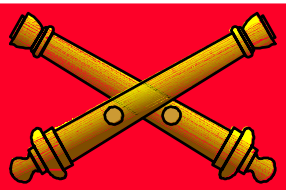


THE KING OF BATTLE

MANUAL SAFETY

SAFETY REFERENCES

PG 15-3

- AR 385-63
- FM 6-50
- TM 43-0001-28
- LOCAL RANGE REGULATIONS
- WEAPONS -10 MANUAL
- FM 6-40

AR 385-63
CHAPTER 11

- SURFACE DANGER ZONES
- DOES NOT REQUIRE DESIGNATED SAFETY OFFICER

FM 6-50

- CHAPTER 6. XO'S MIN QE
- CHAPTER 11. RESPONSIBILITIES AND SAFETY AIDS

TM 43-0001-28

- OUTLINES TECHNICAL DATA ON AMMUNITION

LOCAL RANGE REGULATIONS

- SUPERSEDES FM 6-50
- MAY REQUIRE A DESIGNATED SAFETY OFFICER

WEAPONS -10 MANUAL

- EQUIPMENT PARTICULAR SAFETY MEASURES
- LISTS AUTHORIZED AMMO FOR THAT HOWITZER

LOW ANGLE SAFETY

FOUR BASIC STEPS OF SAFETY

1. RANGE SAFETY CARD
2. BASIC SAFETY DIAGRAM
3. SAFETY MATRIX
4. SAFETY “T”

GUNNERY DEPARTMENT

RANGE SAFETY CARD PG 15-7

Unit/STR **L 3/12** ScheduledDateIn **Ø7/ Ø9/99** ScheduledDate Out **Ø7/ Ø9/99**
TimeIn **Ø7:ØØ** TimeOut **23:59**

Firing Point 185 (6Ø26 411Ø) HT 37Ø.Ø Impact Area S. CARLTON AREA
Weapon M198 (155) Ammunition M1Ø7, M11Ø, M116, M739A1, M582, M732, M577

Type of Fire **LOW ANGLE**

Direction Limits: (Ref GN): **Left 134Ø MILS Right 19ØØ MILS**

Low Angle PD Minimum Range	**39ØØ** METERS	Min Charge 4GB
Fuze TI and High Angle Minimum Range	**4ØØØ** METERS	Min Charge 4GB

To Establish MIN Time for Fuze VT Apply +5.5 seconds to the Low Angle PD Min Rg

Maximum Range to Impact	**62ØØ** METERS	Max Charge 4GB

COMMENTS

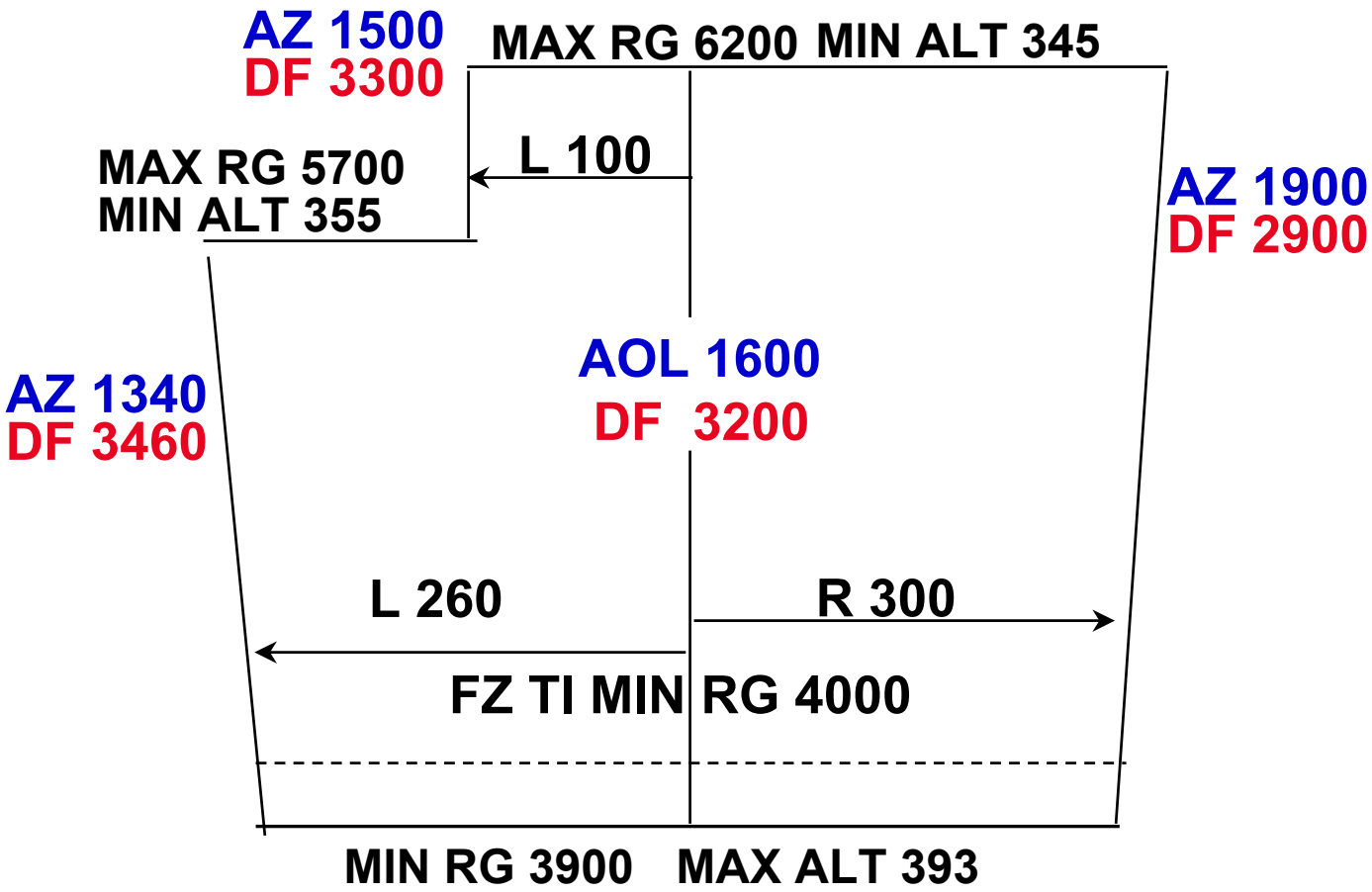
From AZ 134Ø TO AZ 15ØØ MAXIMUM RANGE IS 57ØØ

USAFAS

GUNNERY DEPARTMENT

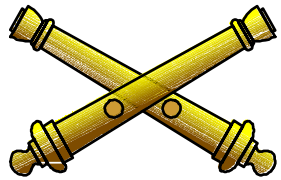
BASIC SAFETY DIAGRAM PG 15-8

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600



USAFAS

GUNNERY DEPARTMENT



LOW ANGLE SAFETY PG 15-10
SAFETY MATRIX PG 15-12

4 □ HE, HC (M116) LOW ANGLE CHG 4GB

DIA. RG +	RG CORR =	TOTAL RG X	RANGE K =	ENTRY RANGE	CHG	VI	SI +	EL =	QE	M564/ M565	M582/ M577	TOF+ 5.5 =	M728/ M732	DFT
3900 +	0 =	3900 X	1.0000 =	3900	4GB	+23	+6 +	225 =	231	-----	-----	13.7/19.2~	20.0	L4
4000 +	0 =	4000 X	1.0000 =	4000	4GB	----------			14.1	----------				
5700 +	0 =	5700 X	1.0000 =	5700	4GB	-15	-3 +	362 =	359	----------				
6200 +	0 =	6200 X	1.0000 =	6200	4GB	-25	-5 +	408 =	403	----------				L9

