

John Kennedy

From: Peterson, Charles E [charles.e.peterson@lmco.com]
Sent: Monday, September 10, 2007 8:05 PM
To: John Kennedy
Subject: Frequency Allocation Request Info
Attachments: FOPEN_DD-1494.doc

Attached is the frequency allocation request submitted to and approved by the Army. As I indicated, the FOPEN system has been operated all over the U.S. and at least one other continent for about 8 years with some restrictions of airspace and time. In terms of frequency allocation, the frequency bands are essentially identical. We are interested in testing changes in pulse width, pulse repetition, etc. within the same operating range.

Hopefully the additional details on this form will help fill in the picture. If there is any other material I can provide or questions I might answer, please call. I'm frequently away from my desk, so I may not be here when you call.

Please leave any questions you might have and maybe we can move forward one voice mail at a time if we don't get to talk directly.

Chuck Peterson
623-925-7612
Cell 602-908-7380

9/11/2007

APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION		CLASSIFICATION UNCLASSIFIED	DATE 2 Jan 2003	FORM APPROVED OMB No. 0704-0188 Page 1 of 10 Pages
DOD GENERAL INFORMATION				
TO Department of the Army Army Spectrum Management, NETCOM 2461 Eisenhower Avenue Suite 1200 Alexandria, VA 22331-1400		FROM US Army CECOM Information & Intelligence Warfare Directorate Fort Monmouth, NJ 07703		
1. APPLICATION TITLE Foliage Penetration (FOPEN) Synthetic Aperture Radar (SAR)				
2. SYSTEM NOMENCLATURE Foliage Penetration Synthetic Aperture Radar				
3. STAGE OF ALLOCATION ☐ a. STAGE 1 ☒ b. STAGE 2 ☐ c. STAGE 3 ☐ d. STAGE 4 <i>(X one)</i> CONCEPTUAL EXPERIMENTAL DEVELOPMENTAL OPERATIONAL				
4. FREQUENCY REQUIREMENTS				
a. FREQUENCY(IES)		227-454 MHz	24-54 MHz	
b. EMISSION DESIGNATOR(S)		225MQ3N, 227MQ3N	29M9Q3N, 30M1Q3N	
5. TARGET STARTING DATE FOR SUBSEQUENT STAGES				
a. STAGE 2 03/1/03		b. STAGE 3 N/A		c. STAGE 4 03/1/04
6. EXTENT OF USE Continuous during mission: 40 Hr Maximum				
7. GEOGRAPHICAL AREA FOR				
a. STAGE 2		See Remarks		
b. STAGE 3		N/A		
c. STAGE 4		Not Available		
8. NUMBER OF UNITS				
a. STAGE 2 1		b. STAGE 3 N/A		c. STAGE 4 Not Available
9. NUMBER OF UNITS OPERATING SIMULTANEOUSLY IN THE SAME ENVIRONMENT 1				
10 OTHER J/F 12 APPLICATION NUMBER(S) TO BE		11. IS THERE ANY OPERATIONAL REQUIREMENT AS DESCRIBED IN THE INSTRUCTIONS FOR PARAGRAPH 11?		
☒ a. SUPERSEDED J/F 12/ 7560 ☐ b. RELATED J/F 12/		☐ a. YES ☒ b. NO ☐ c. N/Avail		
12. NAMES AND TELEPHONE NUMBERS				
a. PROGRAM MANAGER Lee Moyer		(1) COMMERCIAL 703-696-7445	(2) AUTOVON	
b. PROJECT ENGINEER David Thomas		(1) COMMERCIAL 732-427-5759	(2) AUTOVON 987-5759	
13. REMARKS				
Item 6: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 7a&b: Tonopah/Gila Bend, AZ; Flagstaff, AZ; Heiburg-Tully Forest, NY; Huntington Forest, NY; Oak Ridge, TN; Fort Indiantown Gap, PA; Latour State Forest, CA; Grayling, MI; Nellis Range, NV; Cherry Point, NC; Camp Shelby, MS; Eglin AFB, FL				
DOWNGRADING INSTRUCTIONS N/A		CLASSIFICATION UNCLASSIFIED		

