

# Rendezvous

## STS-120

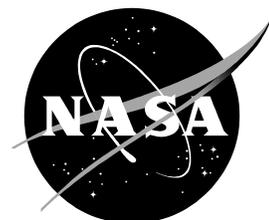
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**Mission Operations Directorate  
Flight Design and Dynamics Division**

**Final  
August 23, 2007**

National Aeronautics and  
Space Administration

**Lyndon B. Johnson Space Center**  
Houston, Texas





MISSION OPERATIONS DIRECTORATE

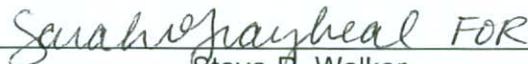
**RENDEZVOUS  
STS-120**

FINAL  
August 23, 2007

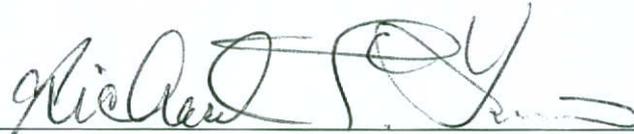
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AREAS OF TECHNICAL RESPONSIBILITY

Book Manager	DM34/J. Ruiz	281-483-1988
Rendezvous Guidance and Procedures	DM34/J. Yencharis	281-483-5976
Flight Dynamics	DM32/D. Mayhew	281-483-2529
Rendezvous Design	USA/S. Snyder	281-282-4351
PROX OPS Design	USA/B. Summa	281-282-3032
Flight Design	USA/R. Moreno	281-483-9040
Rendezvous Training	DT35/A. Fox	281-244-7376
APDS	DF52/J. Dake	281-483-6538

### NOTE

This checklist is the controlling crew document for the ISS-10A rendezvous and separation. The Rendezvous Timeline begins at  $T_i - 3:00$  hr and continues through docking. This is a complete stand-alone document. The Separation Timeline begins 45 min prior to undock and continues through 1:15 after undock.

Timeline pages assume an FD3 rendezvous and undocking on FD10. Lighting is based on planned rendezvous altitude of 205 nm. Targeting I-Loads are based on 210 nm.

## ACRONYMS

AZ, AZM	Azimuth
D/N	Day/Night
EL, ELEV	Elevation
IAH	Inertial
LOS	Line of Sight
LVLH	Local Vertical, Local Horizontal
R	Range
$\dot{R}$ , RDOT	Range Rate
R, RBAR	Radius Vector (toward Earth)
RNDZ	Rendezvous
RR	Rendezvous Radar
SK	Stationkeeping
ST, STRK	Star Tracker
V, VBAR	Velocity Vector (direction of orbital travel)
$\pm X, Y, ZLV$	$\pm X, Y, \text{ or } Z$ Local Vertical ( $\pm X, Y, \text{ or } Z$ toward Earth)
X, Y, ZPOP	X, Y, or Z orbiter body axis Perpendicular to Orbit Plane (aligned with the angular momentum vector)
$\pm X, Y, ZVV$	$\pm X, Y, \text{ or } Z$ orbiter body axis along the LVLH Velocity Vector







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PMA 2/3 HOOKS OPEN – CONTINGENCY.....	8-30
APDS FAILED CAPTURE RECONFIG.....	8-33
PMA 2/3 HOOKS CLOSE .....	8-35
OPEN .....	8-37
REFERENCE DATA .....	8-39
APDS FAILURE/IMPACT MATRIX .....	8-40
(TLM).....	8-43
<u>CUE CARD CONFIGURATION</u> .....	9-1

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DEGRADED CONTROL

DEGRADED  
CONTROL































































































APDS

APDS





























































































TOP, BACK OF 'RCS BURN (+X, -X, Multi-axis)

HOOK  
VELCRO

HOOK  
VELCRO

### RENDEZVOUS PRPLT PAD

When L or R RCS QTY <  :

I'CNCT:  OMS to RCS (ORB PKT, RCS)

When G23  OMS/RCS QTY >  :

I'CNCT TK SWITCH: (ORB PKT, RCS)

When G23  OMS/RCS QTY >  :

I'CNCT RETURN (ORB PKT, RCS)

---

When L or R RCS QTY <  :

or when FRCS QTY <  :

### DAP: NO LO Z

---

When L or R RCS QTY <  :

or when FRCS QTY <  :

If prior to Ti:

Do not perform Ti

If after Ti, but prior to TORVA init (+X burns to start TORVA are complete):

Go to RNDZ BREAKOUT (CONTINGENCY OPS), 5-18

If during TORVA:

Go to SHUTTLE NOSE IN-PLANE BREAKOUT  
(CONTINGENCY OPS), 5-16

If stable on +VBAR:

Go to VBAR BREAKOUT (CONTINGENCY OPS), 5-14

RNDZ-1b/120/O/A

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CC 9-4

RNDZ/120/FIN

## KU OPS

HOOK  
VELCRO

1. CONFIGURE KU FOR RR TGT ACQ

GNC 33 REL NAV

CRT	√SV SEL, ITEM 4 – FLTR
	√INH RNG, ITEM 18 – (*)
	RDOT, ITEM 21 – (*)
	Angles, ITEM 24 – (*)
	KU ANT ENA – ITEM 2 EXEC (*)
	GNC I/O RESET
A2	DIGI-DIS sel – R/RDOT
A1U	KU PWR – STBY
	MODE – RDR PASSIVE
	√RDR OUTPUT – HI
	CNTL – PNL (wait 3 sec)
	PWR – ON

KU SEL – GPC &gt;&gt;

2. AUTO TRK ACQ

KU SEL – AUTO TRK

SLEW – as reqd (as seen in COAS)

√EL, AZ angles &lt; 30 deg

KU SEARCH – SEARCH (tb-gray)

Repeat slew and search as reqd

If acquisition not successful, √MCC &gt;&gt;

3. RR NAVIGATION

GNC 33 REL NAV

CRT	√RADAR, ITEM 13 – (*)
-----	-----------------------

\* If RATIO &gt; 1.0: \*

\* √MCC \*

FLTR TO PROP – ITEM 8 EXEC (\*)