WP (M110 □ WT UNKNOWN) LOW ANGLE CHG 4GB

Determining Range Correction for □ Weight Unknown Projectile

RANGE	CHG	NON-STD COND	-	STD COND	=	⌀ IN STD	X	RG CORR FACTOR	=	RANGE CORRECTION
3900	4GB	8□	-	4□	=	I 4□	X	+28	=	+112 ~ +110
4000	4GB	8□	-	4□	=	I 4□	X	+28	=	+112 ~ +110

DIA. RG +	RG CORR =	TOTAL RG X	RANGE K =	ENTRY RANGE	CHG	VI	SI +	EL =	QE	M564/ M565	M582/ M577	TOF+ 5.5 =	M728/ M732	DFT
3900 +(+110)	= 4010 X		1.0000 =	4010	4GB	+23	+6 +	232 =	238	----------				
4000 +(+110)	= 4110 X		1.0000 =	4110	4GB	----------			14.6	----------				

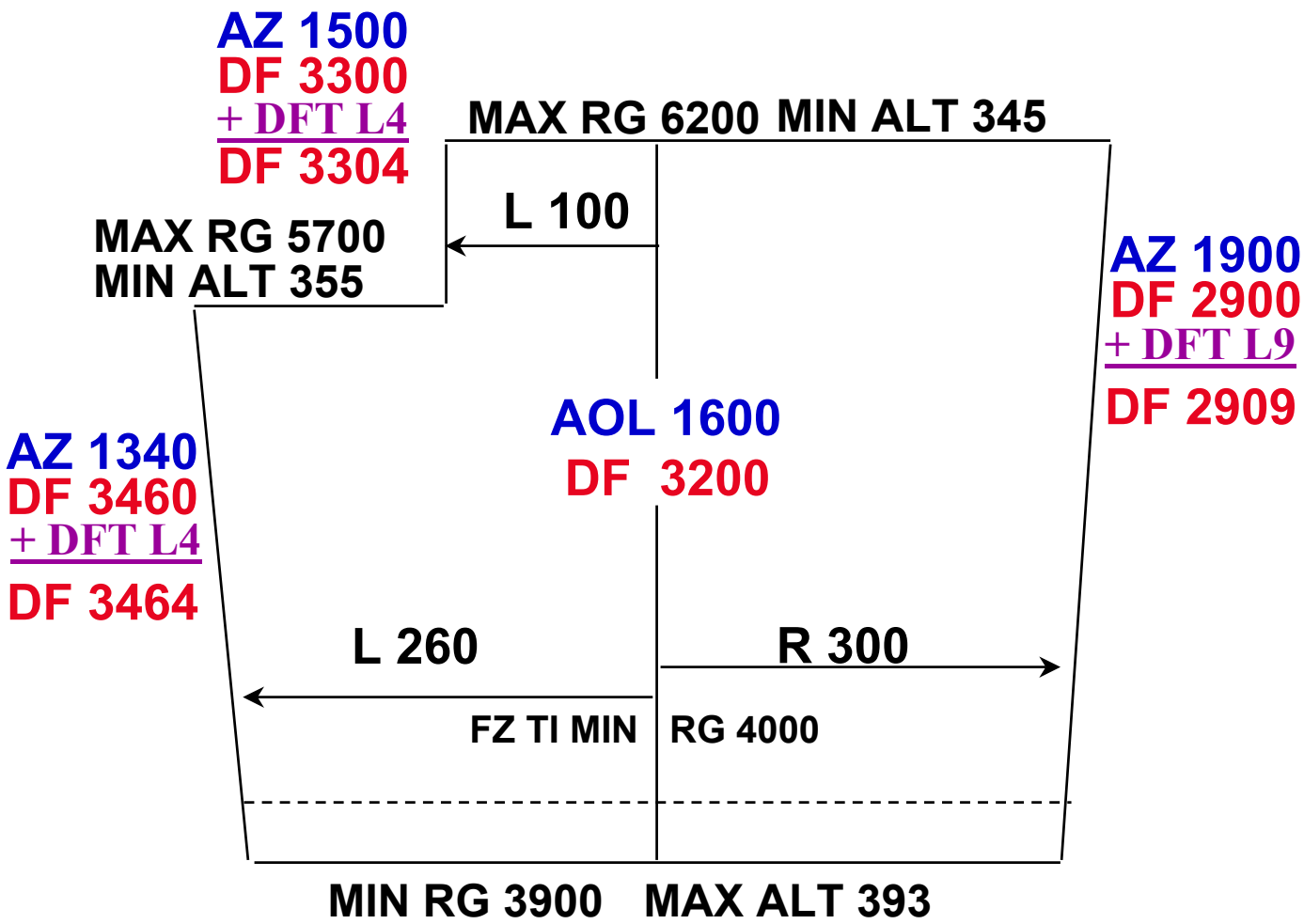
USAFAS

GUNNERY DEPARTMENT

APPLY DRIFT USING "LEAST LEFT, MOST RIGHT" RULE

PG 15-9

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600



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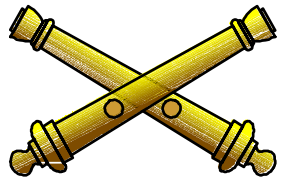
GUNNERY DEPARTMENT



SAFETY "T"
PG 15-13

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600

359	403		MAX QE
3464	3304	2909	DF
231			MIN QE HE
238			MIN QE WP
14.1			MIN TI HE (M582)
14.6			MIN TI WP (M582)
20.0			MIN TI VT (M732)