CLASSIFICATION UNCLASSIFIED		PAGE 2 of 10 Pages																
TRANSMITTER EQUIPMENT CHARACTERISTICS																		
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. FOPEN Radar UHF Transmitter		2. MANUFACTURER'S NAME Lockheed Martin TDS, Arizona																
3. TRANSMITTER INSTALLATION See Remarks		4. TRANSMITTER TYPE Compressed Pulse Radar																
5. TUNING RANGE 227-454 MHz		6. METHOD OF TUNING Synthesizer																
7. RF CHANNELING CAPABILITY (See Remarks)		8. EMISSION DESIGNATOR(S) 225MQ3N 227MQ3N																
9. FREQUENCY TOLERANCE 50 ppm																		
10. FILTER EMPLOYED (X one) ☒ a. YES ☐ b. NO																		
11. SPREAD SPECTRUM (X one) ☐ a. YES ☒ b. NO		12. EMISSION BANDWIDTH (X and complete as applicable) ☒ CALCULATED ☐ MEASURED																
13. MAXIMUM BIT RATE N/A		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">a. -3 dB</td> <td style="width: 35%;">200 MHz</td> <td style="width: 35%;">203 MHz</td> </tr> <tr> <td>b. -20 dB</td> <td>225 MHz</td> <td>227 MHz</td> </tr> <tr> <td>c. -40 dB</td> <td>258 MHz</td> <td>259 MHz</td> </tr> <tr> <td>d. -60 dB</td> <td>295 MHz</td> <td>296 MHz</td> </tr> <tr> <td>e. OC-BW</td> <td>225 MHz</td> <td>227 MHz</td> </tr> </table>		a. -3 dB	200 MHz	203 MHz	b. -20 dB	225 MHz	227 MHz	c. -40 dB	258 MHz	259 MHz	d. -60 dB	295 MHz	296 MHz	e. OC-BW	225 MHz	227 MHz
a. -3 dB	200 MHz	203 MHz																
b. -20 dB	225 MHz	227 MHz																
c. -40 dB	258 MHz	259 MHz																
d. -60 dB	295 MHz	296 MHz																
e. OC-BW	225 MHz	227 MHz																
14. MODULATION TECHNIQUES AND CODING 210 MHz maximum linear frequency modulation during pulse. (See Remarks)		15. MAXIMUM MODULATION FREQUENCY N/A																
16. PRE-EMPHASIS (X one) ☐ a. YES ☒ b. NO		17. DEVIATION RATIO N/A																
19. POWER <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">a. MEAN</td> <td style="width: 35%;">N/A</td> </tr> <tr> <td>b. PEP</td> <td>1450 watts</td> </tr> </table>		a. MEAN	N/A	b. PEP	1450 watts	18. PULSE CHARACTERISTICS <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">a. RATE</td> <td style="width: 35%;">350-580 pps</td> </tr> <tr> <td>b. WIDTH</td> <td>75-140 us</td> </tr> <tr> <td>c. RISE TIME</td> <td>1 us</td> </tr> <tr> <td>d. FALL TIME</td> <td>1 us</td> </tr> <tr> <td>e. COMP RATIO</td> <td>15750; 29400</td> </tr> </table>		a. RATE	350-580 pps	b. WIDTH	75-140 us	c. RISE TIME	1 us	d. FALL TIME	1 us	e. COMP RATIO	15750; 29400	
a. MEAN	N/A																	
b. PEP	1450 watts																	
a. RATE	350-580 pps																	
b. WIDTH	75-140 us																	
c. RISE TIME	1 us																	
d. FALL TIME	1 us																	
e. COMP RATIO	15750; 29400																	
20. OUTPUT DEVICE Transistor		21. HARMONIC LEVEL <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">a. 2nd</td> <td style="width: 35%;">-30 dB</td> </tr> <tr> <td>b. 3rd</td> <td>-30 dB</td> </tr> <tr> <td>c. OTHER</td> <td>-30 dB</td> </tr> </table>		a. 2nd	-30 dB	b. 3rd	-30 dB	c. OTHER	-30 dB									
a. 2nd	-30 dB																	
b. 3rd	-30 dB																	
c. OTHER	-30 dB																	
22. SPURIOUS LEVEL -30 dB		23. FCC TYPE ACCEPTANCE NO. N/A																
24. REMARKS Item 3: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 5, 6, and 7: There is no provision for tuning or channeling per se; a digital synthesizer is employed to produce a 210 MHz linear sweep during pulse. Item 10: An Arbitrary Waveform Generator generates notches as required at user-defined frequencies and with user-defined notch widths. Notch widths vary from 200 kHz to over 20 MHz. Notch depths are approximately 15 dB for notches with width of 500 kHz or less and 20-25 dB for notches with widths of 1 MHz or larger. The following bands are always notched: 242.9-243.1 MHz, 255.35-255.45 MHz, 328.6-355.4 MHz and 406.0 to 406.1 MHz																		
CLASSIFICATION UNCLASSIFIED																		