AUT RNG – ITEM 17 EXEC (\*)

RDOT – ITEM 20 EXEC (\*)

Angles – ITEM 23 EXEC (\*) &gt;&gt;

4. CONFIGURE KU FOR COMM

GNC 33 REL NAV

CRT	INH RNG – ITEM 18 (*)
	RDOT – ITEM 21 (*)
	Angles – ITEM 24 (*)
	KU ANT ENA – ITEM 2 (no *)
A1U	KU PWR – STBY
	MODE – COMM
	√sel – GPC
	CNTL – CMD
A2	DIGI-DIS sel – EL/AZ

HOOK  
VELCRO

RNDZ-2a/120/O/A

TOP  
BACK OF 'KU OPS'

HOOK  
VELCRO

HOOK  
VELCRO

RNDZ-2b/120/O/A

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CC 9-6

RNDZ/120/FIN

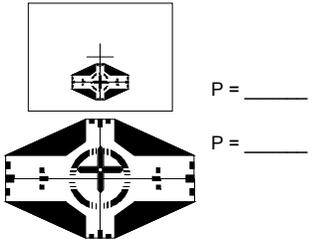




**C/L CAMERA TARGET ALIGNMENT (+VBAR)**

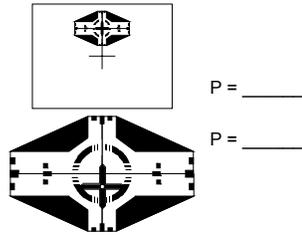
**PITCH (P)  
ITEM 15**

Target Displaced DOWN  
(Cross Displaced UP)



- 3. PITCH = 179 - P = \_\_\_\_ (A)
- 5. PITCH = PITCH - P = \_\_\_\_ (D)

Target Displaced UP  
(Cross Displaced DOWN)



- 3. PITCH = 179 + P = \_\_\_\_ (A)
- 5. PITCH = PITCH + P = \_\_\_\_ (D)

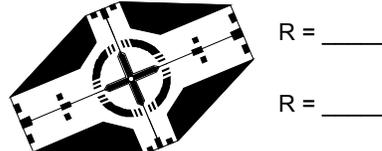
**ROLL (R)  
ITEM 16**

Rotated CW



- 3. YAW = 360 - R = \_\_\_\_ (B)
- 5. YAW = YAW - R = \_\_\_\_ (E)

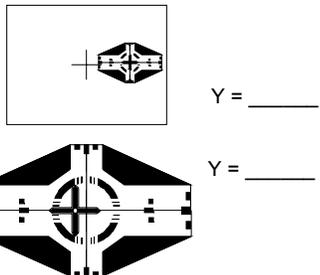
Rotated CCW



- 3. YAW = 0 + R = \_\_\_\_ (B)
- 5. YAW = YAW + R = \_\_\_\_ (E)

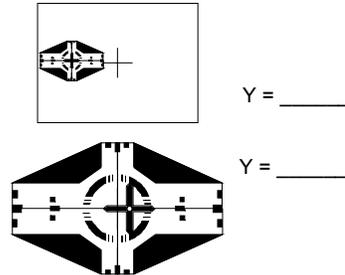
**YAW (Y)  
ITEM 17**

Target Displaced RIGHT  
(Cross Displaced LEFT)



- 3. OM = 0 + Y = \_\_\_\_ (C)
- 5. OM = OM + Y = \_\_\_\_ (F)

Target Displaced LEFT  
(Cross Displaced RIGHT)



- 3. OM = 360 - Y = \_\_\_\_ (C)
- 5. OM = OM - Y = \_\_\_\_ (F)

RNDZ-4a/120/O/A

TOP  
BACK OF 'C/L CAMERA TARGET ALIGNMENT (+VBAR)'

HOOK  
VELCRO

AUTO ANGULAR FLYOUT

**CAUTION**  
AUTO ANGULAR FLYOUT must be  
completed by RNG = 10 ft

1. RECORD ANGULAR MISALIGNMENT

√DAP: A10, B10

Read error from ISS centerline target

PITCH \_\_\_\_\_ (P)

YAW \_\_\_\_\_ (Y)

ROLL \_\_\_\_\_ (R)

Report misalignment to MCC

If all axes within 1.0 deg of zero, no mnvr reqd >>

2. CALCULATE UNIV PTG INPUTS

Use diagrams in TARGET ALIGNMENT (Cue Card) to determine  
UNIV PTG inputs for step 3

3. EXECUTE ALIGNMENT MNVR

**GNC UNIV PTG**

√TGT ID +2

√BODY VECT +5

PITCH +(A)

YAW +(B)

OM +(C)

TRK – ITEM 19 EXEC (CUR-\*)

When mnvr cplt,

4. RECORD REMAINING ANGULAR MISALIGNMENT

Record error from ISS centerline target:

PITCH \_\_\_\_\_ (P)

YAW \_\_\_\_\_ (Y)

ROLL \_\_\_\_\_ (R)

If all axes within 1.0 deg of zero, no additional mnvr reqd >>

Otherwise,

5. REPEAT ALIGNMENT

a. Calculate UNIV PTG inputs:

Use diagrams in TARGET ALIGNMENT (Cue Card) to  
determine UNIV PTG inputs for step 5b

b. Execute alignment MNVR

**GNC UNIV PTG**

√TGT ID +2

√BODY VECT +5

PITCH +(D)

YAW +(E)

OM +(F)

TRK – ITEM 19 EXEC (CUR-\*)

RNDZ-4b/120/O/A

(reduced copy)

HOOK  
VELCRO

**DOCKING SEQUENCE**

<b>CAUTION</b>	
If following failures occur during final approach (< 30 ft), <b>NO-GO</b> for docking. Initiate Corridor Backout. Then proceed with APDS OFF-NOMINAL procedures ( <u>APDS</u> )	
POWER Failed OFF (All STATUS lts OFF)	DAMPING tlm Failed ON
CAPTURE It Failed ON	FIXERS tlm Failed ON