USAFAS

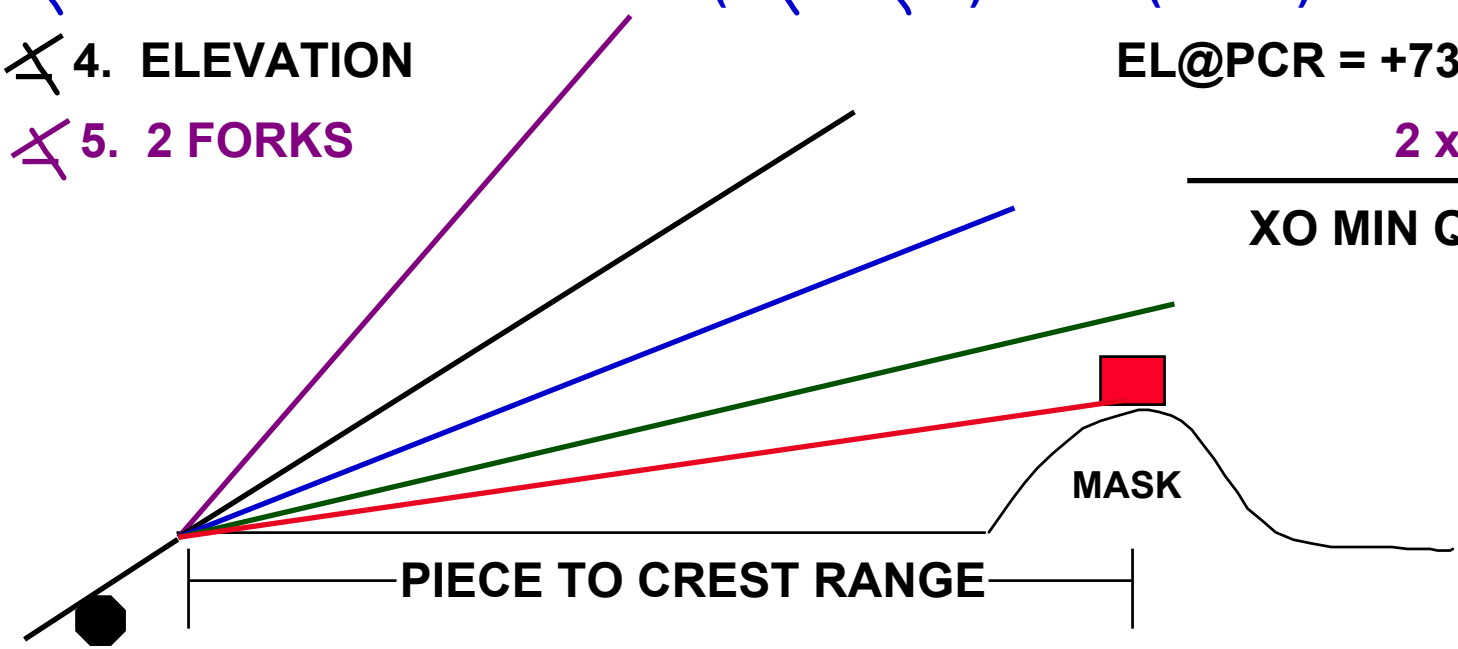
GUNNERY DEPARTMENT

XO'S MIN QUADRANT ELEVATION MANUAL COMPUTATION PG 15-36

NOTE: EXPRESS ALL ANGLES UP TO THE NEAREST WHOLE MIL

1. SITE TO CREST +156
2. VERT. CLEAR (5M) VI/RG x 1.0186= 5/1.4(1.0186)= 3.64 ~ +4
3. CAS CSF x(1+ 2)= 0.005(156+4) = 0.80 ~ +1
4. ELEVATION EL@PCR = +73.4 ~ +74
5. 2 FORKS 2 x 1 = +2

XO MIN QE = 237



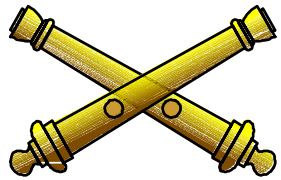
SITE TO CREST = 156 AT 1400M

USAFAS

RAPID FIRE TABLES
PG 15-38

- XO'S HANDBOOK APPENDIX A
- FASTER THAN MANUAL COMPUTATIONS
- ANGLE 1 + ANGLE 2 $\leq$ 300 MILS
- USE PAGE A-1 TO COMPUTE ANGLE 2
- TABLES HAVE BEEN UPDATED FOR LATEST HOWITZERS AND AMMUNITION
- TABLES PROVIDE THE SUM OF ANGLES 2-5

GUNNERY DEPARTMENT



RAPID FIRE TABLES

M198 CHG 4GB	ANGLE 1 + RFT = MIN QE				
GUN 1 156 MILS @ 1400m	156	+	81	=	237
GUN 2 88 MILS @ 2200m	88	+	129	=	217
GUN 3 124 MILS @ 1000m	124	+	61	=	185
GUN 4 100 MILS @ 1900m	100	+	111	=	211

XO'S MIN QE = 237

USAFAS

GUNNERY DEPARTMENT

UPDATE SAFETY "T"
POST OCCUPATION FOR XO'S MIN QE

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600

359	403		MAX QE
3464	3304	2909	DF
~~231~~ 237			MIN QE HE
238			MIN QE WP
14.1			MIN TI HE (M582)
14.6			MIN TI WP (M582)
20.0			MIN TI VT (M732)

USAFAS

ARMED VT

PG 15-39

- USED IN WARTIME
- VT DOES NOT ARM UNTIL 2 SECONDS INTO TOF
- FDO MUST ENSURE PROJECTILE WILL CLEAR INTERVENING CRESTS OR FRIENDLY TROOPS
- CLEARANCE INCREASES FROM 5m TO 70m
- MARSH OR WET TERRAIN CLEARANCE IS 105m
- WATER, ICE, OR SNOW CLEARANCE IS 140m

ARMED VT

1. SITE TO CREST +156
2. VERT. CLEAR (70M) VI/RG x 1.0186= 70/1.4(1.0186)= 50.8 ~ +51
3. CAS CSF x (1+2)= 0.005(156+51) = 1.04 ~ +2
4. ELEVATION EL@PCR = +73.4 ~ +74
5. 2 FORKS 2 x 1 = +2

XO'S MIN QE = 285

GUNNERY DEPARTMENT

ARMED VT EXAMPLES

GIVEN: M198, CHG 4GB

PCR = 1400, SITE TO CREST = 156m

RG TO FLOT = 6000

XO'S MIN QE = 237

ARMED VT MIN QE (CREST) = 285

ARMED VT MIN QE (FLOT) = 481

MIN SAFE TI FOR ARMED VT = TOF ~RG TO FLOT + 5.5 SEC

23.0 SEC + 5.5 SEC = 28.5 SEC ~ UP TO 29.0

1. FM: BTRY 2, SH HE, LOT A/G, CHG 4, FZ VT, TI 30.0, DF3312, QE 263

   IS IT SAFE TO FIRE? YES

   WHY? QE IS ≥ XO'S MIN QE (237) & FS IS ≥ MIN TI TO FLOT (29.0)

USAFAS

GUNNERY DEPARTMENT

ARMED VT EXAMPLES

GIVEN: M198, CHG 4GB

PCR = 1400, SITE TO CREST = 156m

RG TO FLOT = 6000

XO'S MIN QE = 237

ARMED VT MIN QE (CREST) = 285

ARMED VT MIN QE (FLOT) = 481

MIN SAFE TI FOR ARMED VT = TOF ~RG TO FLOT + 5.5 SEC

23.0 SEC + 5.5 SEC = 28.5 SEC ~ UP TO 29.0

2. FM: BTRY 2, SH HE, LOT A/G, CHG 4, FZ VT, TI 27.0, DF3312, QE 263

IS IT SAFE TO FIRE? NO

WHY? QE IS ≥ XO'S MIN QE (237) BUT, FS IS ≤ MIN TI TO FLOT (29.0) THERFORE, TO BE SAFE, THE QE MUST BE ≥ THE SAFEST XO'S MIN QE FOR ARMED VT (481)

USAFAS

GUNNERY DEPARTMENT

ARMED VT EXAMPLES

GIVEN: M198, CHG 4GB

PCR = 1400, SITE TO CREST = 156m

RG TO FLOT = 6000

XO'S MIN QE = 237

ARMED VT MIN QE (CREST) = 285

ARMED VT MIN QE (FLOT) = 481

MIN SAFE TI FOR ARMED VT = TOF ~RG TO FLOT + 5.5 SEC

23.0 SEC + 5.5 SEC = 28.5 SEC ~ UP TO 29.0

3. FM: BTRY 2, SH HE, LOT A/G, CHG 4, FZ VT, TI 28.0, DF3312, QE 495

IS IT SAFE TO FIRE? YES

WHY? FS IS ≤ MIN TI TO FLOT (29.0) HOWEVER, QE IS ≥ SAFEST XO'S MIN QE FOR ARMED VT (481)

USAFAS

UPDATING SAFETY AFTER DETERMINING A GFT SETTING

UPDATING SAFETY AFTER DETERMINING A GFT SETTING (POST REG, MET+VE...) PG 15-14

- GFT SETTING WILL CAUSE DATA TO CHANGE.
- GEOGRAPHICAL LIMITS ON THE GROUND WILL NOT CHANGE.
- AIMPOINTS WILL CHANGE.

