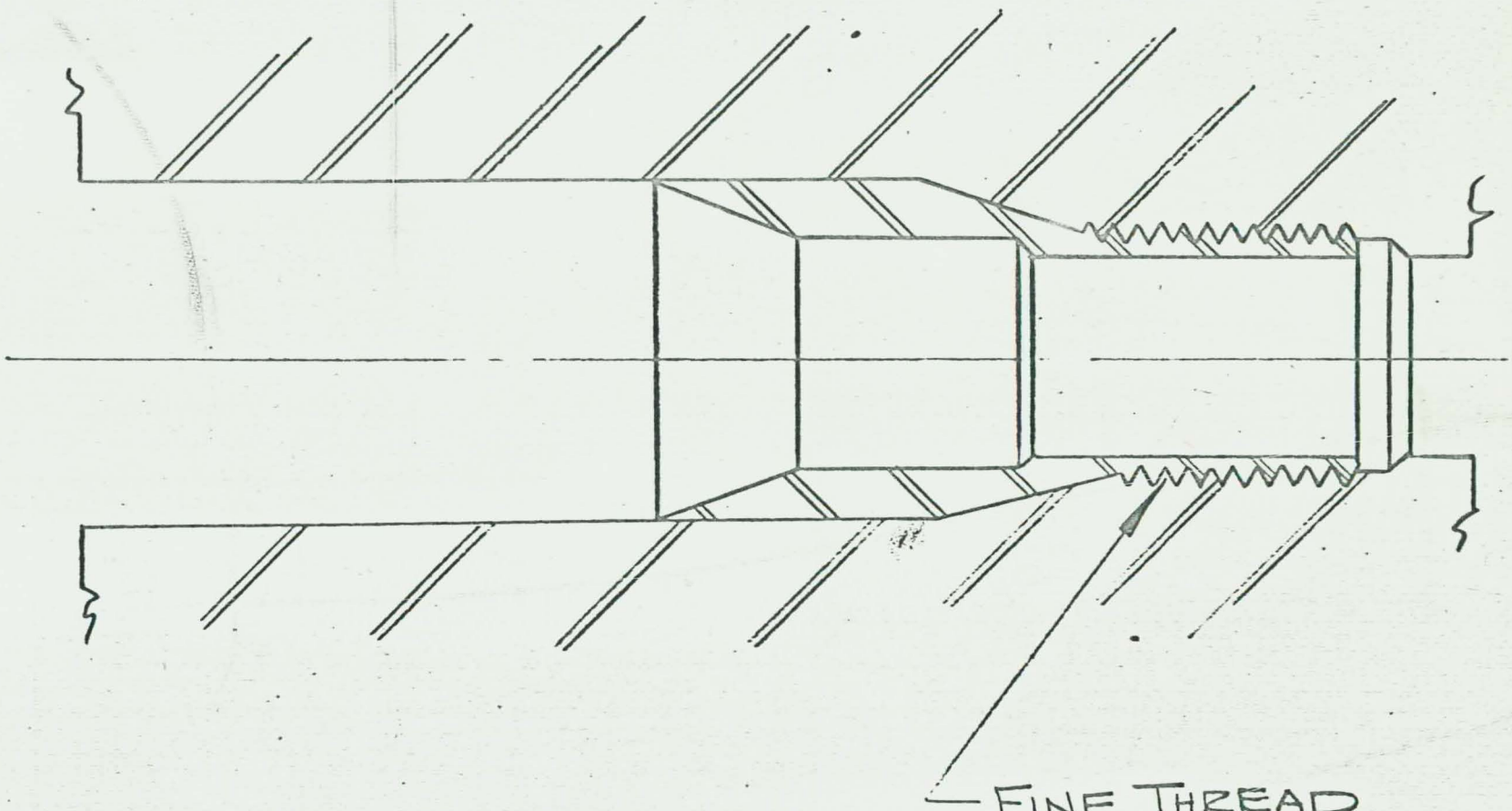

REAM TO M14 HEADSPACE REQUIREMENT

APPENDIX B SA-AZ8552 SH 5 30 OCT 64




ALTENATIVE BUSHING DESIGN #1

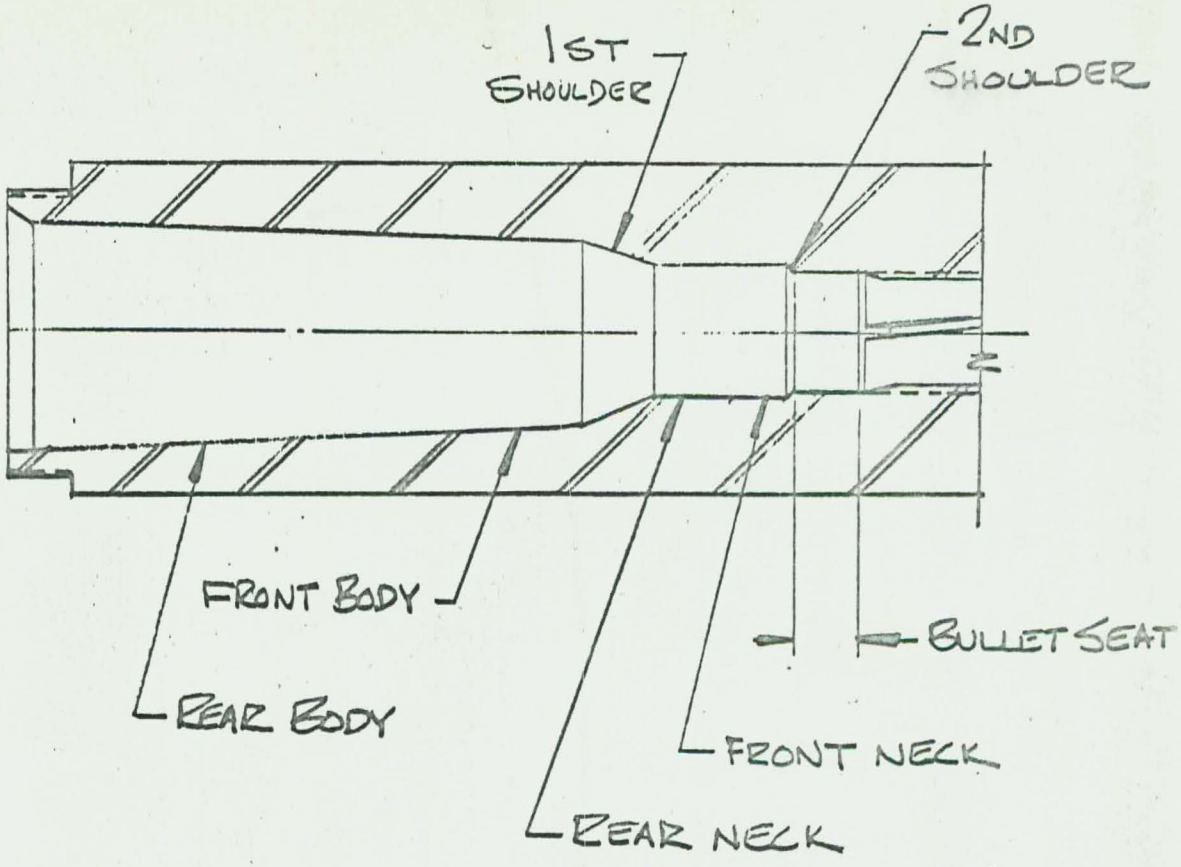