<b>CAUTION</b>	
If any Docking Sequence command occurs out of order or if any STATUS It functions erroneously: A7L POWER OFF pb – push ON pb – push Proceed with APDS OFF-NOMINAL procedures ( <u>APDS</u> )	

**Event Time**

Contact/Capture/Damping		
<b>SM 167 DOCKING STATUS</b>		
0:00	A7L	1. √CAPTURE It – It on (expect RING INITIAL POSITION It off)
0:05	CRT	2. √DAMPING – ON
Disable and Release Dampers		
		3. When no relative motion [PETAL POS BASE (three) not changing for 60 sec]:
	A7L	POWER ON pb – push
	CRT	√DAMPING – OFF
		4. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
	A7L	FIXER OFF pb – push
		√FIXERS OFF It – It on
0:00		RING IN pb – push
	CRT	√DRV CMD – ON [PETAL POS BASE (three) – decr]
		√CLUTCH – LOCK/blank
0:05	A7L	5. POWER ON pb – push
	CRT	√RING DRV CMD – OFF
		6. When no relative motion [PETAL POS BASE (three) not changing for 30 sec]:
	A7L	APDS CIRC PROT OFF pb – push
		√CIRCUIT PROTECT OFF It – It on
0:00		RING OUT pb – push
	CRT	√DRV CMD – ON [PETAL POS BASE (three) – incr]
0:05	A7L	7. POWER OFF pb – push
		ON pb – push
		√FIXERS OFF It – It off
	CRT	√RING DRV CMD – OFF

<b>Retract Ring</b>		
0:00	A7L CRT	8. On MCC GO (RING ALIGNED It on and [PETAL POS BASE (three) not changing] for 30 sec): RING IN pb – push √DRV CMD – ON [PETAL POS BASE (three) – decr] √FIXERS – ON √CLUTCH – LOCK/blank
	CRT,A7L A7L A7L,CRT A7L	* If PETAL POS BASE (three) > 20 % and RING ALIGNED It off: * * POWER ON pb – push * * Wait for ring alignment (up to 30 min) * * When RING ALIGNED It on and [PETAL POS BASE (three) * * not changing] for 30 sec: * * RING IN pb – push *
3:15	A7L CRT	9. √READY TO HOOK It – It on √PETAL POS BASE (three) ≤ 7%
<b>Close Hooks</b>		
0:00	A7L CRT	10. √HOOKS 1,HOOKS 2 OPEN It (two) – It off √HK1,HK2 DRV CMD (two) – ON √POS (two) ≥ 5% & incr
	A7L	* If HK1(2) DRV CMD – OFF or HK1(2) POS not incr: * * CLOSE HOOKS pb – push * * If HOOKS 1(2) CLOSED It failed ON: * * Perform HOOKS 1(2) CLOSED LT FAILED ON, 8-23 *
0:20	CRT	11. √RING DRV CMD – OFF * If RING DRV CMD – ON 20 sec after hooks begin * * driving in step 10: *
	A7L	* POWER ON pb – push *
≤ 1:30	A7L	12. √INTERF SEALED It – It on (expect intermittent It initially)
2:20	CRT	13. √HOOKS 1,HOOKS 2 CLOSED It (two) – It on √HK1,HK2 POS (two) = 92 - 93% √IND (two) – blank/CL √ODS INDIV HK CL (twelve) – CL
<b>Load Relieve Capture Latches (Extend Ring)</b>		
	A7L	14. APDS CIRC PROT OFF pb – push √CIRCUIT PROTECT OFF It – It on
0:00		15. RING OUT pb – push
	CRT	√DRV CMD – ON
0:10	A7L CRT	16. POWER ON pb – push √RING DRV CMD – OFF
<b>Open Capture Latches</b>		
0:00	A7L	17. OPEN LATCHES pb – push √LATCHES CLOSED It – It off
0:05		√OPEN It – It on
<b>Retract Ring to FNL POS</b>		
0:00	CRT	18. RING IN pb – push √DRV CMD – ON [PETAL POS BASE (three) – decr] √FIXERS – ON
0:10	A7L CRT	√FINAL POSITION It – It on √PETAL POS BASE (three) = 5 ± 3%
0:20		√RING DRV CMD – OFF
<b>Power Off</b>		
	A7L	19. POWER OFF pb – push √STATUS It (eighteen) – It off
		20. Go to TERMINATE RNDZ OPS <u>22A</u> , 4-22 >>

TOP

HOOK  
VELCRO

**STOPWATCH RDOT CONVERSION**

TIME BETWEEN 1 FT MARKS (SEC)	RANGE RATE (FT/SEC)
2	0.50
3	0.33
4	0.25
5	0.20
5.5	0.18
6	0.17
6.5	0.15
7	0.14
7.5	0.13
8	0.125
8.5	0.12
9	0.11
10	0.10
11	0.09
12	0.08
13	0.075
14	0.07
15	0.067
16	0.063
18	0.056
20	0.050

NOTE

HHL SPECS state that the HHL will not work if the aimpoint surface is closer than 12 ft from the HHL unit; therefore, no HHL use should be expected at an HHL range less than 12 ft (5 ft interface-to-interface)

RNDZ-6a/120/O/A



H O O K  
 V E L C R O

H O O K  
 V E L C R O

## GPC/MDM FAILURE RESPONSE DURING RNDZ

NOTES

1. GPC assignments assume 1233 NBAT
2. Do NOT restrng for Non-Universal I/O Errors. Otherwise, a restrng for GPC 1,2,3 fails will recover everything (see expected restrng below)
3. If any GNC GPC fails, VERNs ↓
4. If IMUs not commfaulted, THCs are normally GO
5. Loss of FF2, FF4, FA3, and FA4 do not impact Rndz (unless other failures)