CLASSIFICATION UNCLASSIFIED		PAGE 3 of 10 Pages	
TRANSMITTER EQUIPMENT CHARACTERISTICS			
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. FOPEN Radar VHF Transmitter		2. MANUFACTURER'S NAME Lockheed Martin TDS, Arizona	
3. TRANSMITTER INSTALLATION See Remarks		4. TRANSMITTER TYPE Compressed Pulse Radar	
5. TUNING RANGE 24-54 MHz		6. METHOD OF TUNING Synthesizer	
7. RF CHANNELING CAPABILITY (See Remarks)		8. EMISSION DESIGNATOR(S) 29M9Q3N 30M1Q3N	
9. FREQUENCY TOLERANCE 50 ppm			
10. FILTER EMPLOYED (X one) ☒ a. YES ☐ b. NO			
11. SPREAD SPECTRUM (X one) ☐ a. YES ☒ b. NO		12. EMISSION BANDWIDTH (X and complete as applicable) ☒ CALCULATED ☐ MEASURED	
13. MAXIMUM BIT RATE N/A		a. -3 dB 26 MHz 26 MHz	
		b. -20 dB 30 MHz 30 MHz	
		c. -40 dB 36 MHz 36 MHz	
		d. -60 dB 43 MHz 43 MHz	
		e. OC-BW 30 MHz 30 MHz	
14. MODULATION TECHNIQUES AND CODING 27 MHz maximum linear frequency modulation during pulse. (See Remarks)		15. MAXIMUM MODULATION FREQUENCY N/A	
16. PRE-EMPHASIS (X one) ☐ a. YES ☒ b. NO		17. DEVIATION RATIO N/A	
19. POWER a. MEAN N/A b. PEP 200 watts		18. PULSE CHARACTERISTICS a. RATE 350-580 pps b. WIDTH 75-140 us c. RISE TIME 1 us d. FALL TIME 1 us e. COMP RATIO 2025; 3780	
20. OUTPUT DEVICE Transistor		21. HARMONIC LEVEL a. 2nd -30 dB b. 3rd -30 dB c. OTHER -30 dB	
22. SPURIOUS LEVEL -30 dB			
23. FCC TYPE ACCEPTANCE NO. N/A			
24. REMARKS Item 3: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 5, 6, and 7: There is no provision for tuning or channeling per se; a digital synthesizer is employed to produce a 27 MHz linear sweep during pulse. Item 10: An Arbitrary Waveform Generator generates notches as required at user-defined frequencies and with user-defined notch widths.			
CLASSIFICATION UNCLASSIFIED			

