

Smarter (and Simpler) Radar in *Harpoon*⁴

by Larry Bond

In *Naval SITREP* #17 (Oct '99), we published a detailed mathematical description of the radar model used in computer *Harpoon*⁴. With a machine doing all the heavy lifting, we can get realistic radar detection ranges by using the actual radar equation.

For the manual game, that type of detail is simply impossible. Still, as we studied the way radar works, we got a little smarter, and have found a few refinements that we can add to the manual game without slowing play. As a matter of fact, the rules for radar get simpler. What really changes is the way we figure out what the radar ranges should be. We're documenting it here so that players can understand why the ranges in *High Tide* will be slightly different than in the *Harpoon*^{4.1} annexes, and also so they can add radars to the game themselves (or more likely, check our math).

This material appeared in the April (#24) and October (#25) 2003 issues of the *Naval SITREP*, and is combined here for distribution to *Harpoon* players who wish to use the revised figures.

What we used to do:

Radar detection depends on almost a dozen variables. We've always concentrated on the relationship between a radar's detection range and the size of the potential contact. All other things being equal, any radar will detect a large target farther away than a small target. Because the radar signal spreads as it moves away from the antenna, and the echo spreads again on its way from the contact back to the antenna, there is a "fourth power" relationship between radar contact sizes and their detection range.

Example: A contact with a 2 m² RCS is detected at 100 nm. If we increase the size of the contact to 32 m² (sixteen times as large), the contact is detected at $(32/2)^{1/4} = 2$, or twice as far away. Using this principle, we set up five standard radar signatures:

<i>Contact Size</i>	<i>RCS</i>	<i>Sample Range</i>
Large	100 m ²	100 nm
Medium	20 m ²	62 nm
Small	5 m ²	40 nm
Very Small	.1 m ²	18 nm
Stealthy	.01 m ²	10 nm

Note that although the medium size signature is five times smaller than a large signature, the range only drops by 38%. This is the result of the fourth power rule.

What we're changing:

First, we're changing the standard RCS sizes. We were overrating the signatures, and we're also (finally) recognizing that a large ship and a large aircraft do not have the same radar cross-section (Hint: ships are bigger - much bigger).

The new values are:

<i>Contact Size</i>	<i>RCS Surf (db)</i>	<i>RCS Surf (m²)</i>	<i>Sample Range (nm)</i>	<i>RCS Air (db)</i>	<i>RCS Air (m²)</i>	<i>Sample Range (nm)</i>
Large	65	3,000,000	100	18	63	100
Medium	55	300,000	56	10	10	63
Small	45	30,000	32	5	3.2	47
Very Small	35	3,000	18	-10	0.1	20
Stealthy	25	300	10	-30	.001	6

From now on, we'll calculate air search radar ranges using a standard air target. Surface search radar ranges will be calculated using the standard surface target.

Second, we're adding a new limit on the detection range of a radar. All radars send out pulses of energy, then listen for an echo. They can only listen until they send out the next pulse, so the time between pulses, translated into an out and back distance at the speed of light, becomes the upper limit on a radar's range.

The number of pulses a radar sends out each second is called the Pulse Repetition Frequency, and is typically 200 - 2000 pps (pulses per second) for a naval search radar. If it's 1000 pps, that means the gap is 1/1000th of a second. During that time the signal has to go out, bounce, and return. At 186,000 miles per second, the signal can cover at most $(186,000/1000)/2 = 83$ miles = 73 nm. This is R_{\max} , or maximum unambiguous range. It's called "unambiguous" because the echo can only be from that signal and the time of transmission is known. It's also called the "instrumented range."

Example: An SPS-29 has a PRF of 300 pps. This means the maximum range it can detect a target at is $(186,000/300)/2 = 310$ miles, or an R_{\max} of 273 nm. The SPS-29's range against a Large target is 243 nm, so the what's the problem?

Example: An LN-66/SP radar has a PRF of 2000 pps. This works out to an R_{\max} of $(186,000/2,000)/2 = 46.5$ nm. But based on its signal strength, it has a detection range of 51 nm against a large target. Its detection ranges (based on signal strength alone) are:

<i>Large</i>	<i>Medium</i>	<i>Small</i>	<i>VSmall</i>	<i>Stealthy</i>
51	28	16	9	5

The R_{\max} (Instrumented Range) limits that detection to:

<i>Large</i>	<i>Medium</i>	<i>Small</i>	<i>VSmall</i>	<i>Stealthy</i>
46	28	16	9	5

Why not just leave a long time between signals? That way there'd be time for a distant echo to reach the antenna. The designers of a radar want to get as many signals out as possible, because detection isn't certain on any one signal, especially at maximum detection range, which is where you really need to see the contact. The more echoes, the better a

chance of the operator seeing the contact as soon as possible. So they take into account the expected contact type and time the PRF to that optimal detection range.

A Canadian LN-66HP is a surface ship surface search radar. It can't see over the horizon no matter how strong the signal is, so longer detection range doesn't do it any good. The high PRF and high signal strength means that when medium and larger-sized contacts come over the horizon, they will be picked up quickly.

If you are checking the ranges in Annex J, or researching a radar not covered by the rules, look for "instrumented range" as well as a range against a target of a stated size.

Third, we have to change the envelopes for some of the radar types. Here is a complete list of all types and what they detect:

(All ranges are limited by the radar horizon. For detection, VLow is considered part of the Low altitude band)

Surface radar types:

- SS - Surface Search
 - Surface - at full range
 - Air - VLow altitude only at half listed Surf range
- AS - Air Search
 - Surface - at 10% of listed Air range
 - VLow at 10% of listed air range
 - Air - Low and higher altitudes at listed range
- HF - Height Finder
 - Surface - None
 - Air - All altitudes at listed range
- 3D - Three-Dimensional Air Search
 - Surface - at 10% of listed Air range
 - Air - All altitudes at listed range

Airborne radar types:

- SS - Surface Search
 - Surface - at full range
- AS - Air Search
 - Air - Full range co-altitude, two higher, one lower
 - Half range elsewhere
- AI- Specialized airborne AS radar
 - Air - Full range co-altitude, one higher, one lower
 - Half range elsewhere
 - Also functions as FC radar.
- LD/SD - Look Down/Shoot Down (more capable AI)
 - Air - Full range co-altitude, two higher, two lower
 - Half range elsewhere
 - Also functions as FC radar.
- RO - Range Only
 - No search capability, but must be used for radar-guided weapons control
- TF - Terrain Following
 - No search capability, but must be on for NOE flight at night or in bad weather.