GPC	MDM	IMMEDIATE ACTION	MAJOR IMPACT
<b>GPC1</b> (3232*)	<b>FF1</b>	1. If -Z ST NAV, INH ST to NAV 2. Work appropriate ORB PKT procedure 3. If not recovered: Use -Y ST, if reqd	1. C3 DAP lights latched (go out with MDM pwr fail) 2. -Z ST ↓
	<b>FA1</b>	Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO	VERNs ↓
<b>GPC2</b> (1313*)	<b>FA2</b>	Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO	VERNs ↓
<b>Man OMS Shutdown</b>  <b>GPC3</b> (1212*)  <b>Loss of Aft DAP</b>	<b>FF3</b>	1. Pre-MC4: DAP: ALT/AUTO Post-MC4: DAP: PRI/AUTO 2. If RR NAV, INH RR to NAV 3. If -Y ST NAV, INH ST to NAV 4. Work appropriate ORB PKT procedure 5. If not recovered: Work RR FAIL procedures	1. VERNs ↓ 2. RR → NAV/RPOP ↓ (Panel A2 OK) 3. A6 DAP lights latched (go out with MDM pwr fail) 4. -Y ST ↓ 5. Also for loss of GPC3: R OMS GMBL PRI/SEC ↓
<b>GPC4</b> (1212*)	<b>PL</b>	If Ku breaks lock: Ku sel – AUTO TRK	1. GPC Ku ptg ↓, slew in AUTO TRK if Ku breaks lock 2. No Ku self-test