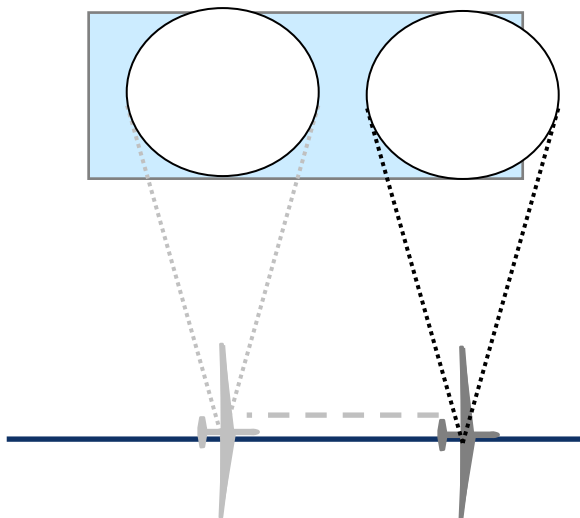
CLASSIFICATION UNCLASSIFIED				PAGE 4 of 10 Pages	
RECEIVER EQUIPMENT CHARACTERISTICS					
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. FOPEN Radar UHF Receiver			2. MANUFACTURER'S NAME Lockheed Martin TDS, Arizona		
3. RECEIVER INSTALLATION (See Remarks)			4. RECEIVER TYPE Triple Conversion Superheterodyne		
5. TUNING RANGE 227-454 MHz			6. METHOD OF TUNING Resonant Filter		
7. RF CHANNELING CAPABILITY (See Remarks)			8. EMISSION DESIGNATOR(S) 225MQ3N 227MQ3N		
9. FREQUENCY TOLERANCE 50 ppm					
10. IF SELECTIVITY	1st	2nd	3rd	11. RF SELECTIVITY (X and complete as applicable) ☒ CALCULATED ☐ MEASURED	
a. -3 dB	435 MHz	82 MHz	85 MHz	a. -3 dB 230 MHz	
b. -20 dB	740 MHz	189 MHz	88 MHz	b. -20 dB 250 MHz	
c. -60 dB	850 MHz	217 MHz	94 MHz	c. -60 dB 275 MHz	
12. IF FREQUENCY				d. Preselection Type Fixed Tuned Filter	
a. 1st 1.761 GHz				13. MAXIMUM POST DETECTION FREQUENCY N/A	
b. 2nd 743.5 MHz				14. MINIMUM POST DETECTION FREQUENCY N/A	
c. 3rd 43.5 MHz				16. MAXIMUM BIT RATE N/A	
15. OSCILLATOR TUNED	1st	2nd	3rd	17. SENSITIVITY	
a. ABOVE TUNED FREQUENCY	X	X	X	a. SENSITIVITY -81 dBm	
b. BELOW TUNED FREQUENCY				b. CRITERIA S/N = 8db	
c. EITHER ABOVE OR BELOW THE FREQUENCY				c. NOISE FIG 7 dB	
18. DE-EMPHASIS (X one) ☐ a. YES ☒ b. NO				d. NOISE TEMP N/A Kelvin	
19. IMAGE REJECTION 40 dB				20. SPURIOUS REJECTION 60 dB	
21. REMARKS Item 3: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 5, 6, and 7: There is no provision for tuning or channeling per se; a digital synthesizer is employed to produce a 210 MHz linear sweep during pulse. Item 17: A processing gain of 49 dB is obtained from the linear FM pulse compression. Item 17b: S/N = 8 dB represents a tangential sensitivity.					

CLASSIFICATION UNCLASSIFIED				PAGE 5 of 10 Pages	
RECEIVER EQUIPMENT CHARACTERISTICS					
1. NOMENCLATURE, MANUFACTURER'S MODEL NO. FOPEN Radar VHF Receiver			2. MANUFACTURER'S NAME Lockheed Martin TDS, Arizona		
3. RECEIVER INSTALLATION (See Remarks)			4. RECEIVER TYPE Triple Conversion Superheterodyne		
5. TUNING RANGE 24-54 MHz			6. METHOD OF TUNING Resonant Filter		
7. RF CHANNELING CAPABILITY (See Remarks)			8. EMISSION DESIGNATOR(S) 29M9Q3N 30M1Q3N		
9. FREQUENCY TOLERANCE 50 ppm					
10. IF SELECTIVITY	1st	2nd	3rd	11. RF SELECTIVITY (X and complete as applicable) ☒ CALCULATED ☐ MEASURED	
a. -3 dB	65 MHz	31 MHz	31 MHz	a. -3 dB 33 MHz	
b. -20 dB	70 MHz	33 MHz	33 MHz	b. -20 dB 40 MHz	
c. -60 dB	80 MHz	39 MHz	38 MHz	c. -60 dB 58 MHz	
12. IF FREQUENCY				d. Preselection Type Fixed Tuned Filter	
a. 1st 326.5 MHz				13. MAXIMUM POST DETECTION FREQUENCY N/A	
b. 2nd 117 MHz				14. MINIMUM POST DETECTION FREQUENCY N/A	
c. 3rd 17 MHz				16. MAXIMUM BIT RATE N/A	
15. OSCILLATOR TUNED	1st	2nd	3rd	17. SENSITIVITY	
a. ABOVE TUNED FREQUENCY	X	X	X	a. SENSITIVITY -85 dBm	
b. BELOW TUNED FREQUENCY				b. CRITERIA S/N = 8db	
c. EITHER ABOVE OR BELOW THE FREQUENCY				c. NOISE FIG 7 dB	
18. DE-EMPHASIS (X one) ☐ a. YES ☒ b. NO				d. NOISE TEMP N/A Kelvin	
19. IMAGE REJECTION 40 dB				20. SPURIOUS REJECTION 60 dB	
21. REMARKS Item 3: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 5, 6, and 7: There is no provision for tuning or channeling per se; a digital synthesizer is employed to produce a 27 MHz linear sweep during pulse. Item 17: A processing gain of 41 dB is obtained from the linear FM pulse compression. Item 17b: S/N = 8 dB represents a tangential sensitivity.					