Changes include a revised range for detection of air contacts by SS radars, and residual SS capability has been removed for airborne AS radars. If a radar has SS capability, it will be listed separately in Annex L.

SS capability has also been removed for AI radars. If it has a SS mode, it will be listed separately in Annex L

Altitudes were corrected for Airborne AS radar.

Fourth, the rules change for radar detection chances. Don't bother rolling detection anymore, It's not worth the trouble. After doing the math, the chance per pulse of detection quickly drives radar detection probabilities into the high nineties. This matches US Navy operational practice. If you're in range, assume you're detected, because you almost certainly are.

Finally, as might be expected, a thorough scrub of the radar annexes (J1, J2, and L) has revealed a lot of new data, especially for the Russians. More Soviet/Russian designations are available, allowing us to correlate them with their NATO nicknames. And of course more performance data is available as well.

We've also found a lot of conflicting data. That's taken a while to sort out, and we ended up having to make a choice. There are several excellent Russian sources available now, and where we've had to choose, we've gone with them.

High Tide, which will be out this summer, will have revised Annexes J1, J2, and L that use the new standard contact sizes and the new limit on maximum radar range.

Bibliography

- Radar Evaluation Handbook*, Barton, Dr. David K., Artech House, 1991
- Jane's Weapons Systems* series
- Jane's Radar and Electronic Warfare* series

Annex J1 - Surface radars

<u>Country</u>	<u>System</u>	<u>Function</u>	<u>Range</u>
Canada	CMR-4	AS	50/50/37/16/5
Canada	LN-66/CMR-85	SS	27/21/12/7/4
Canada	LN-66/SP	SS	46/28/16/9/5
Canada	Sperry Mk2	SS	51/28/16/9/5
Canada	Sperry Mk127E	SS	40/28/16/9/5
Canada	Sperry Mk340	SS	48/32/18/10/6
Canada	SPS-501	AS	145/100/74/32/10
Canada	SPS-502	SS	36/28/16/9/5
Canada	SPS-503	AS	86/86/77/33/10
		SS	48/32/18/10/6
Canada	SPS-505 (Sweden Giraffe 150HC)	AS	72/45/34/14/4
		SS	40/32/18/10/6
Den.	CWS-1	AS	100/80/60/25/8
Denm.	CWS-2	AS	100/80/60/25/8
		SS	47/26/15/8/5
Denm.	CWS-3	AS	85/53/40/17/5
Denm.	NWS-1	SS	25/21/12/7/4
Denm.	NWS-2	SS	25/25/14/8/4
Denm.	NWS-3	SS	36/28/16/9/5
Denm.	NWS-4	SS	27/21/12/7/4
Denm.	NWS-5	SS	36/25/14/8/4
Denm.	NWS-6	SS	40/28/16/9/5
Denm.	NWS-10	SS	40/32/18/10/6

Annex J1 - Surface Radars (continued)

