The Electronic Applications of the Bathurst Class



1942 - 1946



Front cover images: Cessnock (J175) with Australian Mk II yagi antenna, and Colac (J242) with Australian BAP/M flatscreen antenna and A272 lantern (both RAN archives).

Other images from the State Library of Victoria, A. C. Green Collection, the RAN archives and private collections. HMAS Castlemaine (AWA MFDF and A286P/A276 images supplied and approved for reproduction by R. Budzienny).

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This paper provides a brief overview of radar development within the RAN between 1940 to the end of 1945, with specific focus on the Bathurst class corvettes. A multitude of reports and publications are available describing the early development and application of radar more generally from the mid-1930's, and this will not be dealt with in this text.

The early beginnings of Australian radar can be traced to February 1939 when CSIR Radio Physicist David Forbes Martyn was dispatched to England to investigate the application and development of RDF (Range and Direction Finding) for the Australian military. On Martyn's return in early 1940, a conference with CSIR Chairman David Rivett, Director General of Posts and Telegraph Sir Harry Brown, and electrical engineer professor John Madsen lead to a decision to set up an advisory board for the scientific research, development and production of radar in Australia, accompanied by a new research facility on the grounds of Sydney University.

Material covering the development and application

of RDF from that point is freely available to those looking for further information on the subject, and can be found within the public domain under CSIR radar development, and therefore will not be covered in this report. Other information concerning the Australian production of electrical and antenna development and production can also be found by searches on the public domain.

Australian radar development and production evolved into a highly successful industry in the war years and by the end of 1942 was producing some of the best systems available worldwide at that time. In particular, the lightweight LW/AW set produced in early 1942 culminated in the LW/AW Mk IA lightweight set produced in early 1943, which was far superior in all aspects to anything produced by either the UK or US at the time. Information pertaining to Australian production is incorrectly reported in several books written by wellknown authors and the development and production of RDF sets and associated equipment was very much an intensive secret industry by the end of 1941. Australia at the time was party to an intelligence sharing agreement that would evolve into the "Five Eyes" agreement, and research was shared by the UK, US, Australia, Canada and New Zealand. One must wonder exactly how much information was freely shared, but due to

1 Shore defence RDF.

Australia's isolation, self sufficiency in the early years was paramount in the overall plan.

Australia's First Naval Radar

After interest from the navy department, SHD¹ applications were remodelled and by mid-1941 development of the first naval sets was underway. The first Australian naval RDF outfits² were being fitted by early 1942, with HMAS *Kybra* used as a test platform for evaluation of the various sets being produced. HMAS *Yandra* was later used for further RDF testing and the seagoing training of new radar operators. HMAS *Watson* was the RAN shore establishment for testing and final evaluation.

The first RAN ship on the Australia Station fitted for operation was HMAS *Arunta*. Other RAN ships operating or returning from foreign stations were fitted with earlier UK outfits, but *Arunta* was the first with a totally Australian product, the A290 RDF outfit.



The prefix A for an RDF outfit or set³ denotes Australian manufacture. The A290 was a collective term applied to this outfit, but ambiguous archived documents suggest that the RDF set used was the first generation of the A286. Principles of the British Type 286 set were likely used as a development platform.

 ² An RDF 'outfit' generally refers to the aerial array – each antenna had a separate designation – but it could also be used to describe the system including the set and display.
3 An RDE 'set' was the electronic equipment that generated the signal that was sent to the antenna, and then processed the signal that

³ An RDF 'set' was the electronic equipment that generated the signal that was sent to the antenna, and then processed the signal that returned.





It should be stressed at this point that archived information is fragmented, ambiguous and at times contradictory, with much missing from the record. It is unclear if documented reference pertaining to the A290 point to an initial Mk of the A286 set, or if the set used in the A290 and the A286P set were one and the same.





The A290 antenna arrays⁴ of which two Mk`s were developed, were also of Australian design. Many of the early antenna were manufactured by NSWGR⁵ within a special annexed section of Eveleigh Workshops, at Redfern, Sydney. It has been incorrectly identified and reported in several books by well-known authors and also perpetuates the public domain that this antenna was a Canadian SW1C variant, but this is not accurate. The only similarity between both arrays was that they were yagi antenna of broadly similar shape, and whilst their development by Australia and Canada was on parallel paths, they were both designed independently of each other.

⁴ The RDF antenna array (or just antenna) transmitted and received the signal produced by the set.

⁵ New South Wales Government Railways – NSWGR's Electrical Branch assisted in antenna manufacture in the Second World War. Other primary manufacturers contracted for parts and set production included AWA, HMV, STC and PHILIPS plus numerous other Australian electrical companies.