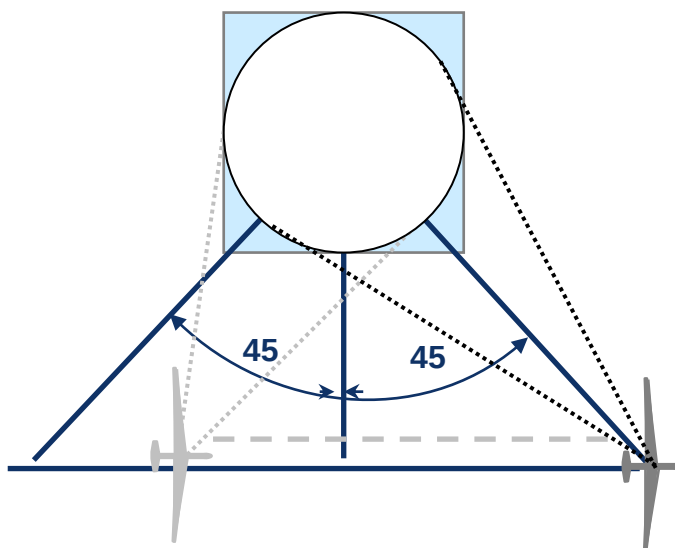
CLASSIFICATION UNCLASSIFIED		PAGE 6 of 10 Pages
ANTENNA EQUIPMENT CHARACTERISTICS		
1. ☐ a. TRANSMITTING ☐ b. RECEIVING ☒ c. TRANSMITTING AND RECEIVING		
2. NOMENCLATURE, MANUFACTURER'S MODEL NO. FOPEN Radar UHF Antenna	3. MANUFACTURER'S NAME Lockheed Martin TDS, Arizona	
4. FREQUENCY RANGE 150-597	5. TYPE Flared Notch	
6. POLARIZATION Dual - Horizontal and Vertical	7. SCAN CHARACTERISTICS	
8. GAIN	a. TYPE See Remarks	
a. MAIN BEAM 12.5 dBi	b. VERTICAL SCAN N/A	
b. 1st MAJOR SIDE LOBE 0 dBi	(1) Max Elev	
	(2) Min Elev	
	(3) Scan Rate	
9. BEAMWIDTH	c. HORIZONTAL SCAN See Remarks	
a. HORIZONTAL 45°	(1) Sector Scanned	
b. VERTICAL 50°	(2) Scan Rate	
	d. SECTOR BLANKING (<i>X one</i>) ☐ (1) YES ☒ (2) NO	
10. REMARKS Item 8: Antenna gains are at mid-band (361 MHz) Item 7: Antenna is either fixed at broadside to aircraft velocity vector or mechanically-horizontally steered between $\pm 45^\circ$ of broadside, as to maintain maximum power radiated on the imaged area		
CLASSIFICATION UNCLASSIFIED		

Foliage Penetration Radar

Area & Map Mode



Point Mode



Area and Map Modes: Area and Map modes produce a Strip Map image around the aimpoint. Map mode operates with horizontally polarized UHF only, while Area mode utilizes full-pol UHF and horizontal VHF. The UHF antenna is fixed at broadside for the duration of the aperture.

Point Mode: Point mode produces a spotlight image of the area around the aimpoint. It utilizes full-pol UHF and horizontal VHF. The UHF antenna is steered toward the aimpoint for the duration of the pass. The VHF antenna always remains fixed at broadside.

All Modes: The radar generally operates at depression angles between 20 and 45 degrees to the aimpoint. Operational altitudes on the RC-12 are between 12 and 30kft. Operation on Global Hawk will extend to 60kft.