\* Expect this NBAT if GPC fail

MALFUNCTION	>>

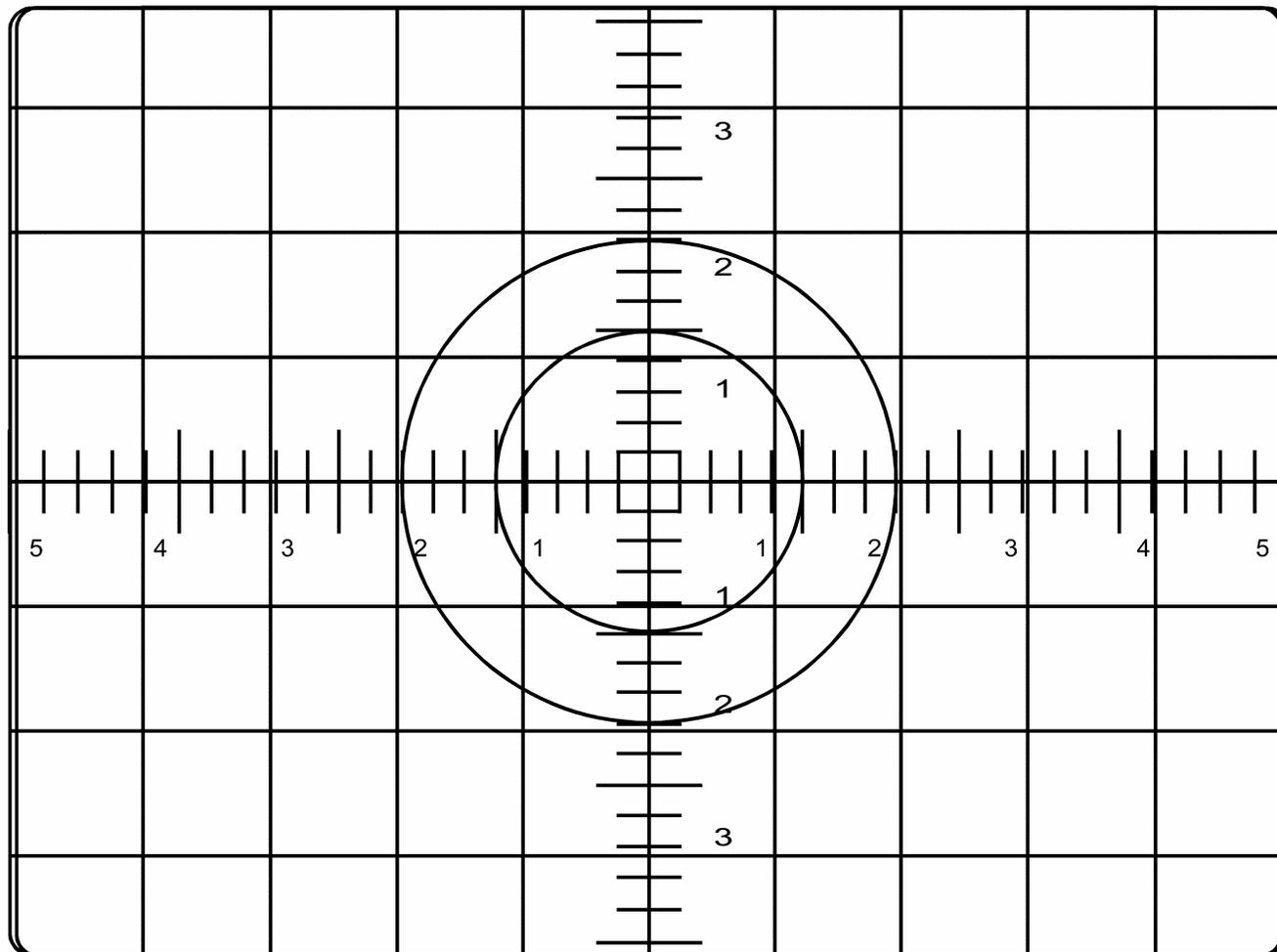
RNDZ-7a/120/O/A



Note: Fabricate As Transparency

**C/L CAMERA**

**CORRIDOR AND ALIGNMENT**



**CTVC 40.0 DEG HFOV - CORRIDOR**  
**CTVC FULL ZOOM - ALIGNMENT**

RNDZ-8a/120/O/A