THERE ARE TWO TECHNIQUES TO UPDATE SAFETY:

1. APPLY A GFT SETTING TO A GFT
2. RANGE K METHOD

NOTE: THE RANGE K METHOD ALLOWS US TO APPLY TOTAL CORRECTIONS TO SAFETY DATA FOR MUNITIONS WHICH DO NOT HAVE A CORRESPONDING GFT

UPDATING SAFETY
METHOD #1: APPLY GFT SETTING
PG 15-15

- APPLY GFT SETTING.
- GFT C, CHG 4, LOT A/G, RG 4450, EL 278, TI 16.3(M582) TOT DF CORR L10, GFT DF CORR L5
- GFT DF CORR APPLIED TO DF LIMITS
- DETM NEW ELEVATIONS FROM EL GAUGE LINE
- SITE REMAINS THE SAME
- DETM MIN TI FROM TI GAUGE LINE
- VT FUZE SETTING IS A FUNCTION OF ELEVATION

UPDATING SAFETY
METHOD #2: RANGE K TECHNIQUE

NOT ALL MUNITIONS HAVE ASSOCIATED GFT's THEREFORE, THE RANGE K TECHNIQUE MUST BE USED

THE GFT DF CORR IS STILL APPLIED TO THE DF LIMITS

RANGE K IS DETM'D WHICH REPRESENTS AN EL GAUGE LINE
REFER TO APPENDIX F, PG F-5

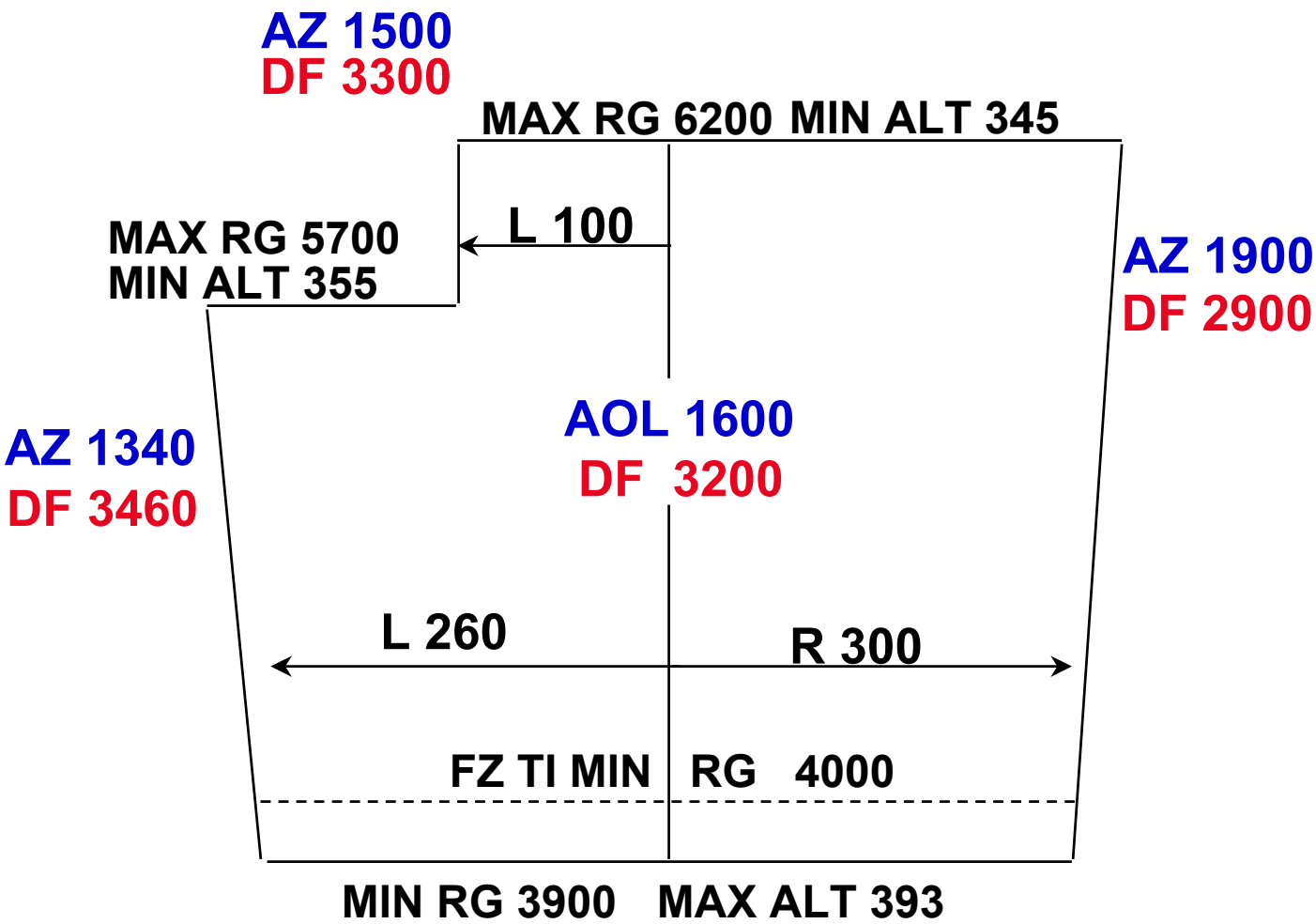
THE MAIN DIFFERENCE BETWEEN THE TWO METHODS IS THE WAY IN WHICH THE MINIMUM FUZE SETTING IS DETERMINED
REFER TO PG 15-15

FOLLOW THE LOW ANGLE STEP-ACTION PROCEDURES ON PG 15-10

GUNNERY DEPARTMENT

UPDATE AFTER REGISTRATION

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600



USAFAS

GUNNERY DEPARTMENT

UPDATING LOW ANGLE SAFETY USING GFT METHOD - P. 15-15 & APPENDIX G

4 □ HE, HC (M116) LOW ANGLE CHG 4GB

DIA. RG	+	RG CORR	=	TOTAL RG	X	RANGE K	=	ENTRY RANGE	CHG	VI	SI	+	EL	=	QE	M564/ M565	M582/ M577	TOF+ 5.5	=	M728/ M732	DFT
3900	+	0	=	3900	X	1.0000	=	3900	4GB	+23	+6	+	238	=	244	-	-	14.5 /20.0	~	20.0	L4
4000	+	0	=	4000	X	1.0000	=	4000	4GB	----------							14.4	----------			
5700	+	0	=	5700	X	1.0000	=	5700	4GB	-15	-3	+	384	=	381	----------					
6200	+	0	=	6200	X	1.0000	=	6200	4GB	-25	-5	+	434	=	429	----------					L10

WP (M110 □ WT UNKNOWN) LOW ANGLE CHG 4GB

Determining Range Correction for □ Weight Unknown Projectile

RANGE	CHG	NON-STD COND	-	STD COND	=	⌀ IN STD	X	RG CORR FACTOR	=	RANGE CORRECTION
3900	4GB	6□	-	4□	=	I 2□	X	+28	=	+56 ~ +60
4000	4GB	6□	-	4□	=	I 2□	X	+28	=	+56 ~ +60