APPENDIX B



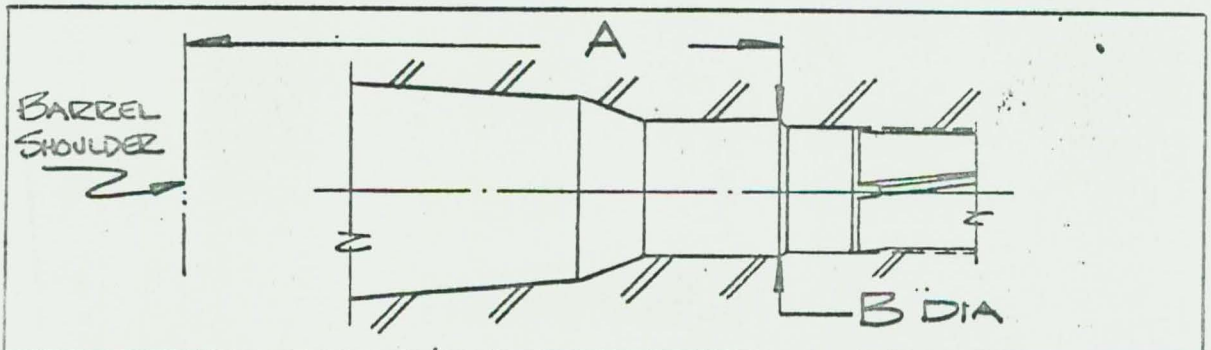

ALTERNATIVE BUSHING DESIGN * 2

APPENDIX B

30 OCT 64

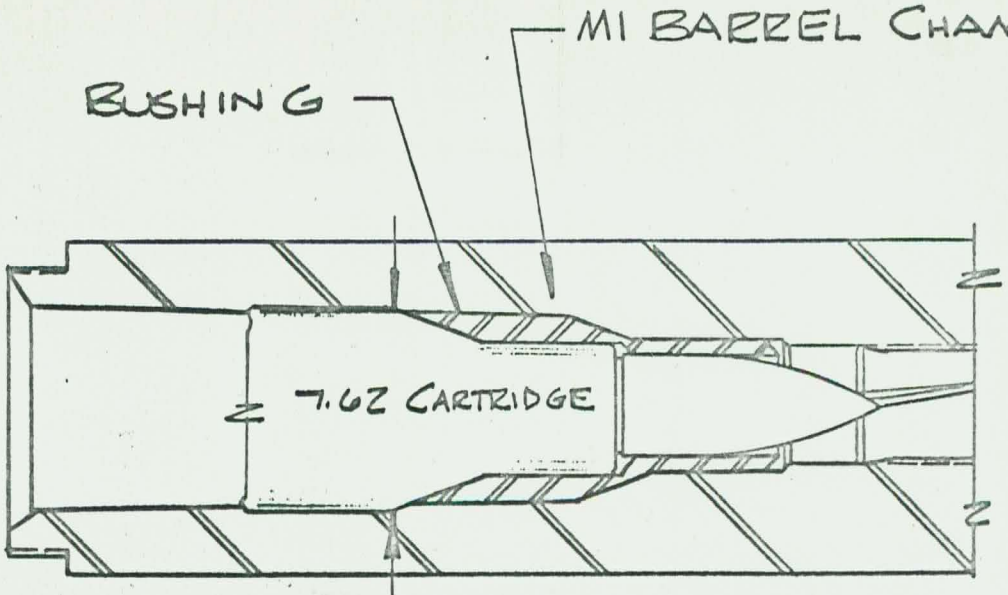



(1) M1 BARREL CHAMBER NOMENCLATURE



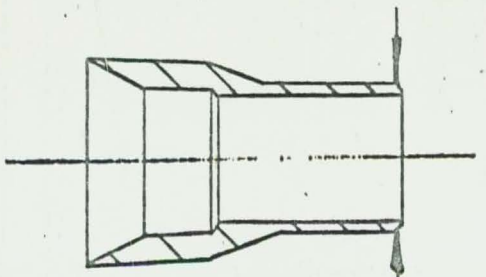

| DIM. | CURRENT | PRE 1942 |
|---|---|---|
| A | 1.850 +.0060 | 1.840 +.004 |
| B | .3405 +.0015 | .3401 +.0015 |
| | | REF SKETCH 4&5 |