<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>	<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>
Denm.	PN-612	SS	36/25/14/8/4	Israel	EL/M-2228S	3D or AS	54/53/40/17/5
Denm.	Skanter 009	SS	36/21/12/7/4			SS	54/35/20/11/6
France	Arabel	3D, FC	80/53/40/17/5	Israel	EL/M-2228X	AS	54/36/27/11/3
France	Calypso/DRUA 33A	SS	27/21/12/7/4			SS	54/35/20/11/6
France	Calypso II/DRUA 33B	SS	36/25/14/8/4	Italy	3RM series	SS	32/25/14/8/4
France	Calypso III/DRUA 33C	SS	36/28/16/9/5	Italy	BPS-704	SS	32/25/14/8/4
France	Calypso IV	SS	27/21/12/7/4	Italy	GEM BX-132/164	SS	47/27/15/9/5
France	DRBI 10	HF	150/113/84/36/11	Italy	GEM BX Series	SS	32/23/13/7/4
France	DRBI 23	3D	150/113/84/36/11	Italy	MLA-1, -1B	AS	148/93/70/30/9
France	DRBJ 11, 11B	3D	165/126/94/40/12	Italy	MLN-1	SS	47/27/15/9/5
France	DRBN 30	SS	24/21/12/7/4	Italy	MLT-2, 4	AS	160/113/84/36/11
France	DRBN 31	SS	36/25/14/8/4	Italy	RAN-3L (SPS-768)	AS	150/133/99/42/13
France	DRBN 32	SS	48/28/16/9/5	Italy	RAN-7S	AS	85/53/40/17/5
France	DRBN 34	SS	48/28/16/9/5	Italy	RAN-10S (SPS-774)	AS	85/53/40/17/5
France	DRBV 13	3D	80/53/40/17/5	Italy	RAN-11L/X	AS	25/16/12/5/2
France	DRBV 15A/Sea Tiger	AS	91/79/59/25/7			SS	48/35/20/11/6
		SS	40/32/18/10/6	Italy	RAN-12L/X	AS	30/19/14/6/2
France	DRBV 15C/	AS	91/79/59/25/7			SS	48/35/20/11/6
	Sea Tiger Mk2	SS	40/32/18/10/6	Italy	RAN-20S	AS	137/87/65/27/8
France	DRBV 20	AS	254/160/119/51/15	Italy	RAN-30X	3D	42/27/20/8/3
France	DRBV 21A MARS	AS	59/47/35/15/4	Italy	SPN-703	SS	32/25/14/8/4
		SS	43/35/20/11/6	Italy	SPN-728	SS	48/32/18/10/6
France	DRBV 22	AS	70/53/40/17/5	Italy	SPN-748/751	SS	44/25/14/8/4
France	DRBV 23/Jupiter	AS	160/133/99/42/13	Italy	SPN-749	SS	48/28/16/9/5
France	DRBV 26A/Jupiter II	AS	194/146/109/46/14	Italy	SPN-753	SS	48/32/18/10/6
France	DRBV 26C/Jupiter IIS	AS	194/146/109/46/14	Italy	SPQ-2/-2D/-2F	AS	74/47/35/15/4
France	DRBV 26D Jupiter 08	AS	160/133/99/42/13			SS	32/32/18/10/6
France	DRBV 27 Astral	3D	150/126/94/40/12	Italy	SPQ-701/702	AS	53/33/25/11/3
France	DRBV 31	SS	25/25/14/8/4			SS	40/32/18/10/6
France	DRBV 50	AS	27/21/16/7/2	Italy	SPY-790 EMPAR	3D, FC	97/72/54/23/7
		SS	27/27/15/9/5	Japan	Furuno Generic	SS	48/28/16/9/5
France	DRBV 51A Triton	AS	30/21/16/7/2	Japan	Furuno FR-1500		
		SS	30/27/15/9/5		Mk2 Series	SS	57/32/18/10/6
France	DRBV 51B&C/Triton II	AS	45/32/24/10/3	Japan	Furuno FR-1600 Series	SS	24/21/12/7/4
		SS	45/32/18/10/6	Japan	Furuno FR-1700 Series	SS	36/27/15/9/5
France	DRUA 31	SS	27/19/11/6/3	Japan	Furuno FR-1900 Series	SS	48/28/16/9/5
France	DRUA 32	SS	27/21/12/7/4	Japan	Kyoritsu Generic	SS	44/25/14/8/4
France	MRR	3D	97/80/60/25/8	Japan	Kyoritsu ME Series	SS	47/27/15/9/5
		SS	43/35/20/11/6	Japan	Kyoritsu ML/MM Series	SS	48/32/18/10/6
France	Neptune	AS	30/21/16/7/2	Japan	Kyoritsu MS Series	SS	48/28/16/9/5
		SS	30/27/15/9/5	Japan	Kyoritsu MT Series	SS	36/21/12/7/4
France	Ramses	AS	60/53/40/17/5	Japan	Oki Generic	SS	36/25/14/8/4
France	Saturne I	AS	81/80/60/25/8	Japan	Oki NC/NS Series	SS	48/32/18/10/6
France	Saturne II	AS	81/80/60/25/8	Japan	Oki NX Series	SS	36/27/15/9/5
France	Triton G	AS	25/16/12/5/2	Japan	Oki ONX Series	SS	36/23/13/7/4
		SS	45/35/20/11/6	Japan	OPS-1	AS	135/93/70/30/9
France	Triton S	AS	38/24/18/8/2	Japan	OPS-2	AS	127/80/60/25/8
		SS	45/35/20/11/6	Japan	OPS-6	SS	25/25/15/9/5
FRG	Atlas Generic	SS	44/25/14/8/4	Japan	OPS-9	SS	24/24/16/9/5
FRG	Atlas 1500-4300	SS	44/25/14/8/4	Japan	OPS-11A	AS	211/133/99/42/13
FRG	Atlas 4300-6500	SS	50/30/17/10/5	Japan	OPS-11B	AS	211/133/99/42/13
FRG	Atlas 7600/8600/9600	SS	57/32/18/10/6	Japan	OPS-11C	AS	211/133/99/42/13
FRG	SGR-103	AS	50/40/30/13/4	Japan	OPS-12	3D	220/146/109/46/14
		SS	32/28/16/9/5	Japan	OPS-13	SS	24/24/15/9/5
FRG	TRS-C	SS	63/35/20/11/6	Japan	OPS-14A	AS	145/107/79/34/10
FRG	TRS-3D/16	3D	68/43/32/14/4	Japan	OPS-14B	AS	145/107/79/34/10
		SS	50/32/18/10/6	Japan	OPS-14C	AS	145/107/79/34/10
FRG	TRS-3D/32	3D	85/53/40/17/5	Japan	OPS-15	SS	47/27/15/9/5
		SS	50/35/20/11/6	Japan	OPS-16A	SS	47/27/15/9/5
FRG	TRS-N	SS	27/27/15/9/5	Japan	OPS-16B	SS	47/27/15/9/5
Intl	Nav radar (Generic)	SS	36/25/14/8/4	Japan	OPS-16C/D	SS	47/27/15/9/5
Intl	Perisc. radar (Generic)	SS	24/21/12/7/4	Japan	OPS-17	SS	48/28/16/9/5
Israel	EL/M-2207/2208	AS	54/40/30/13/4	Japan	OPS-18	SS	48/32/18/10/6
		SS	30/30/18/10/6	Japan	OPS-18-1	AS	42/27/20/8/3
Israel	EL/M-2216	AS	54/40/30/13/4			SS	48/32/18/10/6
		SS	54/35/20/11/6	Japan	OPS-19	SS	48/28/16/9/5
				Japan	OPS-22	SS	48/28/16/9/5

Annex J1 - Surface Radars (continued)