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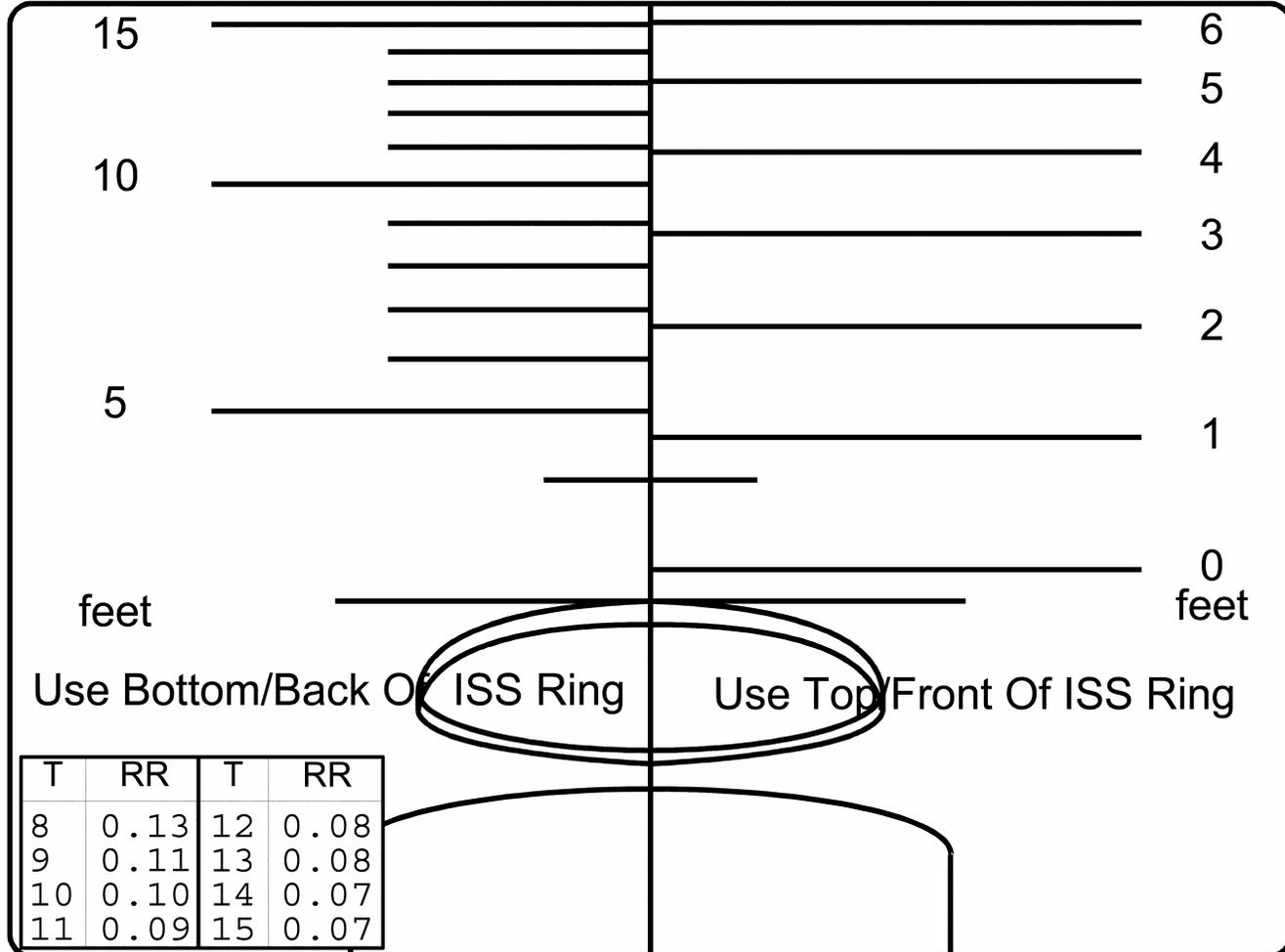
CC 9-17

RNDZ/120/FIN

Note: Fabricate As Transparency

**CAMERA A/D**

**RANGE RULER**



**CTVC FULL NO ZOOM**

**RNDZ-9a/120/O/A**

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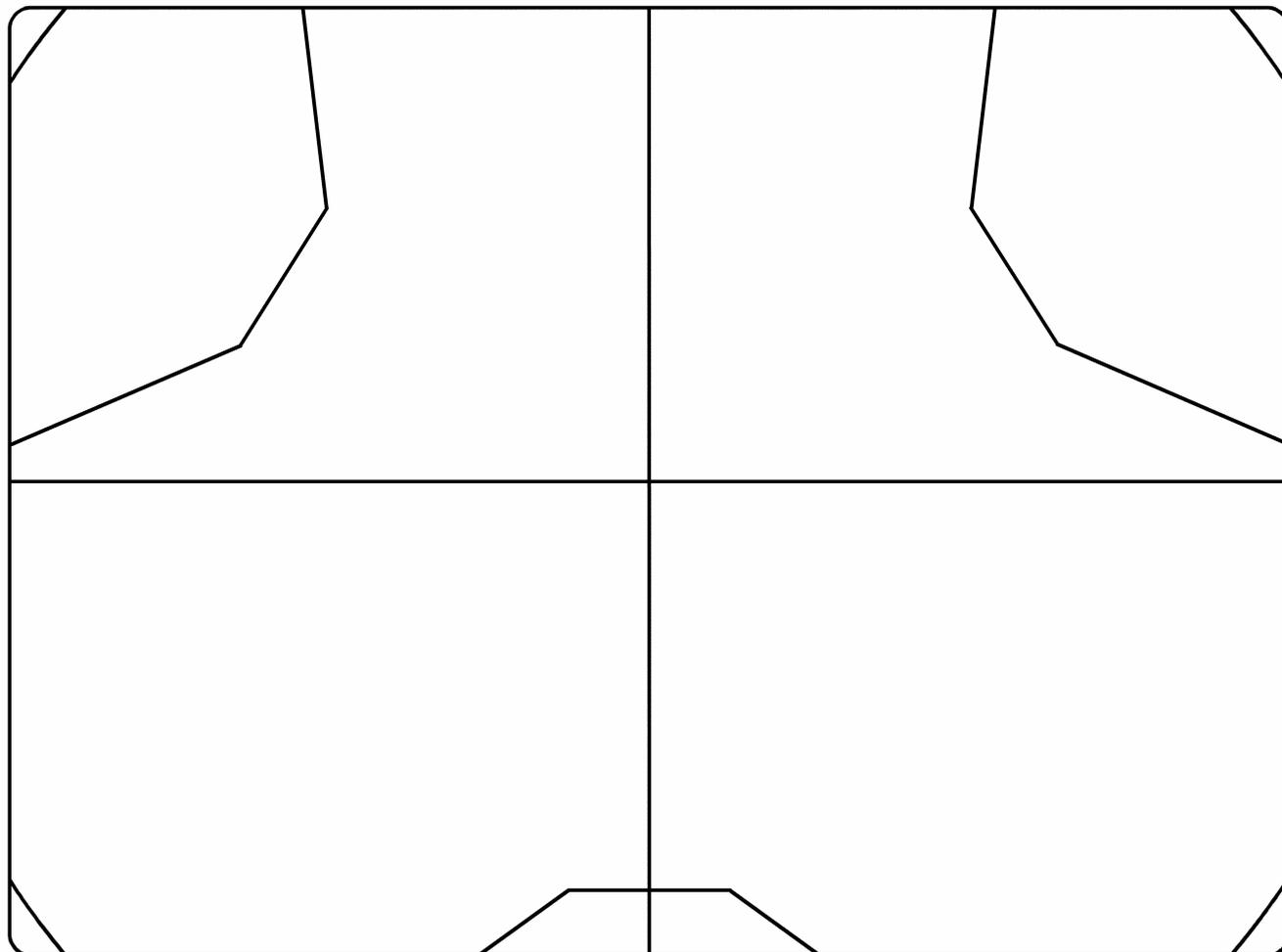
CC 9-18