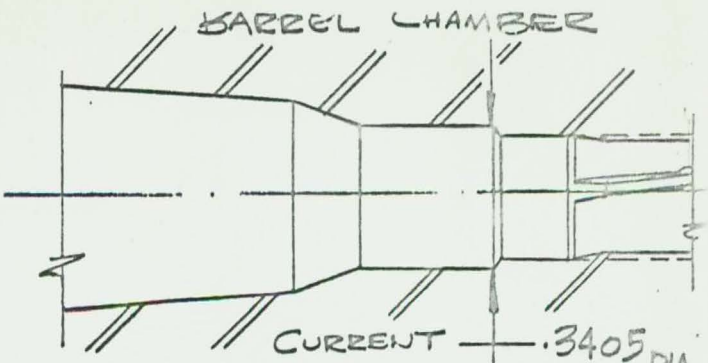
(2) COMPARISON OF CURRENT & PRE 1942 CHAMBER DIMS
APPENDIX C SKETCHES
30 OCT 64




(3) CARTRIDGE INTERFERENCE IN CHAMBER

APPENDIX C SKETCH 30 OCT 6

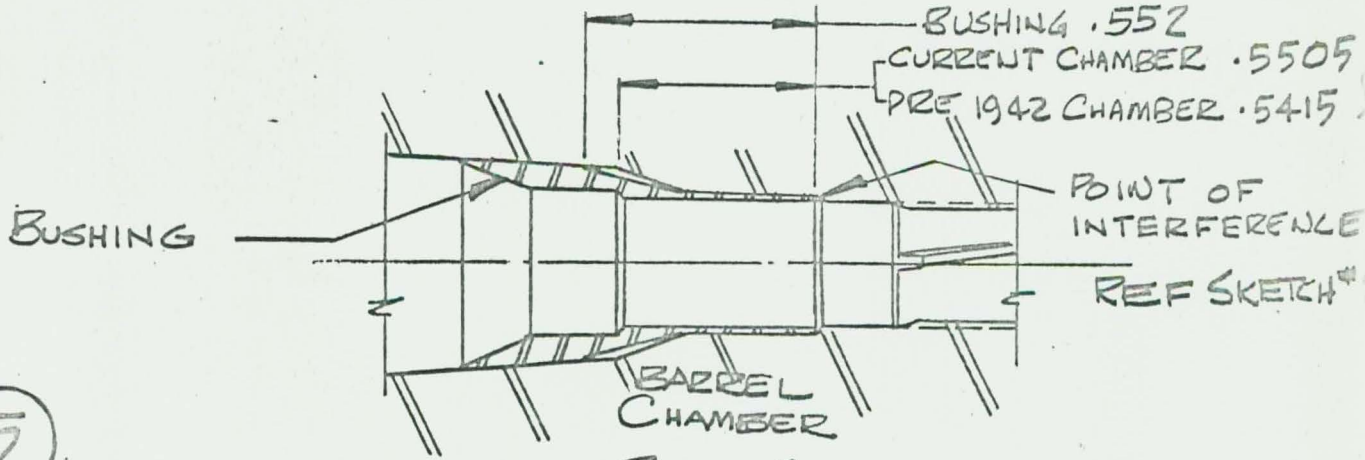




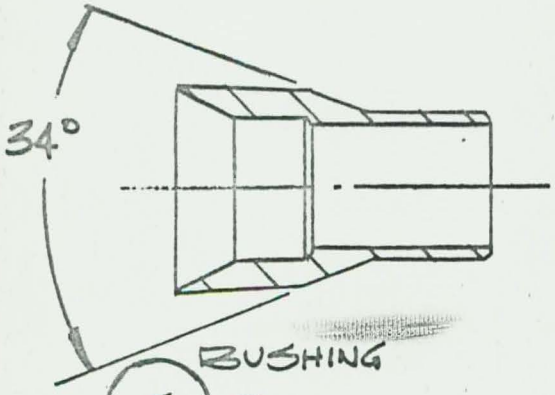

(4) BUSHING .342 DIA MAX

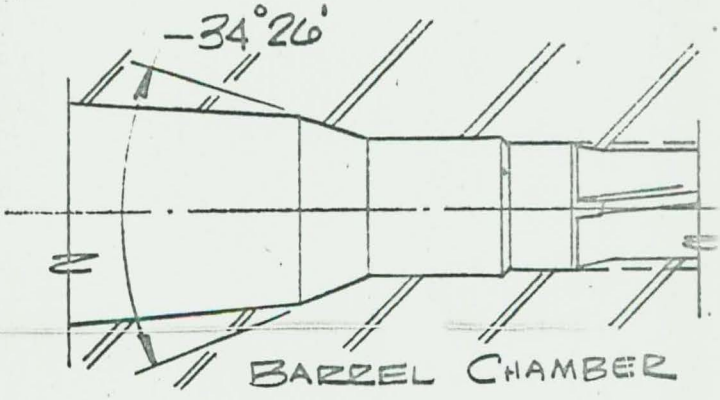
CURRENT .3405 DIA.
PRE 1942 .3401 MI

INTERFERENCE AT NECK REF SKETCH #2

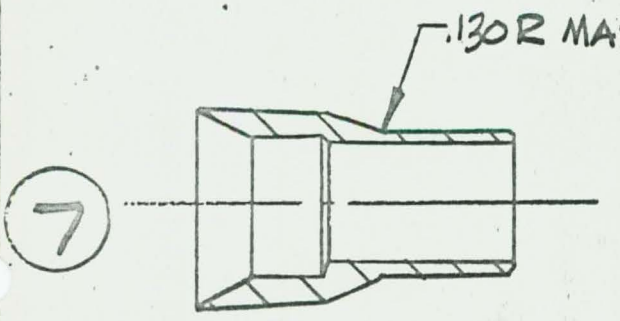