<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>	<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>
Japan	OPS-24	3D	240/186/139/59/18	Russia	Bukhta [Snoop Head]	SS	35/25/14/8/4
Japan	OPS-28	AS	63/40/30/13/4	Russia	Burya [Snoop Slab]	SS	20/16/9/5/3
		SS	40/35/20/11/6	Russia	Cheese Cake	SS	20/16/9/5/3
Japan	OPS-29	SS	36/27/15/9/5	Russia	Don, Don 2	SS	35/21/12/7/4
Japan	ZPS-2	SS	24/16/9/5/3	Russia	Donets/Donets 2	SS	24/18/10/6/3
Japan	ZPS-3	SS	24/18/10/6/3	Russia	Dubravna [Peel Pair]	SS	24/24/16/9/5
Japan	ZPS-4	SS	35/19/11/6/3	Russia	Ekran [Curl Stone A/B]	SS	35/19/11/6/3
Japan	ZPS-6	SS	36/21/12/7/4	Russia	Flag [Snoop Plate]	SS	20/14/8/5/3
Nethl	APAR	AS, FC	80/60/45/19/6	Russia	Flat Spin	AS	148/93/70/30/9
		SS	40/35/20/11/6	Russia	Fut-N [Slim Net]	AS	57/36/27/11/3
Nethl	DA.01	AS	100/67/50/21/6			SS	25/21/12/7/4
Nethl	DA.02	AS	85/53/40/17/5	Russia	Gyuys-1M4 [Cross Bird]	AS	29/18/13/6/2
Nethl	DA.04	AS	100/67/50/21/6			SS	16/16/9/5/3
Nethl	DA.05, DA.05/2	AS	145/107/79/34/10	Russia	Gyuys-2M [Sea Gull]	AS	38/24/18/8/2
		SS	24/24/18/10/6			SS	25/19/11/6/3
Nethl	DA.08 Variant	AS	145/120/89/38/11	Russia	Garpun		
		SS	24/24/18/10/6		[Plank Shave A]	SS, FC	50/35/20/11/6
Nethl	LW.01	AS	145/100/74/32/10	Russia	Garpun-B		
Nethl	LW.02/03	AS	145/100/74/32/10		[Plank Shave B]	SS, FC	76/43/24/14/8
Nethl	LW.04	AS	145/120/89/38/11	Russia	High Lune	HF	95/60/45/19/6
Nethl	LW.08	AS	145/142/106/45/14	Russia	Kaktus [Top Trough]	AS	142/89/67/28/8
		SS	24/24/18/10/6			SS	25/25/14/8/4
Nethl	LW.09	AS	145/145/124/53/16	Russia	Kivach 1/2	SS	20/19/11/6/3
		SS	24/24/18/10/6	Russia	Kivach 3	SS	44/25/14/8/4
Nethl	MARS-05	AS	60/59/44/19/6	Russia	Lotsiya	SS	20/20/12/7/4
		SS	45/35/20/11/6	Russia	Mars-Passat		
Nethl	MW.08	3D	57/45/33/14/4		[Sky Watch]	3D	270/173/129/55/16
		SS	24/24/18/10/6	Russia	Mineral [Band Stand]	SS, FC	76/43/24/14/8
Nethl	Scout	SS	24/24/18/10/6	Russia	Mius [Spin Trough]	SS	44/25/14/8/4
Nethl	SMART/SMART-S	3D	65/60/45/19/6	Russia	Monolit [Band Stand]	SS, FC	76/43/24/14/8
		SS	32/32/18/10/6	Russia	MR-102 Balkan		
Nethl	SMART-L	3D	216/157/117/50/15		[Pot Drum]	SS	25/21/12/7/4
		SS	32/32/18/10/6	Russia	MR-212/201 Vaygach-U		
Nethl	SPS-01	3D	145/133/99/42/13		[Palm Frond]	SS	57/32/18/10/6
		SS	40/32/18/10/6	Russia	MR-302 Fut-B	AS	133/84/63/27/8
Nethl	Variant	AS	38/38/30/13/4		[Strut Curve]	SS	20/20/14/8/4
		SS	38/32/18/10/6	Russia	MR-310 Angara	AS	80/51/38/16/5
Nethl	VI.01	HF	150/133/99/42/13		[Head Net A/B]	SS	25/25/16/9/5
Nethl	WM20 series	3D, FC	45/33/25/11/3	Russia	MR-310U Angara-M	3D	80/51/38/16/5
		SS	45/32/18/10/6		[Head Net C]	SS	25/25/16/9/5
Nethl	ZW.01, ZW.03	AS	50/40/30/13/4	Russia	MR-312 Nayada	SS	41/23/13/7/4
		SS	32/28/16/9/5	Russia	MR-320M Topaz V	AS	144/91/68/29/9
Nethl	ZW.04	SS	32/28/16/9/5		[Strut Pair]	SS	27/27/20/11/6
Nethl	ZW.06, ZW.07	AS	34/21/16/7/2	Russia	MR-320M Topaz 2V	AS	95/60/45/19/6
		SS	40/25/14/8/4		[Strut Pair]	SS	27/27/20/11/6
PRC	ESR-1	AS	33/21/15/7/2	Russia	MR-352 Positiv	AS	63/40/30/13/4
		SS	40/27/15/9/5		[Cross Dome]	SS	27/27/16/9/5
PRC	Fin Curve (Decca 707)	SS	24/21/12/7/4	Russia	MR-352M Positiv-ME1	3D	74/47/35/15/4
PRC	Hai Ying [God Eye]	AS	169/107/79/34/10		[Cross Dome]	SS	27/27/18/10/6
PRC	Type 351 [Pot Head]	AS	16/12/9/4/1	Russia	MR-500 Kliver [Big Net]	AS	148/93/70/30/9
		SS	25/19/11/6/3			SS	27/27/18/10/6
PRC	Type 352 [Square Tie]	AS	25/16/12/5/2	Russia	MR-600 Voshkod		
		SS, FC	35/28/16/9/5		[Top Sail]	3D	243/153/114/49/15
PRC	Type 352C [Square Tie]	AS	29/18/13/6/2	Russia	MR-700 Fregat	3D	160/129/96/41/12
		SS, FC	40/32/18/10/6		[Top Steer]	SS	27/27/18/10/6
PRC	Type 354 (MX-902)	AS	87/55/41/17/5	Russia	MR-700M Fregat MR	3D	160/129/96/41/12
	[Eye Shield]	SS	35/32/18/10/6		[Plate Steer]	SS	27/27/18/10/6
PRC	Type 360	AS	133/84/63/27/8	Russia	MR-710 Fregat M2	3D	160/129/96/41/12
		SS	48/32/18/10/6		[Top Plate B]	SS	30/30/20/11/6
PRC	Type 363	AS	74/47/35/15/4	Russia	MR-750 Fregat M	3D	160/129/96/41/12
PRC	Type 381 (Sea Eagle)				[Top Plate A]	SS	30/30/20/11/6
	[Rice Screen]	3D	100/67/50/21/6	Russia	MR-755 Fregat-MA	3D	80/80/68/29/9
PRC	Type 515 [Bean Sticks/ Pea Sticks]	AS	101/64/48/20/6		[Half Plate]	SS	30/30/20/11/6
PRC	Type 726	SS	25/23/13/7/4	Russia	MR-800 Flag [Top Pair]	3D	243/153/114/49/15
PRC	Type 756	SS	47/27/15/9/5			SS	27/27/18/10/6
Russia	Boat Sail	AS	127/80/60/25/8				

Annex J1 - Surface Radars (continued)