As an aside, there was a 3rd smaller yagi array developed for installation on RAN Fairmile B motor gunboats, of which 16 ships are recorded fitted, all powered by an A286P set (except *ML428* fitted with a Q set). These outfits were replaced in late 1944 with U.S. sets Type SO. There are no details recorded for this array, but the few images of it show that its design was slightly different to the original design. It is only noted in this report to illustrate how much development was actually undertaken and will not be covered any further.



The physical appearance of the Australian yagi antenna cannot be mistaken for any other. The first Mk of this antenna consisted of four director elements, a dipole on the origin point and a reflector element fitted rear of origin point, all mounted on the boom, while two extra reflectors were mounted on the support column above and below the boom. A rectangular plate was mounted at the rear of the boom, the purpose of which is not definitively known but was likely to correct/influence the characteristics of the signal. A second smaller bar was mounted vertically on the column below the boom and perhaps may have been the gamma match⁶. Two support bars stabilized the boom and the whole array was mounted on a canister housing the rotation motor. It is unknown if limits were fitted to stop rotation at 360 degrees and reverse the antenna direction. The A286/P/Q sets used an A scope display.

This Mk I antenna outfit was designated as BAM/M and was fitted to 8 RAN ships in total - Australia, Canberra, Hobart, Adelaide, Arunta, Warramunga, Westralia and Manoora. The last ship still fitted with this outfit was Manoora, which retained it until it was replaced in an August 1945 refit with a BAP/M flatscreen antenna panel mounted on a secondary lattice mast, on which an A276 parabolic antenna was also fitted. The Mk I yagi antenna was parked facing forward when not in operation but various images show it at various points of the compass which would imply those images were taken while the set was operating. Its combined weight negated its fitting to the Bathurst class and a second antenna Mk was designed specifically for corvettes and destroyers with lightweight foremasts.

The second Mk antenna was smaller and had three director elements on the boom, one less than the larger array, but other than these two factors its appearance was identical to the BAM/M. Its designation is unknown but would likely follow the previous designation of BAM with an unknown suffix letter. It was mounted on the truck of the Bathurst foremast, the height of which was not reduced to accommodate the array. Unlike the Canadian yagi, which was rotated by an inferior design of shafts and linkages down the mast to the RDF room, the A290 antenna was rotated via a Bowden cable connected to a bicycle pedal arrangement and manually powered by a second operator (in other words, unlike the Mk I BAM/M antenna, the antenna used on the Bathurst class relied on an operator manually rotating). Its design was not devoid of problems but was far superior to the Canadian setup. The antenna was parked facing forward when not in operation, and it is unknown if its rotation was checked at the 360-degree mark and then rotation was reversed.

This smaller antenna was powered by an A286P set (the second production variant of the A286 set) but the possibility exists, inferred by archived

6 Gamma matching was used to tune the antenna(s) to the desired input impedance.



documentation, that it could also operate with acceptable performance from the first Mk A290/286 set. The antenna performance details are unknown, and the RDF set performance characteristics are not covered in this report. Not all Bathursts were fitted with this RDF outfit and many carried no radar until fitted with the flatscreen antenna and A286P/Q, from approximately mid-1943 onwards. The first recorded RAN ship fitted with the flatscreen antenna was HMAS *Australia* during her February 1943 refit, followed closely by *Arunta*.

Whilst these sets and antenna arrays were for the majority fitted to RAN ships, documentation lists that Australian RDF equipment was also fitted to a number of ships of foreign navies operating within the Australia station under RAN control, or on the RN East Indies Station. Three ships have thus far been identified in images fitted with the smaller A290 Mk II yagi array, these being Free French destroyer *Le Triomphant*, and the Dutch ships *Tromp* and *Soemba*. Radar fits were changed frequently and just because images of any particular ship show no fitting at that time does not mean they were not fitted at some stage. No documentation nor images exist to verify that any RN ship was ever fitted.



An A286P set, as displayed on the museum ship HMAS *Castlemaine*



Later Radar Arrangements

The A290 Mk I and II antenna were replaced by a flatscreen array of Australian development, although it has frequently been incorrectly identified as a US SC antenna. No RAN ships except *Arunta* and *Bataan* were ever fitted with US SC radar (*Arunta* and *Bataan* both received a SC4 outfit, antenna 66AET/AEU, in mid-1945). The SC and SC1 antenna panels were of rectangular shape, had a different motor housing and were mounted with a 2/3 degree lean backwards. This contrasts with the Australian antenna panel which was square and mounted vertically.



The Australian flatscreen array was produced in two separate Mk's. The correct designations for these arrays were BAP/H and BAP/M, the difference being the drive housing. As can be seen in the below image, the H Mk was mounted on a stumpy motor canister which did not project much above the lower edge of the panel - ships fitted with this antenna variant were *Australia, Hobart, Adelaide, Westralia* and *Kybra*. The second M Mk was mounted on an elongated motor assembly, the top of which finished behind the centre of the panel. It was mounted usually, but not always, on the aft face of the foremast truck - this was the variant fitted to the Bathurst class. When the BAP/M was fitted,



the foremast was reduced slightly in height and the upper W/T⁷ yardarm was removed, to help compensate for the increase in topweight. This antenna could operate from either an A286P or later A286Q set, both of which were WC (Warning Combined), providing surface and air search capability.