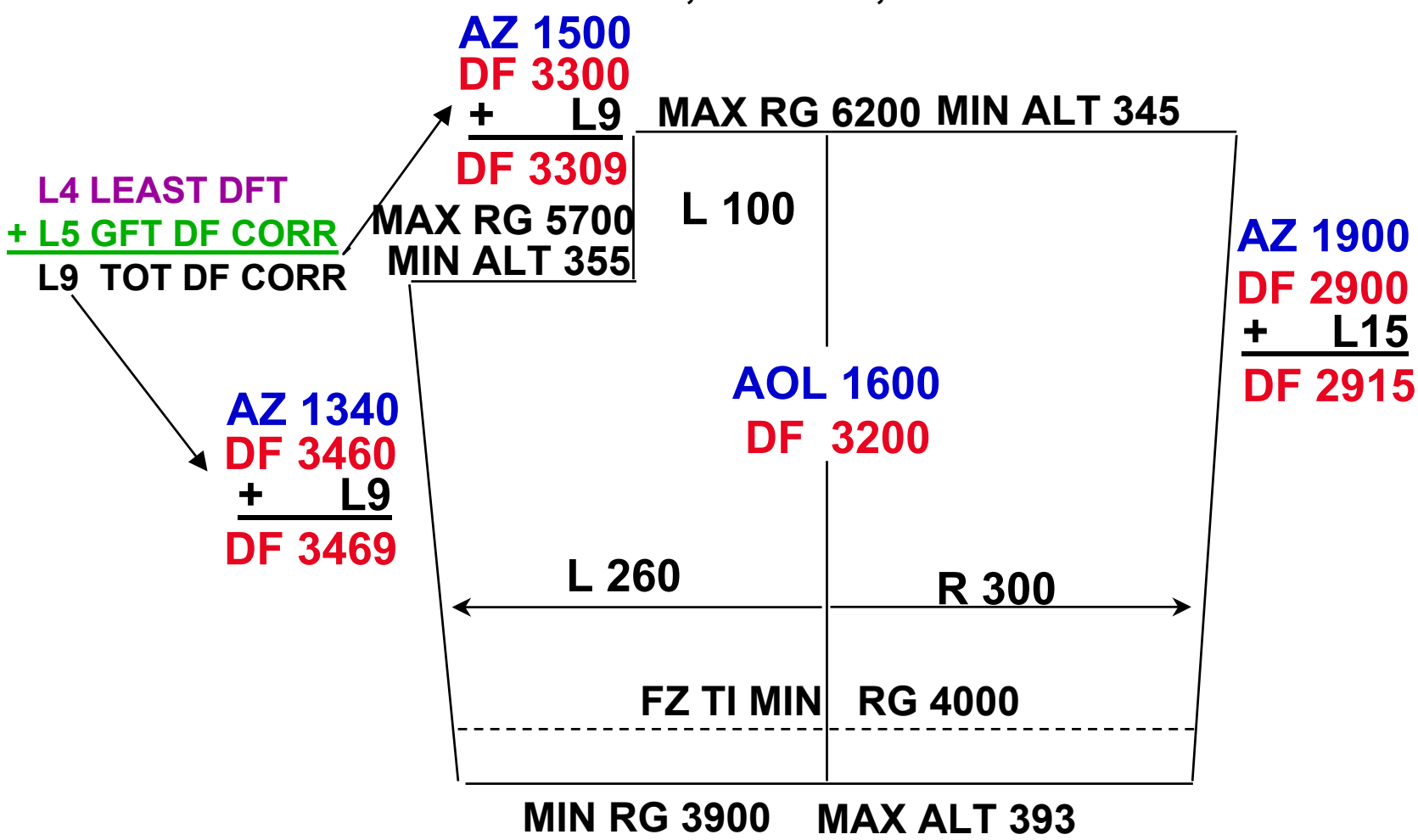
DIA. RG	+	RG CORR	=	TOTAL RG	X	RANGE K	=	ENTRY RANGE	CHG	VI	SI	+	EL	=	QE	M564/ M565	M582/ M577	TOF+ 5.5	=	M728/ M732	DFT
3900	+(+60)		=	3960	X	1.0000	=	3960	4GB	+23	+6	+	242	=	248	----------					
4000	+(+60)		=	4060	X	1.0000	=	4060	4GB	----------							14.7	----------			

USAFAS

GUNNERY DEPARTMENT

UPDATE SAFETY DIAGRAM

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600



USAFAS

GUNNERY DEPARTMENT

UPDATE SAFETY "T"

GFT C, CHG 4, LOT A/G, RG 4450, EL 278, TI 16.3(M582)
TOT DF CORR L10, GFT DF CORR L5

FP 185 60264110 ALT 370, CHG 4GB, LOW ANGLE, HE/WP/HC, PD/TI/VT, AOL 1600

381	429		MAX QE
3469	3309	2915	DF
244			MIN QE HE
248			MIN QE WP
14.4			MIN TI HE (M582)
14.7			MIN TI WP (M582)
20.0			MIN TI VT (M732)

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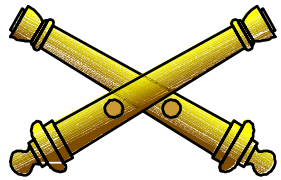
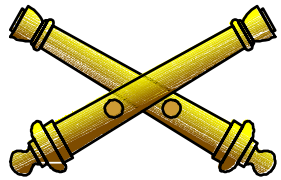
GUNNERY DEPARTMENT



HIGH ANGLE SAFETY

USAFAS



HIGH ANGLE SAFETY
PG 15-28

- SAME BASIC 4 STEPS APPLY
- USE HIGH ANGLE GFT OR TFT
- HIGH DRIFT AND TIME OF FLIGHT
- ACCOUNT FOR DRIFT ON SAFETY DIAGRAM
- RULE **LEAST LEFT, MOST RIGHT**

GUNNERY DEPARTMENT

RANGE SAFETY CARD PG 15-7

Unit/STR **L 3/12** ScheduledDateIn **Ø7/09/99** ScheduledDate Out **Ø7/09/99**
TimeIn **Ø7:ØØ** TimeOut **23:59**

Firing Point 185 (6Ø26 411Ø) HT 37Ø.Ø Impact Area S. CARLTON AREA
Weapon M198 (155) Ammunition M1Ø7, M739A1

Type of Fire **HIGH ANGLE**

Direction Limits: (Ref GN): **Left 134Ø MILS Right 19ØØ MILS**

Low Angle PD Minimum Range	**4ØØØ** METERS	Min Charge 3GB
Fuze TI and High Angle Minimum Range	**4ØØØ** METERS	Min Charge 3GB

To Establish MIN Time for Fuze VT Apply +5.5 seconds to the Low Angle PD Min Rg

Maximum Range to Impact	**62ØØ** METERS	Max Charge 3GB

COMMENTS

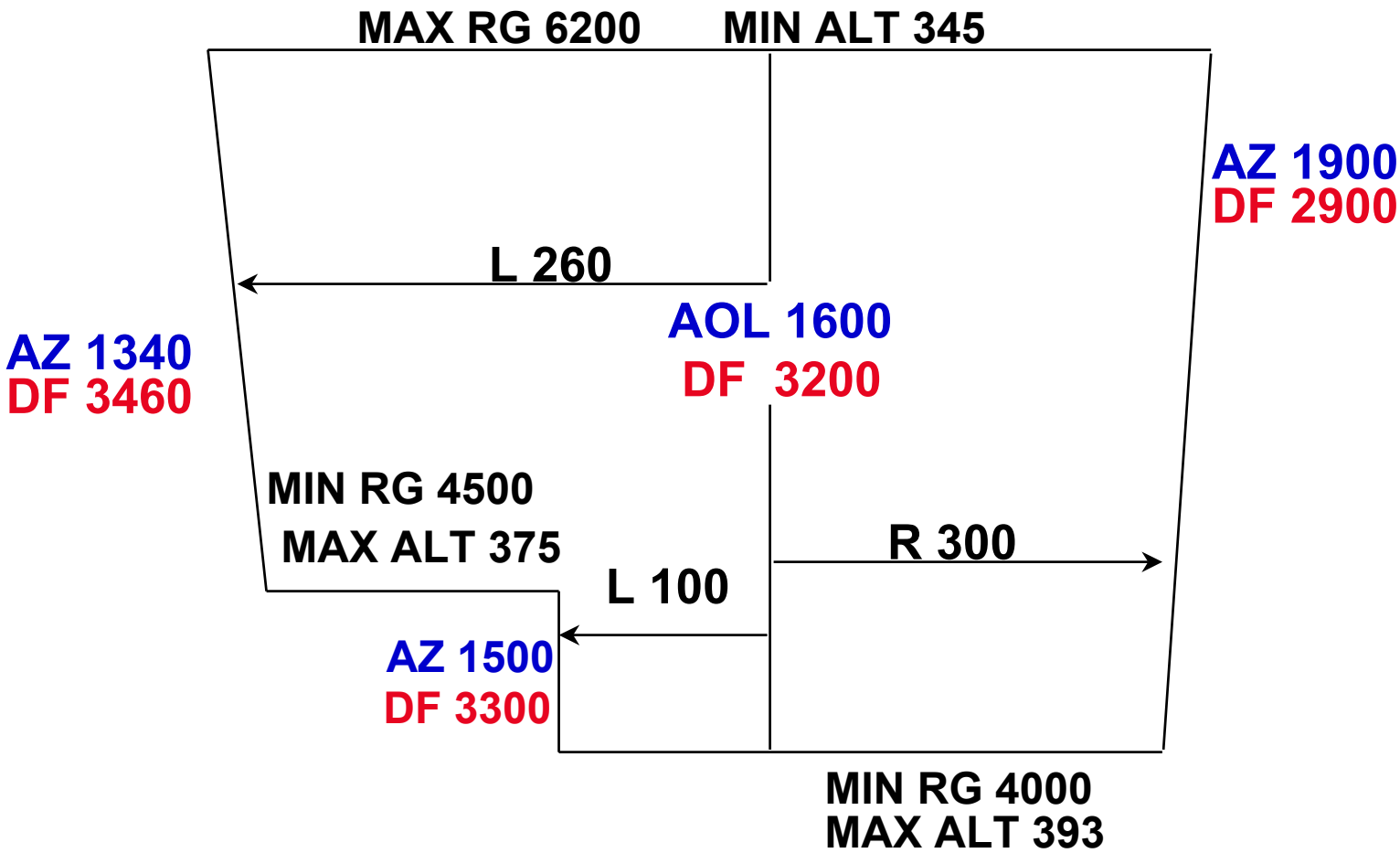
From AZ 134Ø TO AZ 15ØØ MINIMUM RANGE IS 45ØØ