<u>Country</u>	<u>System</u>	<u>Function</u>	<u>Range</u>	<u>Country</u>	<u>System</u>	<u>Function</u>	<u>Range</u>
Russia	MRK-50 Tobol			UK	Marconi S1810/	AS	25/20/15/6/2
	[Snoop Tray 2]	SS	25/18/10/6/3		1830/1834	SS	25/25/15/9/5
Russia	MRKP-59 Korall-B			UK	Marconi S1812	3D	35/32/24/10/3
	[Snoop Pair/			UK	Radar 267	SS	25/14/8/5/3
	Snoop Half]	SS	35/25/14/8/4	UK	Radar 268	SS	16/9/5/3/2
Russia	Neptune	SS	14/14/10/6/3	UK	Radar 271	SS	16/9/5/3/2
Russia	P-8 [Knife Rest A]	AS	76/48/36/15/5	UK	Radar 276	SS	37/25/14/8/4
Russia	P-10 [Knife Rest B]	AS	89/56/42/18/5	UK	Radar 277 series	SS	36/20/11/6/4
Russia	P-12 [Spoon Rest]	AS	101/64/48/20/6			HF	60/40/30/13/4
Russia	Plinth Net	AS	74/47/35/15/4	UK	Radar 278	HF	60/40/30/13/4
		SS	20/20/16/9/5	UK	Radar 279	AS	86/54/40/17/5
Russia	Podberezovik	3D	270/180/134/57/17	UK	Radar 281	AS	127/80/60/25/8
	[Flat Screen]	SS	30/30/20/11/6	UK	Radar 286	SS	13/7/4/2/1
Russia	Okean	SS	44/25/14/8/4	UK	Radar 291	SS	16/9/5/3/2
Russia	Rangout [Square Tie]	AS	25/16/12/5/2	UK	Radar 293, 293Q	AS	32/20/15/6/2
		SS, FC	35/28/16/9/5			SS	38/21/12/7/4
Russia	Reya [Pot Head]	AS	16/12/9/4/1	UK	Radar 960	AS	158/100/74/32/10
		SS	25/19/11/6/3	UK	Radar 965	AS	174/110/82/35/10
Russia	Reyd [Peel Cone]	SS	25/23/13/7/4	UK	Radar 965M	AS	174/110/82/35/10
Russia	RLK-101 Albatros			UK	Radar 967/968	AS	106/67/50/21/6
	[Snoop Tray 1]	SS	25/18/10/6/3			SS	50/32/18/10/6
Russia	Ryf [Ball End/Ball Gun]	SS	20/20/12/7/4	UK	Radar 974	SS	25/19/11/6/3
Russia	Ryf-1M [High Sieve]	SS	20/20/14/8/4	UK	Radar 975	SS	40/27/15/9/5
Russia	Titanit [Band Stand]	SS, FC	50/35/20/11/6	UK	Radar 978/979	SS	24/24/16/9/5
Russia	Volga [Don Kay]	SS	30/27/15/9/5	UK	Radar 982	AS	53/33/25/11/3
Russia	Zarnitsa [Skin Head]	AS	14/11/8/3/1	UK	Radar 983	HF	53/33/25/11/3
		SS	14/14/8/5/3	UK	Radar 984	3D	159/100/75/32/10
Sweden	9GR600	SS	27/25/14/8/4	UK	Radar 992	AS	63/40/30/13/4
Sweden	PILOT	SS	24/24/15/9/5	UK	Radar 992P/Q	AS	85/53/40/17/5
Sweden	PILOT Mk2	SS	24/24/18/10/6	UK	Radar 993	AS	42/26/20/8/2
Sweden	Sea Giraffe 50	AS	46/29/22/9/3			SS	40/22/13/7/4
		SS	30/28/16/9/5	UK	Radar 994 (AWS-4)	AS	95/60/45/19/6
Sweden	Sea Giraffe 50HC	AS	46/29/22/9/3			SS	47/26/15/8/5
		SS	30/28/16/9/5	UK	Radar 996 (AWS-9)	3D	96/61/45/19/6
Sweden	Sea Giraffe 100	AS	51/32/24/10/3			SS	57/32/18/10/6
		SS	30/28/16/9/5	UK	Radar 1001	SS	35/19/11/6/3
Sweden	Sea Giraffe 150	AS	72/45/34/14/4	UK	Radar 1002	SS	38/21/12/7/4
		SS	40/32/18/10/6	UK	Radar 1003	SS	38/21/12/7/4
Sweden	Sea Giraffe 150HC	AS	72/45/34/14/4	UK	Radar 1006	SS	41/23/13/7/4
		SS	40/32/18/10/6			AS	3/2/1/1/0
Sweden	Sea Giraffe AMB	3D	91/57/43/18/5	UK	Radar 1007	SS	47/27/15/9/5
		SS	50/35/20/11/6	UK	Radar 1008	SS	48/28/16/9/5
UK	AWS-1	AS	100/80/60/25/8	UK	Radar 1022	AS	201/126/94/40/12
UK	AWS-2	AS	100/80/60/25/8	UK	Sampson	3D, FC	97/72/54/23/7
		SS	47/26/15/8/5	USA	BPS-4	AS	24/15/11/5/1
UK	AWS-3	AS	140/100/75/32/10	USA	BPS-5	SS	38/21/12/7/4
		SS	47/26/15/8/5	USA	BPS-9	SS	38/21/12/7/4
UK	AWS-5	AS	130/113/84/36/11	USA	BPS-11	SS	38/21/12/7/4
		SS	24/24/18/10/6	USA	BPS-12/14	SS	38/21/12/7/4
UK	AWS-6 (Dolphin)	AS	130/126/94/40/12	USA	BPS-15/16	SS	35/19/11/6/3
		SS	30/30/20/11/6	USA	Mk23 TAS	AS	74/47/35/15/4
UK	Decca Generic	SS	25/25/14/8/4			SS	40/40/40/40/40
UK	Decca 200/300 Series	SS	25/19/11/6/3	USA	Mk92	3D, FC	45/33/25/11/3
UK	Decca 400 Series	SS	25/23/13/7/4			SS	45/32/18/10/6
UK	Decca 600 Series	SS	25/19/11/6/3	USA	Raytheon Generic	SS	36/25/14/8/4
UK	Decca 900 Series	SS	25/25/14/8/4	USA	Raytheon Pathfinder	SS	35/19/11/6/3
UK	Decca 1200 Series	SS	48/28/16/9/5	USA	Raytheon R series	SS	36/23/13/7/4
UK	Decca 1600 Series	SS	48/28/16/9/5	USA	Raytheon FR series	SS	48/28/16/9/5
UK	Decca 2000 Series	SS	48/32/18/10/6	USA	SG-6	SS	25/23/13/7/4
UK	Decca 2459	AS	48/33/25/11/3	USA	SPQ-9A	SS	20/20/15/9/5
		SS	48/28/16/9/5	USA	SPQ-9B	SS	30/30/20/11/6
UK	Kelvin-Hughes Generic	SS	36/25/14/8/4	USA	SPS-4	SS	25/25/15/9/5
UK	Kelvin-H. 500 series	SS	38/21/12/7/4	USA	SPS-5	SS	48/28/16/9/5
UK	Kelvin-H. 1600 series	SS	47/27/15/9/5	USA	SPS-6A	AS	135/107/79/34/10
UK	Marconi S810/S811	AS	25/20/15/6/2	USA	SPS-6B	AS	135/93/70/30/9
		SS	25/25/15/9/5	USA	SPS-6C	AS	127/80/60/25/8

(continued on page 8)