RNDZ/120/FIN

Note: Fabricate As Transparency

**C/L CAMERA**

**ZOOM CALIBRATION (RING READY FOR DOCK)**



**CTVC AT HFOV = 40.0 DEG**

RNDZ-10a/120/O/A

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CC 9-19

RNDZ/120/FIN

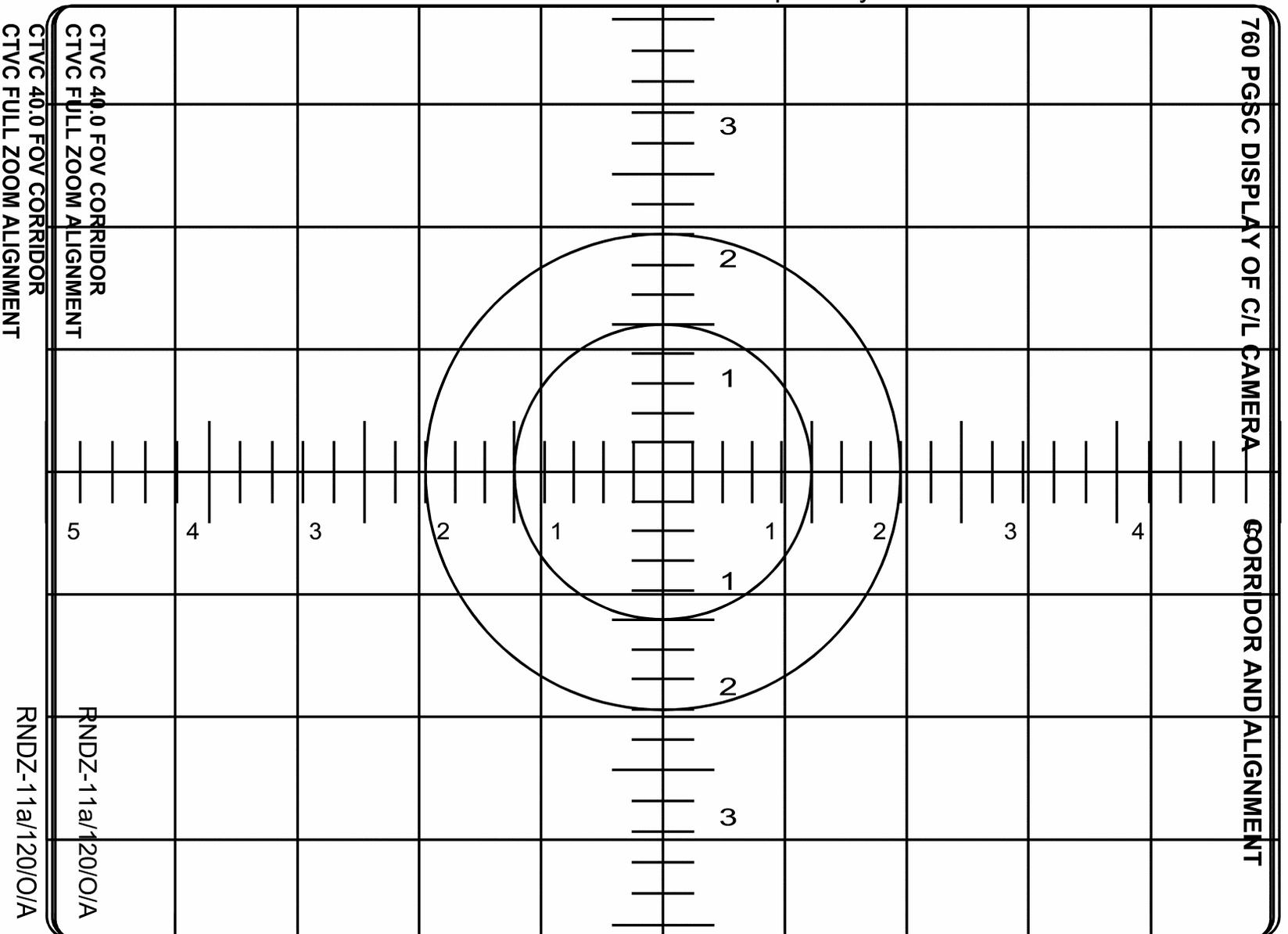
760 PGSC DISPLAY OF C/L CAMERA

CORRIDOR AND ALIGNMENT

760 PGSC DISPLAY OF C/L CAMERA

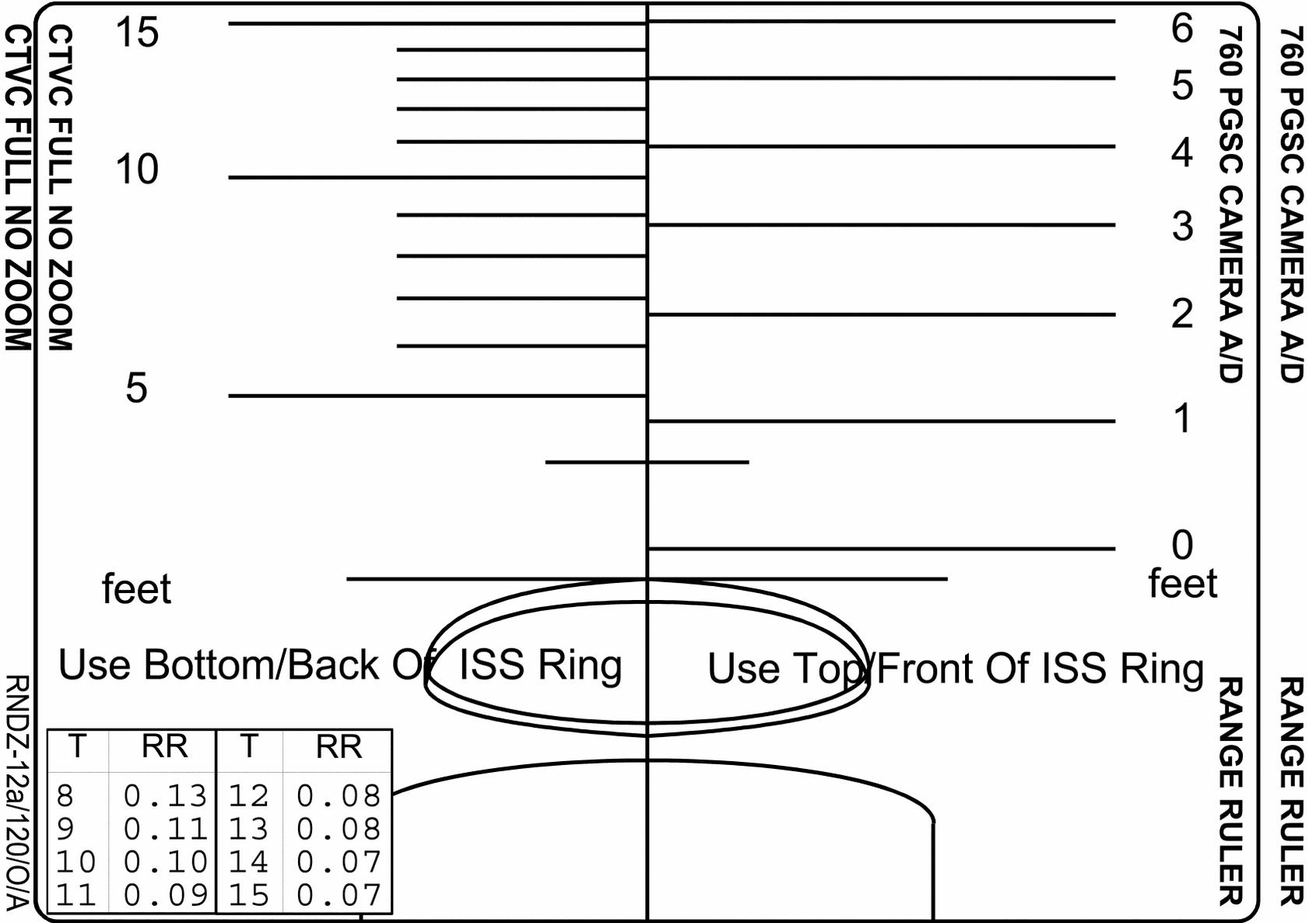
CORRIDOR AND ALIGNMENT

Note: Fabricate As Transparency



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Note: Fabricate As Transparency



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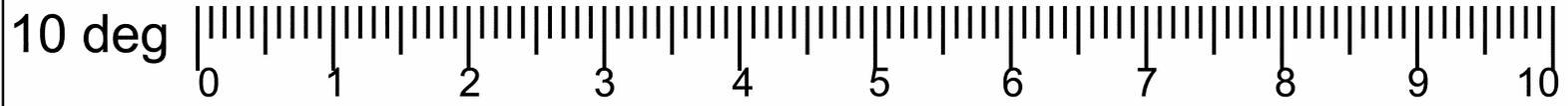
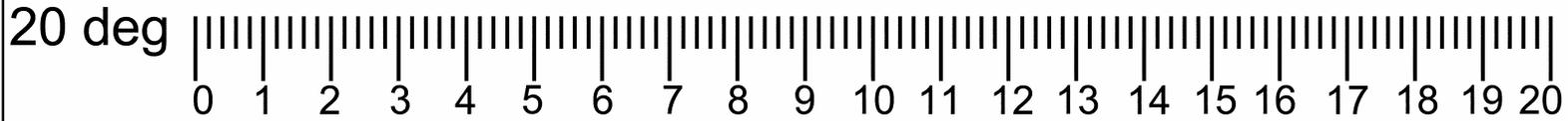
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RNDZ/120/FIN