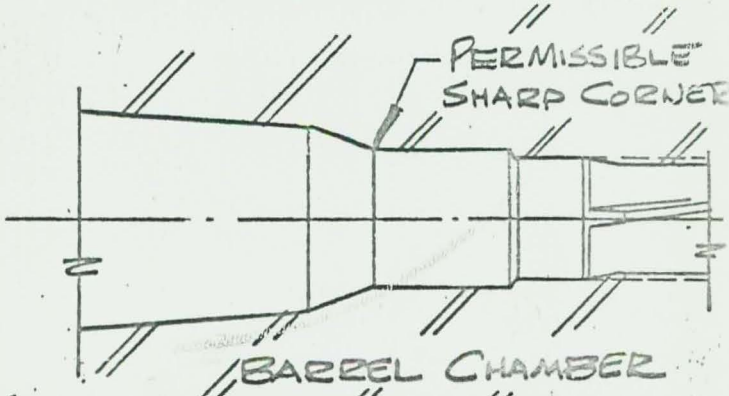

(5) INTERFERENCE AT 2ND SHOULDER 30 OCT 6



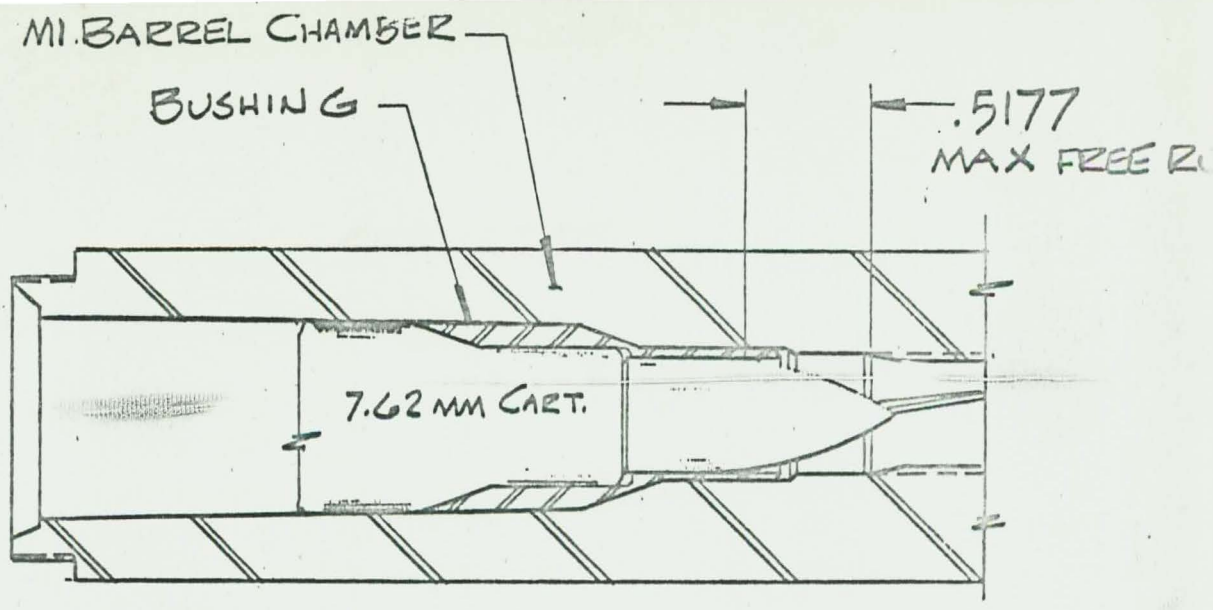




(6) DIFFERENCE IN ANGLE OF FIRST SHOULDER

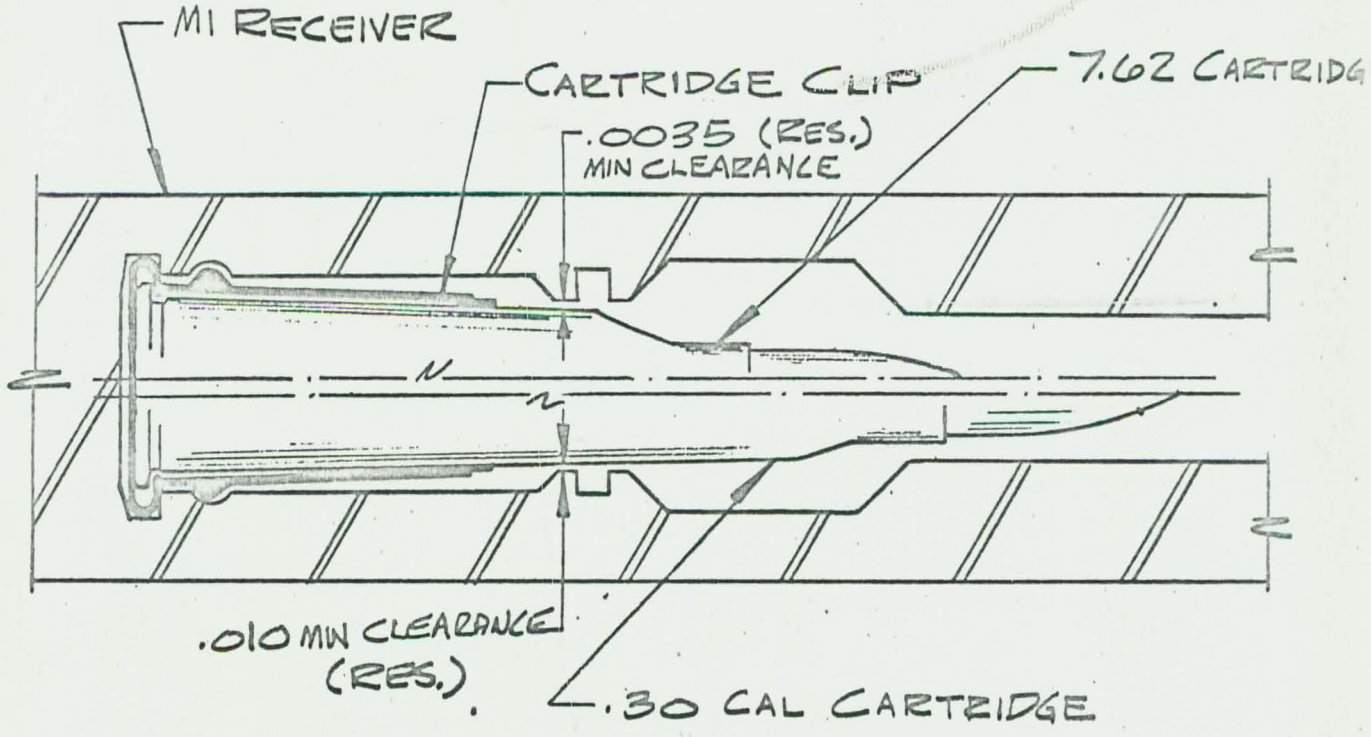



(7) APPENDIX C RADIUS VS SHARP CORNER SKETCHES 30 OCT 6




(8) MAX BULLET FREE RUN (M1 - .065
M14 - .060




(9) MINIMUM CLEARANCE IN M1 RECEIVER WHEN 8 ROUND CLIP IS LOADED WITH CAL. .30 AMMUNITION AND WHEN LOADED WITH 7.62 MM AMMUNITION