Annex L - Air Radars

<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>	<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>
Canada	APS-503	SS	49/35/20/11/6	Italy	Grifo-7	LD/SD	45/45/34/14/4
Canada	APS-504(V)2	SS	200/200/126/71/40	Italy	R21G/M1 Setter	LD/SD	25/20/15/6/2
Canada	APS-504(V)3/ APS-141(V)	SS	200/200/126/71/40	Japan	HPS-104	SS	160/126/72/40/22
Canada	APS-504(V)5/ APS-140(V)	SS	200/200/126/71/40	PRC	JL-7	AI	25/16/12/5/2
Canada	LN-66/66HP	SS	72/71/40/23/13	PRC	JL-10	AI, SS	46/38/29/12/4
France	Agave	SS	85/85/54/30/17	PRC	SR-4	AI	60/38/28/12/4
		AI	32/20/15/6/2	PRC	Type 222	RO	—/—/—/—/—
		SS	85/85/54/30/17	PRC	Type 245	SS	175/98/56/32/18
France	Agriion 15	SS	135/135/108/61/34	Russia	Berkrut [Wet Eye I]	SS	125/89/51/28/16
France	Aida I	RO - Air	8/7/5/2/1	Russia	EN/Yen [Puff Ball]	SS	200/177/101/57/32
		RO - SS	8/8/8/8/4	Russia	Iniatsiava	SS	80/63/36/20/11
France	Aida II	RO - Air	9/8/6/3/1		Iniatsiava-2		
		RO - SS	9/9/9/9/5		[Short Horn]	SS	108/89/51/28/16
France	Anemone	AI	150/100/75/32/10	Russia	Komar	LD/SD, TF	50/50/38/16/5
		SS	200/200/126/71/40	Russia	Super-Komar	LD/SD, TF	55/55/43/18/5
France	Antilope 5	TF	—/—/—/—/—	Russia	Kopyo	AI	24/24/18/8/2
France	Antilope 50	TF	—/—/—/—/—	Russia	Kopyo-25	AI	40/40/30/13/4
France	Cyrano I	AI	16/16/12/5/2			SS	40/38/22/12/7
France	Cyrano IIbis/IIIB	AI	16/16/12/5/2	Russia	Super Kopyo	AI	40/40/30/13/4
France	Cyrano IV	AI	27/27/20/9/3	Russia	Super Kopyo-PH	LD/SD	40/40/30/13/4
France	Cyrano IVM	AI	30/30/22/10/3	Russia	Korshun [Wet Eye II]	SS	150/106/61/34/19
		SS	50/50/30/17/9	Russia	Kub	SLAR	—/—/—/—/—
		SS	190/106/61/34/19	Russia	Kvant	3D	190/144/107/46/14
France	Iguane/Varan	SS	200/189/108/61/34			SS	190/159/91/51/28
France	ORB 31AS/S1 Heracles I	SS	75/75/63/35/20	Russia	Liana [Flat Jack]	AS	114/72/54/23/7
France	ORB 31D Heracles I	SS	100/100/77/44/24			SS	248/215/123/69/38
France	ORB 31W Heracles I	SS	135/135/90/51/28	Russia	Moskit	LD/SD, TF	45/33/25/11/3
France	ORB 32 Heracles II	SS	150/150/101/57/32	Russia	Mosquito	LD/SD, TF	45/33/25/11/3
France	RBE2	LD/SD, TF	175/113/84/36/11			SS	70/70/70/55/30
		SS	175/133/76/43/24	Russia	N-001 Mech		
France	RC 400	LD/SD	110/73/55/23/7		[Slot Back II]	LD/SD	65/64/48/20/6
		SS	110/80/46/26/14	Russia	N-001VE Zhuk	LD/SD	65/64/48/20/6
France	RDI	LD/SD	100/80/60/25/8	Russia	N-010M Zhuk-M	LD/SD	75/75/60/25/8
France	RDM	LD/SD, TF	100/80/60/25/8			SS	135/135/92/52/29
		SS	100/100/61/34/19	Russia	N-010ME Zhuk-ME	LD/SD	75/75/74/32/10
France	RDY	LD/SD, TF	120/80/60/25/8			SS, TF	135/135/92/52/29
		SS	120/89/51/28/16	Russia	N-010 Zhuk 29	LD/SD	65/64/48/20/6
Intl	AMSAR	LD/SD	180/120/89/38/11			SS,TF	135/135/130/73/40
Intl	Ocean Master	SS	240/177/101/57/32	Russia	N-011 Zhuk 27	LD/SD	75/73/55/23/7
Intl	Sea Falcon	SS	270/195/111/63/35			SS,TF	135/135/130/73/40
Intl	Tornado Nose Radar	AI	40/25/19/8/2	Russia	N-011M Zhuk PH	LD/SD	100/96/72/30/9
		SS, TF	100/89/51/28/16			SS,TF	135/135/130/73/40
Israel	EL/M-2001B	RO	8/5/4/2/1	Russia	N-012	AI	27/27/27/11/3
Israel	EL/M-2011	AI	17/11/8/3/1	Russia	N-019 Sapfir-29		
Israel	EL/M-2021B	AI	65/41/31/13/4		[Slot Back I]	LD/SD	55/55/43/18/5
Israel	EL/M-2022(V)1	SS	150/97/56/31/17	Russia	N-019M Topaz		
Israel	EL/M-2022(V)2	SS	175/124/71/40/22		[Mod Slot Back I]	LD/SD	55/55/43/18/5
Israel	EL/M-2022(V)3	SS	200/142/81/46/25	Russia	Novella/Sea Dragon	SS	200/172/98/55/31
Israel	EL/M-2032	LD/SD	55/40/30/13/4	Russia	Obzor [Clam Pipe]	SS	200/177/101/57/32
Israel	EL/M-2035	AI	25/24/18/8/2	Russia	Oko	AS	171/108/80/34/10
Israel	EL/M-2075	AS	340/216/161/68/21			SS	135/124/71/40/22
		SS	340/319/182/102/57	Russia	Orion-A/2A [Drop Kick]	AS	81/72/54/23/7
		SS	80/80/46/26/14			SS	81/71/40/23/13
Italy	APQ-706	SS	60/53/30/17/9	Russia	Osa	LD/SD, TF	60/60/45/19/6
Italy	APS-702	SS	80/80/46/26/14	Russia	Osminog		
Italy	APS-705	SS	80/80/46/26/14		[Splash Drop]	SS	100/90/51/29/16
Italy	APS-707	SS	80/80/46/26/14	Russia	Pharaon/ Pharaon-M	LD/SD, TF	75/60/45/19/6
Italy	APS-784	SS	125/124/71/40/22				
Italy	F15A-41B	AI	22/15/11/5/1	Russia	PNA Series		
Italy	Grifo ASV	AI	25/25/19/8/2		[Down Beat]	SS	200/177/101/57/32
		SS	65/65/37/21/12	Russia	RBP-1 Kobal't-N		
Italy	Grifo F	AI	35/33/25/11/3		[Mushroom I]	SS	100/89/51/28/16
Italy	Grifo L	AI	35/33/25/11/3	Russia	RBP-2 Rubin-1D		
Italy	Grifo M	LD/SD	35/33/25/11/3		[Mushroom II]	SS	162/133/76/43/24
		SS	45/45/30/17/9				