USAFAS

GUNNERY DEPARTMENT

HIGH ANGLE SAFETY DIAGRAM

FP 185 60264110 ALT 370, CHG 3GB, HIGH ANGLE, HE, PD, AOL 1600



USAFAS

GUNNERY DEPARTMENT

SAFETY MATRIX
HIGH ANGLE SAFETY
PG 15-30

HIGH ANGLE SHELL HE

DIA. RG	+	RG CORR	=	TOTAL RG	X	RANGE K	=	ENTRY RANGE	CHG	VI	<SI/10	X	10 MIL SI FAC	=	SI	+	EL	=	QE	DFT
4000	+	0	=	4000	x	1.0000	=	4000	3GB	+23	+0.6	X	-1.0	=	-1	+	1247	=	1246	L101
4500	+	0	=	4500	X	1.0000	=	4500	3GB	+5	+0.1	X	-1.6	=	0	+	1201	=	1201	---
6200	+	0	=	6200	X	1.0000	=	6200	3GB	-25	-0.4	X	-10.4	=	+4	+	954	=	958	L34

FOR -VI :

HI < SITE = (<SI / 10) * [10(1-CSF)]

HI < SITE = (-4.1 / 10)* [10(1-2.041)]

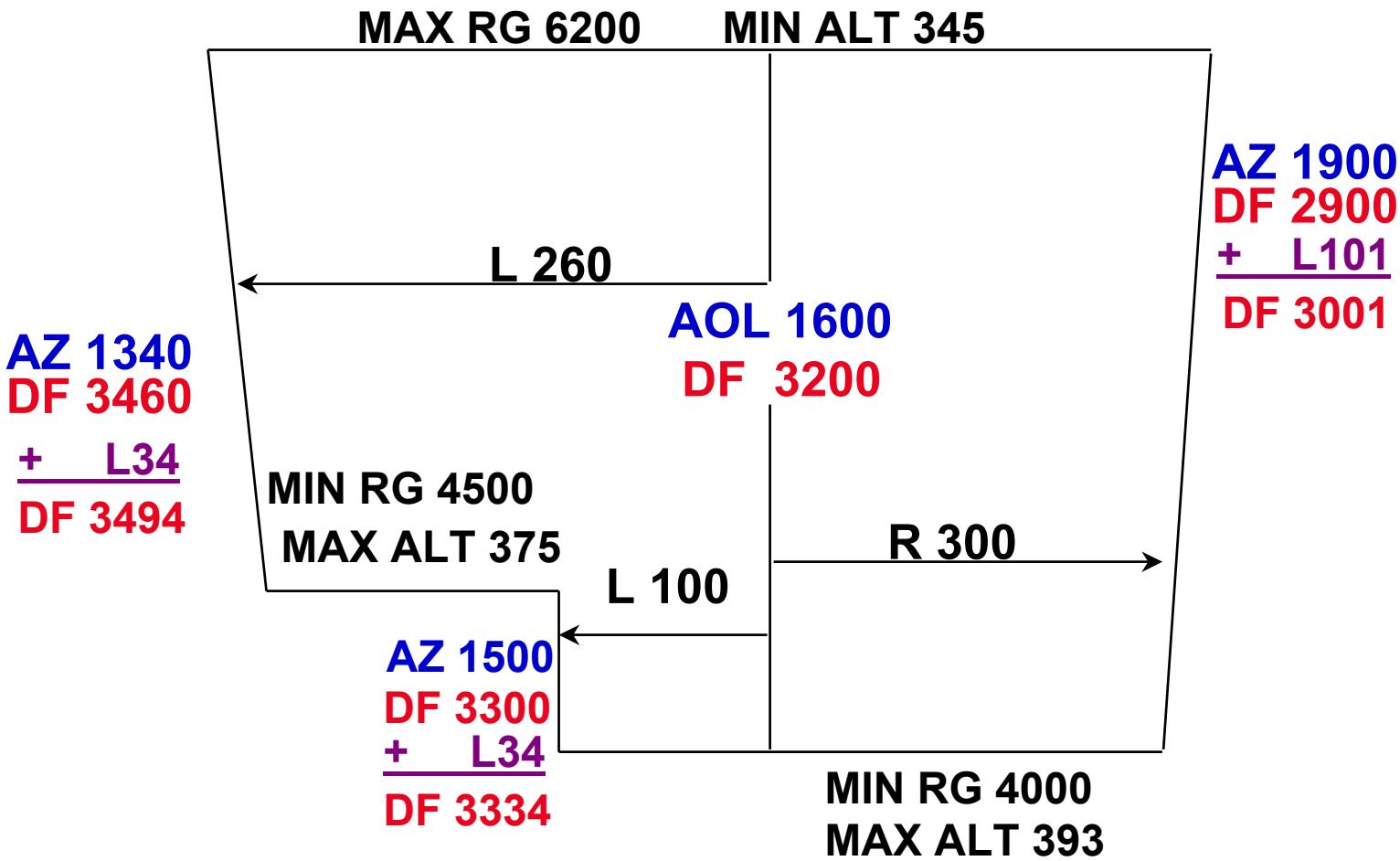
HI < SITE = (-0.4) * (-10.4) = +4.16 ~ +4

USAFAS

GUNNERY DEPARTMENT

HIGH ANGLE SAFETY DIAGRAM

FP 185 60264110 ALT 370, CHG 3GB, HIGH ANGLE, HE, PD, AOL 1600



USAFAS

HIGH ANGLE SAFETY "T"

FP 185 (60264110 ALT 370), CHG 3GB, HIGH ANGLE, HE, PD, AOL 1600

1201	1246		MAX QE
3494	3334	3001	DF
958			MIN QE HE

GUNNERY DEPARTMENT

ILLUMINATION (BASE-EJECTING) SAFETY

USAFAS

LOW ANGLE ILLUMINATION SAFETY
PG 15-10

- 4 BASIC STEPS STILL APPLY

- THE GFT (ETI SCALE) OR TABLE C TO PART II OF FT 155-AM-2 CAN BE UTILIZED TO TO COMPUTE ILLUM SAFETY.