# FLIGHT

# SUB ANG RULER

H-FOV



RNDZ-13a/120/O/A

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CC 9-22

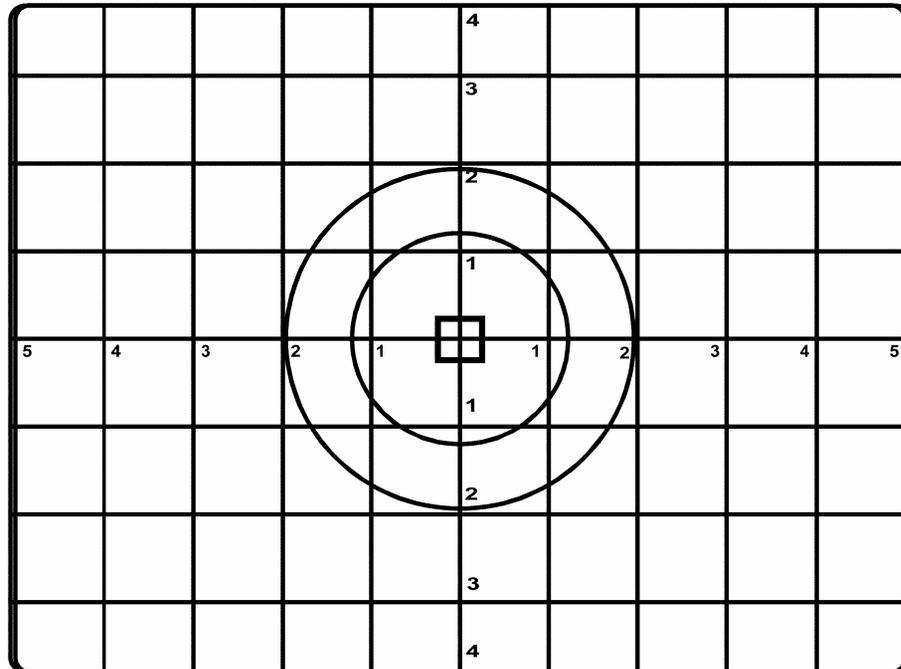
RNDZ/120/FIN

Note: Fabricate As Transparency

RNDZ-14a/120/O/A

**V10 MONITOR**

**CORRIDOR**



**CTVC 40.0 DEG HFOV - CORRIDOR**

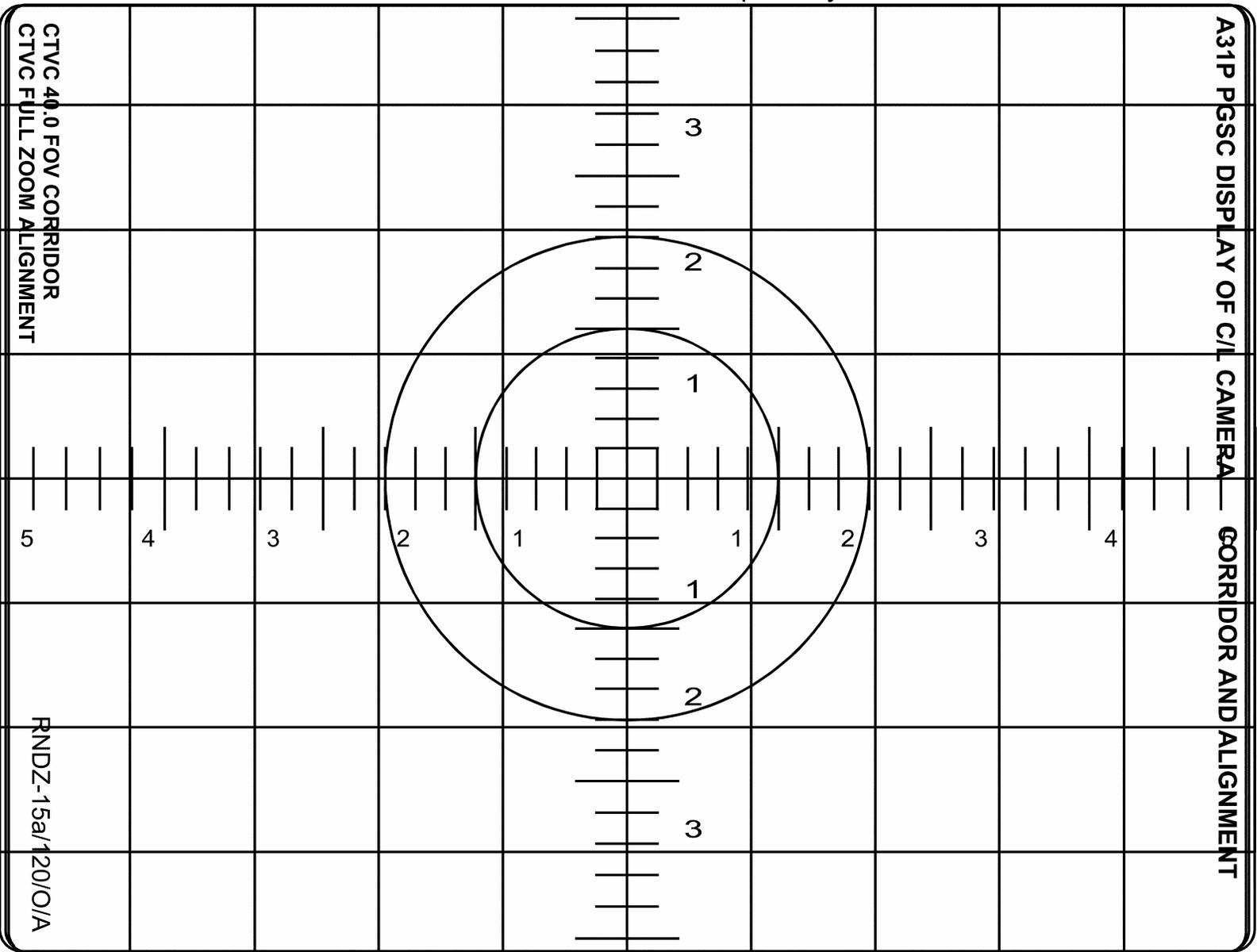
**CTVC FULL ZOOM - ALIGNMENT**

A31P PGSC DISPLAY OF C/L CAMERA

CORRIDOR AND ALIGNMENT

A31P PGSC DISPLAY OF C/L CAMERA

CORRIDOR AND ALIGNMENT



CTVC 40.0 FOV CORRIDOR  
CTVC FULL ZOOM ALIGNMENT

CTVC 40.0 FOV CORRIDOR  
CTVC FULL ZOOM ALIGNMENT

RNDZ-15a/120/O/A

RNDZ-15a/120/O/A

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CC 9-24

RNDZ/120/FIN



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**RENDEZVOUS**

**STS  
120**