Annex L - Air Radars (continued)

<u>Country</u>	<u>System</u>	<u>Function</u>	<u>Range</u>	<u>Country</u>	<u>System</u>	<u>Function</u>	<u>Range</u>
Russia	RBP-3 [Look Two]	SS	90/71/40/23/13	UK	ASV 19	SS	120/80/46/26/14
Russia	RBP-4 Rubin-1K [Mushroom II]	SS	190/154/88/50/28	UK	ASV 21 Blue Silk	SS	170/112/64/36/20
Russia	RP-1 Izumrud	AI	6/5/4/2/1	UK	AW.391 (ARI 5955)	SS	50/35/20/11/6
Russia	RP-5 Izumrud 2 [Scan Can]	AI	8/7/5/2/1	UK	Blue Fox	AI	35/25/19/8/2
Russia	RP-6 Sokol	AI	16/10/7/3/1	UK	Blue Hawk	LD/SD	79/50/37/16/5
Russia	RP-9U [Spin Scan B]	AI	11/10/7/3/1	UK	Blue Kestrel 5000	SS	80/80/51/28/16
Russia	RP-15 Orel-D	AI	22/20/15/6/2	UK	Blue Kestrel 6000	AS	125/115/66/37/21
Russia	RP-15M Orel-DM	AI	22/20/15/6/2	UK	Blue Kestrel 7000	AS	119/75/56/24/7
Russia	RP-21 Saphir	AI	11/10/7/3/1	UK	Blue Parrot	SS	125/115/66/37/21
Russia	RP-22 Saphir-21	AI	16/15/11/5/1	UK	Blue Vixen	LD/SD	79/50/37/16/5
Russia	RP-25 Saphir-25	LD/SD	62/48/36/15/5	UK	Blue Vixen	SS	80/50/28/16/9
Russia	RP-26 Taifun	AI	28/24/18/8/2	UK	Foxhunter	LD/SD	119/75/56/24/7
Russia	RP-26M Taifun-M	AI	32/29/22/9/3	UK	Green Satin	SS	120/106/61/34/19
Russia	RP-31/S-800 Zaslon	LD/SD	125/96/72/31/9	UK	H2S	SS	125/100/74/32/10
Russia	RP-31M Zaslon-M	LD/SD	194/173/129/55/16	UK	Marec II/Super Marec	SS	20/18/10/6/3
Russia	RP-35	LD/SD, TF	110/100/75/32/10	UK	Marec III	SS	70/53/30/17/9
Russia	Sapfir-23D	AI	43/28/21/9/3	UK	Sea Searcher	SS	250/159/91/51/28
Russia	Sapfir-23ML	LD/SD	51/34/25/11/3	UK	Sea Searcher	SS	250/177/101/57/32
Russia	Shmel	3D	249/157/117/50/15	UK	Sea Spray Mk1/2000	SS	115/97/56/31/17
Russia	Shmel-M	3D	300/189/141/60/18	UK	Sea Spray Mk3/3000	SS	100/80/46/26/14
Russia	Shompol	SLAR	—/—/—/—/—	UK	Sea Spray 4000	SS	100/80/46/26/14
Russia	Shtyk	SLAR	—/—/—/—/—	UK	Sea Spray 7000	AS	80/71/40/23/13
Russia	Smerch-A/2A	AI	54/48/36/15/5	UK	Searchwater 1/2	AS	80/71/40/23/13
Russia	Smerch-S/M	AI	54/48/36/15/5	UK	Searchwater	AS	169/107/79/34/10
Russia	SOKOL	LD/SD, TF	150/129/96/41/12	UK	Searchwater 2000MR/AEW	AS	175/124/71/40/22
Russia	SRD-1M [Scan Fix]	RO	4/4/3/1/0	USA	Skyranger	AI	200/133/99/42/13
Russia	SRD-5M [High Fix]	RO	5/4/3/1/0	USA	Skyranger	LD/SD	200/144/83/46/26
Russia	Uspek-1 [Big Bulge A]	SS	230/215/123/69/38	USA	Super Skyranger	LD/SD	8/8/6/3/1
Russia	Uspek-2 [Big Bulge B]	SS	195/184/105/59/33	USA	Super Searcher	SS	35/27/20/8/3
Russia	Virazh	SLAR	—/—/—/—/—	USA	Super Searcher	SS	125/115/66/37/21
Russia	YaD [Crown Drum]	SS	150/106/61/34/19	USA	APG-53	SS	8/8/8/5/3
Sweden	AESA	LD/SD	0/0/0/0/0	USA	APG-63	LD/SD	87/60/45/19/6
Sweden	Ericsson SLAR	SS	150/97/56/31/17	USA	APG-65	LD/SD	160/101/75/32/10
Sweden	Erieye	AS	250/250/188/80/24	USA	APG-66	LD/SD	160/115/66/37/21
Sweden	Hera	SS	150/97/56/31/17	USA	APG-67	LD/SD	80/60/45/19/6
Sweden	PS-01/A	AI	40/27/20/8/3	USA	APG-68	LD/SD	80/60/45/19/6
Sweden	PS-05/A	LD/SD	80/73/55/23/7	USA	APG-69	LD/SD	80/80/46/26/14
Sweden	PS-37/A, PS-371/A	LD/SD	65/53/40/17/5	USA	APG-70	LD/SD	160/101/75/32/10
Sweden	PS-46/A	LD/SD	65/62/35/20/11	USA	APG-71	LD/SD	160/115/66/37/21
Sweden	UAP 13 Series	AI	40/27/20/8/3	USA	APG-72	LD/SD	60/40/30/13/4
UK	AI.17	AI	15/10/7/3/1	USA	APG-73	LD/SD	80/80/72/40/22
UK	AI.18	AI	20/13/10/4/1	USA	APG-76	LD/SD	100/80/60/25/8
UK	AI.22	AI	20/13/10/4/1	USA	APG-77	LD/SD	180/136/102/43/13
UK	AI.23	AI	30/19/14/6/2	USA	APG-79	LD/SD	160/113/84/36/11
UK	AI.27	AI	30/19/14/6/2	USA	APG-80	LD/SD	160/113/84/36/11
UK	ASTOR	SS	162/159/91/51/28	USA	APQ-41	AI	160/133/76/43/24
				USA	APQ-94	AI	100/80/60/25/8
				USA	APQ-99	TF	80/80/46/26/14
				USA	APQ-100	AI	80/80/46/26/14
				USA	APQ-104	AI	180/140/104/44/13
				USA	APQ-109	AI	160/113/84/36/11
				USA	APQ-110	TF	160/133/76/43/24
				USA	APQ-113	AI	160/113/84/36/11
				USA	APQ-114	SS, TF	160/133/76/43/24
						AI	24/15/11/5/1
						SS, TF	30/20/15/6/2
						SS, TF	—/—/—/—/—
						SS, TF	40/25/19/8/2
						SS, TF	40/25/19/8/2
						SS, TF	40/25/19/8/2
						SS, TF	—/—/—/—/—
						SS, TF	30/20/15/6/2
						SS, TF	80/71/40/23/13
						SS, TF	30/20/15/6/2
						SS, TF	80/71/40/23/13