APPLICATION FOR SPECTRUM REVIEW		CLASSIFICATION: UNCLASSIFIED	PAGE 9 of 10 Pages
NTIA GENERAL INFORMATION			
1. APPLICATION TITLE Foliage Penetration (FOPEN) Synthetic Aperture Radar (SAR)			
2. SYSTEM NOMENCLATURE Foliage Penetration Synthetic Aperture Radar			
3. STAGE OF ALLOCATION (<i>X one</i>) ☐ a. STAGE 1 CONCEPTUAL ☒ b. STAGE 2 EXPERIMENTAL ☐ c. STAGE 3 DEVELOPMENTAL ☐ d. STAGE 4 OPERATIONAL			
4. FREQUENCY REQUIREMENTS a. FREQUENCY(IES) 227-454 24-54 b. EMISSION DESIGNATOR(S) 225MQ3N, 227MQ3N 29M9Q3N, 30M1Q3N			
5. PURPOSE OF SYSTEM, OPERATIONAL AND SYSTEM CONCEPTS (WARTIME USE) (<i>X one</i>) ☒ a. YES ☐ b. NO Demonstrate Feasibility of detecting targets under foliage and camouflage			
6. INFORMATION TRANSFER REQUIREMENTS Compressed radar pulses			
7. ESTIMATED INITIAL COST OF THE SYSTEM \$22.9 M For development and fabrication of one unit			
8. TARGET DATE FOR			
a. APPLICATION APPROVAL ASAP		b. SYSTEM ACTIVATION N/A	c. SYSTEM TERMINATION N/A
9. SYSTEM RELATIONSHIP AND ESSENTIALITY This system is a near-real-time foliage penetration, synthetic aperture radar to detect targets under foliage and camouflage.			
10. REPLACEMENT INFORMATION None			
11. RELATED ANALYSIS AND/OR TEST DATA None			
12. NUMBER OF MOBILE UNITS One			
13. GEOGRAPHICAL AREA FOR			
a. STAGE 2 See Remarks			
b. STAGE 3 N/A			
c. STAGE 4 Not Available			
14. LINE DIAGRAM See page(s) 8		15. SPACE SYSTEMS See page(s) N/A	
16. TYPE OF SERVICE(S) FOR STAGE 4 Radiolocation		17. STATION CLASS(ES) FOR STAGE 4 MR	
18. REMARKS Item 2: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar Item 13a&b: Tonopah/Gila Bend, AZ; Flagstaff, AZ; Heiburg-Tully Forest, NY; Huntington Forest, NY; Oak Ridge, TN; Fort Indiantown Gap, PA; Latour State Forest, CA; Grayling, MI; Nellis Range, NV; Cherry Point, NC; Camp Shelby, MS; Eglin AFB, FL			
DOWNGRADING INSTRUCTIONS N/A		CLASSIFICATION UNCLASSIFIED	

APPLICATION FOR FOREIGN SPECTRUM SUPPORT		CLASSIFICATION: UNCLASSIFIED	PAGE 10 of 10 Pages
FOREIGN COORDINATION GENERAL INFORMATION			
1. APPLICATION TITLE Foliage Penetration (FOPEN) Synthetic Aperture Radar (SAR)			
2. SYSTEM NOMENCLATURE Foliage Penetration Synthetic Aperture Radar			
3. STAGE OF ALLOCATION (<i>X one</i>) ☐ a. STAGE 1 CONCEPTUAL ☒ b. STAGE 2 EXPERIMENTAL ☐ c. STAGE 3 DEVELOPMENTAL ☐ d. STAGE 4 OPERATIONAL			
4. FREQUENCY REQUIREMENTS a. FREQUENCY(IES) 227-454 24-54 b. EMISSION DESIGNATOR(S) 225MQ3N, 227MQ3N 29M9Q3N, 30M1Q3N			
5. PROPOSED OPERATING LOCATIONS OUTSIDE US&P Peru, Columbia, Ecuador			
6. PURPOSE OF SYSTEM, OPERATIONAL AND SYSTEM CONCEPTS This system is a near-real-time foliage penetration, synthetic aperture radar to detect targets under foliage and camouflage.			
7. INFORMATION TRANSFER REQUIREMENTS Compressed radar pulses			
8. NUMBER OF UNITS OPERATING SIMULTANEOUSLY IN THE SAME ENVIRONMENT 1			
9. REPLACEMENT INFORMATION None			
10. LINE DIAGRAM See page(s) 8		11. SPACE SYSTEMS See page(s) N/A	
12. PROJECTED OPERATIONAL DEPLOYMENT DATE 5 May 2003			
13. REMARKS Item 2: Stage 2 radar is installed on RC-12D aircraft. Stage 4 FOPEN radar will be installed on Global Hawk UAV, or A160 UAV or similar			
DOWNGRADING INSTRUCTIONS N/A		CLASSIFICATION UNCLASSIFIED	