# APPENDIX C

## CHART I

KINEMATIC AND PRESSURE DATA ( AVG OF 10 READINGS / EACH RIFLE.)

| RIFLE TYPE → | | U.S. CAL. 30, M1 | | | 7.62MM, M1E14 (CONVERSION.) | | |
|---|---|---|---|---|---|---|---|
| AMMUNITION → | | CAL. 30, M2 BALL LOT RA 43153 | | | CAL 7.62 MM, M80 BALL LOT WRA 22075 | | |
| | RIFLE NO. ↓ | BOLT OPENING VELOCITY - FT/SEC | BOLT VEL, END OF RECOIL - FT/SEC | PEAK GAS CYLINDER PRESSURE - P.S.I. | BOLT OPENING VELOCITY - FT/SEC | BOLT VEL, END OF RECOIL - FT/SEC | PEAK PRESSURE IN GAS CYLINDER - P.S.I. |
| 1 | 2630715 | 24.8 | 12.5 | 1930 | 24.9 ** | S.R. ** | 1810 ** |
| 2 | 3211416 | 27.7 | 19.8 | 2370 | 26.8 ** | 16.9 ** | 2090 ** |
| 3 | 2287011 | 27.4 | 20.7 | 2100 | 26.3 * | 15.8 * | 1960 * |
| 4 | 2501369 | 25.2 | 13.4 | 1980 | 23.9 * | S.R. * | 1650 * |

* .0995 PORT HOLE.

** .1065 PORT HOLE.

S.R. – SHORT RECOIL.

# APPENDIX C

## CHART II

INSTRUMENTAL PROJECTILE VELOCITIES (AVG OF 10 READINGS / EACH RIFLE.)