- CAN'T USE HE GFT BECAUSE OF PROJO. WEIGHT

- MIN TI EXTRACTED FROM TABLE C OF PART II TO FT 155-AM-2

GUNNERY DEPARTMENT

RANGE SAFETY CARD PG 15-7

Unit/STR **L 3/12** ScheduledDateIn **Ø7/Ø9/99** ScheduledDate Out **Ø7/Ø9/99**
TimeIn **Ø7:ØØ** TimeOut **23:59**

Firing Point 185 (6Ø26 411Ø) HT 37Ø.Ø Impact Area S. CARLTON AREA
Weapon M198 (155) Ammunition M485, M577

Type of Fire **LOW ANGLE**

Direction Limits: (Ref GN): **Left 134Ø MILS Right 19ØØ MILS**

Low Angle PD Minimum Range	**39ØØ** METERS	Min Charge 3GB
Fuze TI and High Angle Minimum Range	**4ØØØ** METERS	Min Charge 3GB

To Establish MIN Time for Fuze VT Apply +5.5 seconds to the Low Angle PD Min Rg

Maximum Range to Impact	**62ØØ** METERS	Max Charge 3GB

COMMENTS

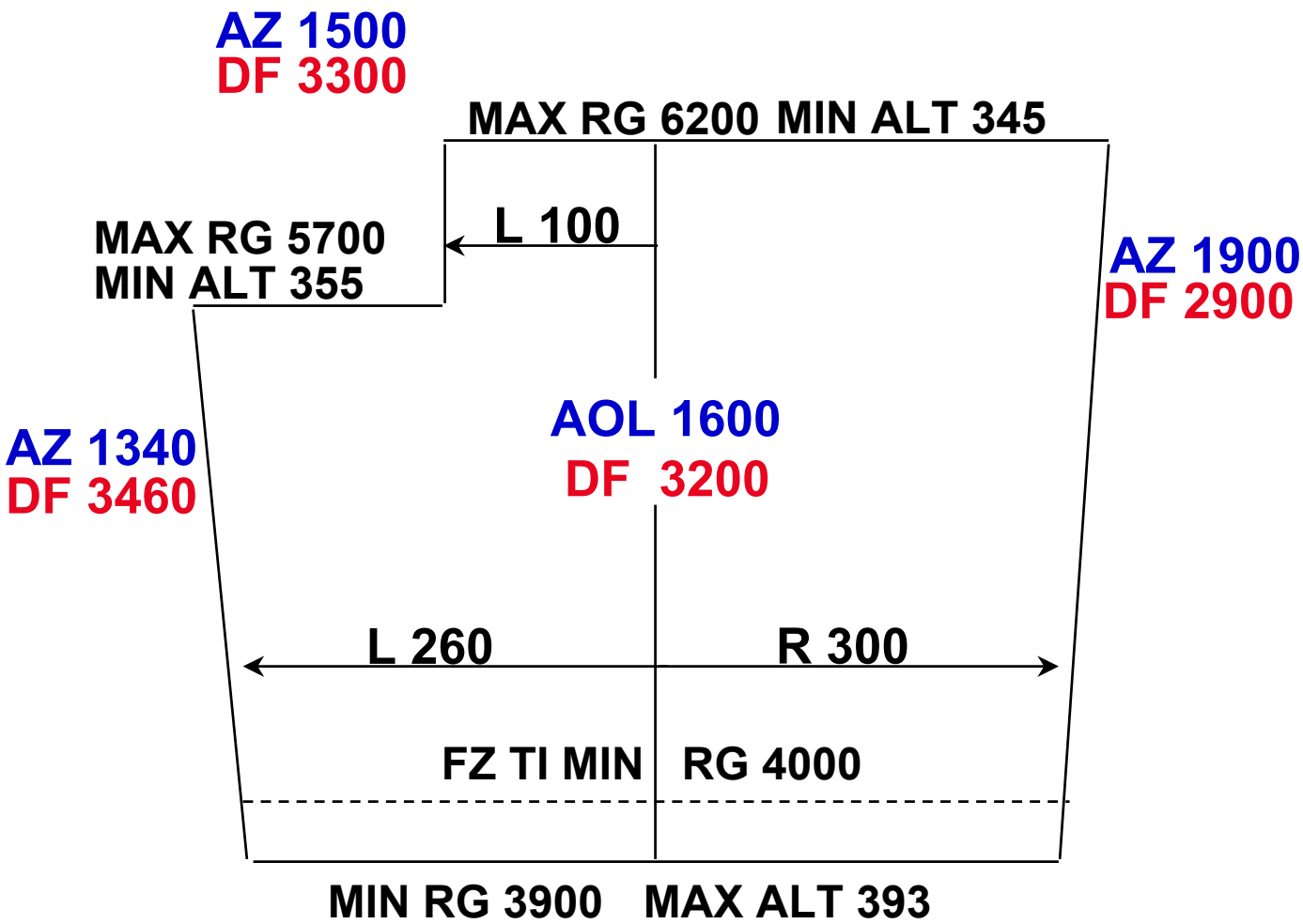
From AZ 134Ø TO AZ 15ØØ MAXIMUM RANGE IS 57ØØ

USAFAS

GUNNERY DEPARTMENT

ILLUMINATION SAFETY DIAGRAM

FP 185 (60264110 ALT 370), CHG 3GB, LOW ANGLE, ILLUM, AOL 1600



USAFAS

GUNNERY DEPARTMENT

METHOD #2: RANGE K, AFTER A REGISTRATION

USING TECHNIQUE 2 (PG F-5) DETM RANGE CORRESPONDING TO ADJUSTED EL AND DIVIDE BY CHT RG

5100

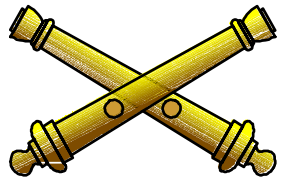
GFT K, CHG 3GB, LOT A/G, RG 4880, EL 428, TI 21.3 (M582)

TOT DF CORR L10
GFT DF CORR L0

RANGE K = 5100/4880 ~ 1.0451

USAFAS

GUNNERY DEPARTMENT



LOW ANGLE ILLUMINATION SAFETY MATRIX PG 15-10

LOW ANGLE ILLUM CHG 3

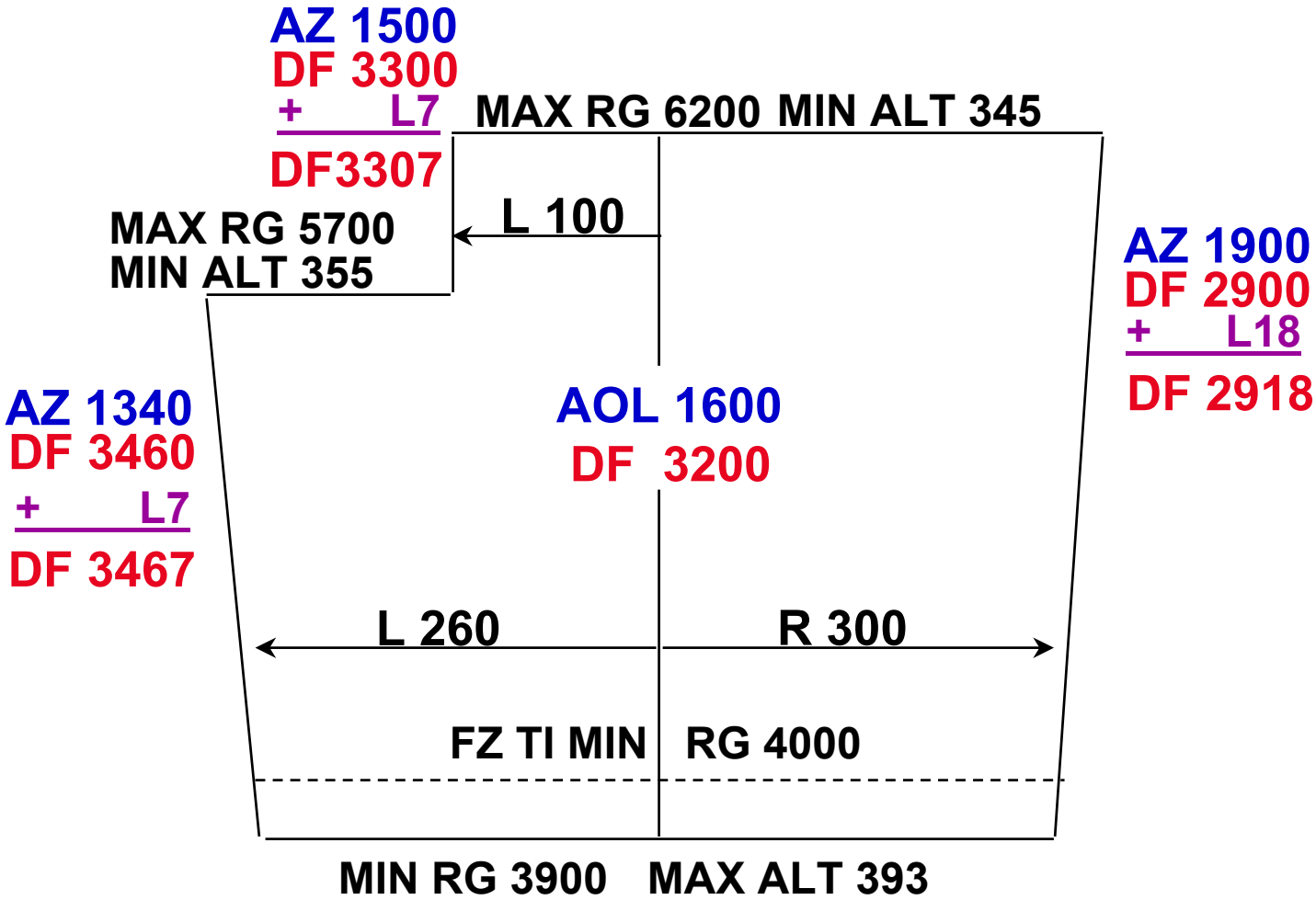
DIA. RG	+	RG CORR	=	TOTAL RG	X	RANGE K	=	ENTRY RANGE	CHG	VI	SI	+	EL	=	QE	M564/ M565	M582/ M577	TOF+ 5.5	=	M728/ M732	DFT
3900	+	0	=	3900	X	1.0451	=	4080	3GB	+23	+7	+	307	=	314	----------					L7
4000	+	0	=	4000	X	1.0451	=	4180	3GB	----------							17.0			----------	
5700	+	0	=	5700	X	1.0451	=	5960	3GB	-15	-4	+	540	=	536	----------					
6200	+	0	=	6200	X	1.0451	=	6480	3GB	-25	-7	+	665	=	658	----------					L18