Annex J1 - Surface Radars (continued)

<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>
USA	SPS-8A-B	HF	152/96/72/30/9
USA	SPS-10	SS	48/28/16/9/5
USA	SPS-12	AS	211/133/99/42/13
USA	SPS-21	SS	38/21/12/7/4
USA	SPS-23	SS	40/28/16/9/5
USA	SPS-29D	AS	243/153/114/49/15
USA	SPS-30	HF	211/133/99/42/13
USA	SPS-32	AS	400/266/199/85/25
USA	SPS-33	3D	250/173/129/55/16
USA	SPS-35	SS	32/19/11/6/3
USA	SPS-36	SS	16/16/13/7/4
USA	SPS-37	AS	243/153/114/49/15
USA	SPS-37A	AS	296/186/139/59/18
USA	SPS-39/42	3D	160/111/82/35/11
USA	SPS-40A-B	AS	225/150/112/48/14
USA	SPS-40C-D	AS	225/150/112/48/14
USA	SPS-40E	AS	225/150/112/48/14
USA	SPS-41	SS	32/21/12/7/4
USA	SPS-43	AS	270/173/129/55/16
USA	SPS-43A	AS	270/206/154/66/20
USA	SPS-46	SS	32/25/14/8/4
USA	SPS-48A	3D	220/160/119/51/15
USA	SPS-48C	3D	220/160/119/51/15
USA	SPS-48E	3D	220/160/119/51/15
USA	SPS-49 (V)1	AS	284/213/159/68/20
USA	SPS-49 (V)2-4	AS	284/213/159/68/20
USA	SPS-49 (V)5-7	AS	284/213/159/68/20
USA	SPS-52A	3D	246/180/134/57/17
USA	SPS-52B, C	3D	246/180/134/57/17
USA	SPS-53, SPS-60	SS	32/25/14/8/4
USA	SPS-55	SS	36/32/18/10/6
USA	SPS-58A-C	AS	125/100/75/32/10
USA	SPS-59/LN-66	SS	40/28/16/9/5
USA	SPS-63	SS	40/25/14/8/4
USA	SPS-64	SS	57/32/18/10/6
USA	SPS-65	AS	125/100/75/32/10
USA	SPS-66	SS	32/19/11/6/3
1982	SPS-67	SS	63/35/20/11/6
USA	SPS-69/71	SS	44/25/14/8/4
USA	SPS-72	SS	51/28/16/9/5
USA	SPS-73	SS	32/21/12/7/4
USA	SPY-1A	3D, FC	250/173/129/55/16
		SS	50/44/25/14/8
USA	SPY-1B/D	3D, FC	250/173/129/55/16
		SS	50/44/25/14/8
USA	SPY-1F	3D, FC	185/126/94/40/12
		SS	40/40/25/14/8
USA	SS-2	SS	38/21/12/7/4

Annex L - Air Radars (continued)

<i>Country</i>	<i>System</i>	<i>Function</i>	<i>Range</i>
USA	APQ-120	AI	50/35/26/11/3
USA	APQ-126	SS	150/106/61/34/19
USA	APQ-144	AI	40/25/19/8/2
		SS, TF	100/89/51/28/16
USA	APQ-153	AI	20/20/15/6/2
USA	APQ-156/148	SS	150/97/56/31/17
USA	APQ-157	AI	20/20/15/6/2
USA	APQ-159	AI	40/25/19/8/2
USA	APQ-160	AI	50/35/26/11/3
		SS	125/89/51/28/16
USA	APQ-161	AI	50/35/26/11/3
		SS	125/89/51/28/16
USA	APQ-164	AI	30/20/15/6/2
		SS, TF	160/106/61/34/19
USA	APQ-166	AI	30/20/15/6/2
		SS, TF	160/106/61/34/19
USA	APQ-181	AI	30/20/15/6/2
		SS, TF	180/124/71/40/22
USA	APS-20A/20C	AS	150/120/89/38/11
		SS	65/62/35/20/11
USA	APS-20E/20F	AS	200/150/112/48/14
		SS	90/80/46/26/14
USA	APS-38A/B	SS	125/89/51/28/16
USA	APS-80	SS	150/106/61/34/19
USA	APS-81	SS	150/97/56/31/17
USA	APS-82	AS	200/150/112/48/14
USA	APS-88	SS	150/106/61/34/19
USA	APS-115	SS	150/133/76/43/24
USA	APS-116	SS	150/133/76/43/24
USA	APS-120	AS	238/150/112/48/14
		SS	130/97/56/31/17
USA	APS-124	SS	160/124/71/40/22
USA	APS-125	AS	250/175/130/55/17
		SS	130/97/56/31/17
USA	APS-128	SS	120/100/57/32/18
USA	APS-130	SS	150/97/56/31/17
USA	APS-134	SS	150/150/96/54/30
USA	APS-137	SS	180/180/116/65/36
USA	APS-138	AS	250/175/130/55/17
		SS	180/124/71/40/22
USA	APS-139	AS	250/175/130/55/17
		SS	180/124/71/40/22
USA	APS-143	SS	120/100/57/32/18
USA	APS-145	AS	350/240/179/76/23
		SS	250/195/111/63/35
USA	APS-147	SS	120/100/57/32/18
USA	APS-181	SS, TF	0/0/0/0/0
USA	APY-1	AS	350/240/179/76/23
		SS	210/177/101/57/32
USA	APY-2	AS	350/240/179/76/23
		SS	210/177/101/57/32
USA	ASB-7	B/N	80/71/40/23/13
USA	AWG-9	LD/SD	180/119/89/38/11
USA	AWG-10/11/12	LD/SD	50/35/26/11/3
USA	Bendix RDR-1400	SS	80/62/35/20/11
USA	Bendix RDR-1500	SS	160/133/76/43/24