| RIFLE TYPE → | | U.S. CAL. 30, M1 | | 7.62 MM, M1E14 (CONVERSION.) | | | |
|---|---|---|---|---|---|---|---|
| AMMUNITION → | | CAL. 30, M2 BALL LOT RA 43153 | | CAL 7.62 MM, M80 BALL LOT WRA 22075 | | CAL 7.62 MM, M80 BALL LOT RAL 5130 | |
| | RIFLE NO. ↓ | AVG VEL AT 78 FT- FT/SEC | EXTREME VARIATION FT/SEC | AVG VEL AT 78 FT- FT/SEC | EXTREME VARIATION, FT/SEC | AVG VEL AT 78 FT- FT/SEC | EXTREME VARIATION. FT/SEC |
| 1 | 2501369 | 2604 | 107 | 2838 | 115 | 2754 | 116 |
| 2 | 2287011 | 2632 | 77 | 2838 | 197 | 2721 | 144 |
| 3 | 2630715 | 2612 | 59 | 2866 | 145 | 2747 | 138 |
| 4 | 3211416 | 2618 | 65 | 2853 | 171 | 2719 | 88 |

# APPENDIX C

## CHART III

KINEMATIC DATA FOR GRENADE FIRING (AVG OF 5 READINGS/EACH RIFLE)

| | RIFLE TYPE → | U.S. CAL.30, M1 | | 7.62MM, M1E14 (CONVERSION) | |
|---|---|---|---|---|---|
| | AMMUNITION → | CARTRIDGE, GRENADE - M3 LOT LC 12201 (.30 CAL) | | CARTRIDGE, GRENADE - M64 LOT FA 4 (7.62MM) | |
| | RIFLE NO. ↓ | LENGTH OF BOLT RECOIL - INCHES | BOLT VELOCITY AT END OF RECOIL - FT/SEC. | LENGTH OF BOLT RECOIL - INCHES | BOLT VELOCITY AT END OF RECOIL - FT/SEC. |
| 1 | 2501369 | 2.24 | NOT RECORDED (ONLY PARTIAL RECOIL) | FULL * | 35.50 * |
| 2 | 2287011 | 1.82 | " | FULL * | 15.10 * |
| 3 | 2630715 | 1.80 | " | FULL ** | 39.80 ** |
| 4 | 3211416 | 1.46 | " | FULL ** | 12.50 ** |

*.0995 PORT HOLE.
** .1065 PORT HOLE.

# APPENDIX C

## CHART IV

LEGEND:
FF - FAILURE TO FEED, BOLT CLOSED ON EMPTY CHAMBER.
FX - FAILURE TO EXTRACT.
BFR - BOLT FAILED TO REMAIN OPEN, CLIP FAILED TO EJECT.
RS - ROUND STUCK
UR - BOLT UNDERRIDE.

## FUNCTION DATA

| | | | | |
|---|---|---|---|---|
| RIFLE TYPE → | | U.S. CAL.30, M1 | 7.62 MM, M1E14 (CONVERSION) | |
| AMMUNITION → | | CAL.30, M2 BALL LOT RA 43153 | CAL 7.62 MM, M80 BALL LOT WRA 22075 | |
| RIFLE NO. ↓ | | MALFUNCTIONS PER 100 RDS. - STANDARD PORT HOLE | MALFUNCTIONS PER 100 RDS - .0995 PORT HOLE. | MALFUNCTIONS PER 100 RDS - .1065 PORT HOLE |
| 1 | 2501369 | 1 - FF | 2 - FF<br>1 - BFR | NO MALFUNCTIONS |
| 2 | 2630715 | NO MALFUNCTIONS | — | NO MALFUNCTIONS |
| 3 | 2033164 | NO MALFUNCTIONS | NO MALFUNCTIONS | — |
| 4 | 4728502 | 1 - UR | 1 - BFR | — |
| 5 | 6090632 | NO MALFUNCTIONS | — | NO MALFUNCTIONS |
| 6 | 847867 | NO MALFUNCTIONS | — | NO MALFUNCTIONS |
| 7 | 2287011 | NO MALFUNCTIONS | 1 - FX (BROKEN EXTRACTOR) | 1 - UR<br>1 - RS |
| 8 | 3211416 | NO MALFUNCTIONS | — | 1 - FX (SHEARED RIM) |