USAFAS

GUNNERY DEPARTMENT

ILLUMINATION SAFETY DIAGRAM

FP 185 (60264110 ALT 370), CHG 3GB, LOW ANGLE, ILLUM, AOL 1600



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GUNNERY DEPARTMENT

ILLUMINATION SAFETY "T"

FP 185 60264110 ALT 370, CHG 3GB, LOW ANGLE, ILLUM, AOL 1600

	536	658	MAX QE
3467	3307	2918	DF
	314		MIN QE
	17.0		MIN TI (M577)

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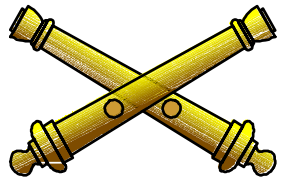
MAXIMUM EFFECTIVE ILLUMINATION AREA
PG 15-27

- 600m HOB SEVERELY LIMITS IMPACT AREA WHEN FIRING LOW ANGLE ILLUM
- DEPICTS WHERE ILLUM ROUNDS CAN ACTUALLY BE FIRED OBTAINING OPTIMUM HOB
- ALTERNATIVE IS TO FIRE HIGH ANGLE

GUNNERY DEPARTMENT



FP 185 (60264110 ALT 370), CHG 3GB, LOW ANGLE, ILLUM, AOL 1600

AZ 1500
DF 3300
\+ L7
DF3307

MAX RG 6200 MIN ALT 345

MAX RG 5700
MIN ALT 355

AZ 1900
DF 2900
\+ L18
DF 2918

AZ 1340
DF 3460
\+ L7
DF 3467

AOL 1600
DF 3200

MAX RG

EFFECTIVE ILLUM

RG 4800

RG 4300

FZ TI MIN RG 4000

MIN RG

MIN RG 3900 MAX ALT 393

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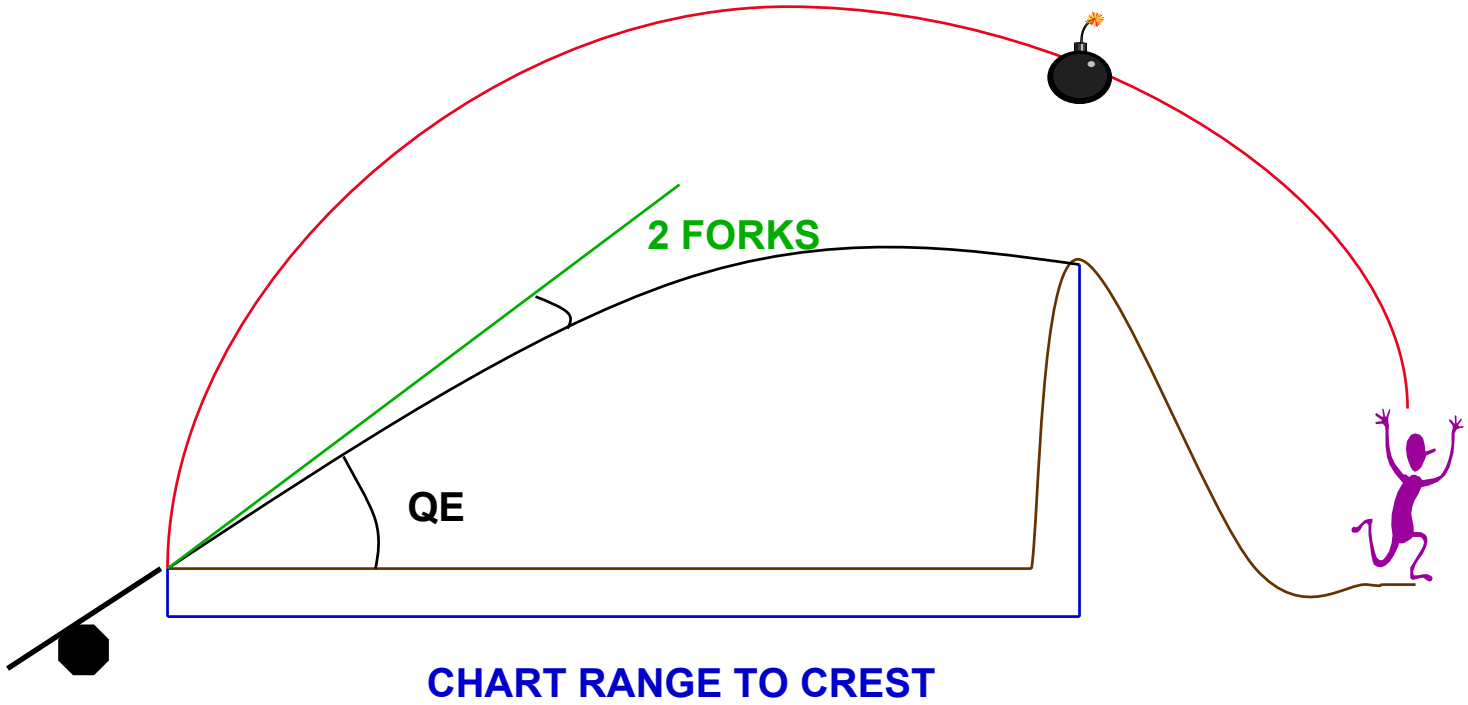
GUNNERY DEPARTMENT

INTERVENING CRESTS ARE THE FDC's RESPONSIBILTY
PG 15-42

OPTION 1: DETERMINE FIRING DATA TO CREST (QE)
+ 2 FORKS (~ CHART RANGE)
= SAFE QE TO CLEAR CREST



OPTION 2: UTILIZE XO'S HANDBOOK TO DETERMINE SAFE QE

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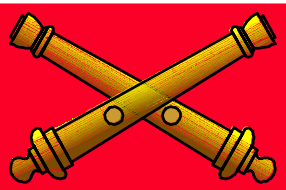

THE KING OF BATTLE