As time and refits allowed, the installation of the BAP/M outfit on the Bathurst class was usually accompanied by installation of a SW (Surface Warning) set A272 with antenna array mounted on a platform above the Mk IV 20 inch searchlight, and housed in a plywood Lantern enclosure. The possible, but unconfirmed, designation of that outfit was CPT/M.

The A272 was modelled on the Type 271, the antenna array consisting of 2 cheese assemblies in an identical layout to the 271, as reported by Jake Kerr in the book It's Nothing to Do With Me, I'm Radar by P. H. R. Watson. Jake served in the 20th Minesweeping Flotilla, and in the book describes that the A272 array was rotated by a small, squat motor resembling that fitted to BAP/H. This motor is reported to have been part of the AS1/AS3 Asdic controllers, although it is possible that it may also have been very similar to that fitted to the A276. It had a 360-degree rotation with a 5 degree overshoot dead astern, controlled by limit switches (in other words, it did not continually rotate in one direction, but rather rotated clockwise and counter-clockwise around the rotation limiting point). The A272 was a precursor to the A276, and was designed and

manufactured by AWA. More details on the A272 are available on pages 21 and 22 of *It's Nothing to Do With Me, I'm Radar*.



A Type 271 cheese array. The A272 antenna (for which no images can be located) is reported as similar to this array. It was rotated by an electric motor.





⁷ Wireless Telegraphy – strictly speaking used at the time for Morse code radio communication on RAN ships, but in contemporary texts and more recent books it can sometime be used to refer to all radio communications.

These installations, as corroborated by ROP's (Report of Proceedings), started approximately mid-1943 but some ships were not fitted until late 1944. *Toowoomba* and *Burnie* were fitted with a British Type 271P set of which the TX/RX⁸ array was housed in the larger lantern mounted in place of the searchlight. That lantern was still fitted to *Burnie* when she was transferred in 1946 to the Royal Netherlands Navy, East Indies Station and renamed *Ceram. Toowoomba* lost the 271P Lantern and was fitted with A272 in 1945, which was retained on its 1946 transfer to the Royal Netherlands Navy, East Indies Station where it was renamed *Boeroe*.

Of the Bathurst class serving on foreign station with the RN, three ships, *Geraldton, Maryborough* and *Launceston* were fitted with a British Type 291 set including its standard, British-developed X antenna outfit ATQ or ATR. *Maryborough* was initially fitted with an A290 Mk II Yagi in 1943, before it was replaced with the X antenna in 1944. *Lismore* was fitted with an A286P set with A290 Mk II yagi, with the antenna being replaced by the X antenna in 1944. The changes of these two antenna suggests the sets were capable of working with either antenna outfit with no discernible loss to performance.



The only other RDF set fitted to some Bathurst class vessels in the second half of 1945 was the A276, which was also the first Australian-designed set with a PPI display⁹. This set was a much-improved A272 and was one of the most versatile Australian RDF systems produced. It replaced or substituted the A272 and its lantern on a number of ships and looked very different to a British Type 276. The parabolic antenna of the A276 (known as a monostatic aerial system), AWA designation Y50241, was very similar to a US SG. The original A276 antenna design also incorporated in a lantern enclosure, but this was never installed. The main visual differences between the Australian and US array were the A276 had a smaller, stout motor enclosure and the feed horn

had a different shape – making it possible to clearly discern one from the other even at a distance. No Bathurst class vessel was ever fitted with a US SG outfit/set.

To conclude this section, as noted in opening paragraph, its main focus is those RDF types fitted to RAN Bathurst class vessels during the Second World War, with particular attention on those produced in Australia (details on the British sets/outfits are more readily available in the public domain). There were many other types of radar, either Australian, UK or US in origin, which were fitted to other RAN units. That the A286Q set with its BAP/M antenna was still fitted on those Bathursts in commission in the early 1950's is testament to its performance. Although not specific to the time period discussed, the radar set fitted to those Bathurst class transferred to RNZN in 1952 was a Type 974 set, with antenna outfit AKL, mounted on a raised platform behind the wheelhouse.



An A276 antenna, as displayed on the museum ship HMAS Castlemaine



The PPI display for an A276 set, as displayed on the museum ship HMAS *Castlemaine*

⁸ TX/RX is short-hand for transmit/receive.

⁹ PPI stands for Plan Position Indicator, and is a circular radar display with the radar antenna represented at the centre, with a line extending from the centre to the side of the circle that sweeps around the circle, with contacts showing up on the display as "blips". This type of radar display is by far the one most commonly represented in popular media.



IFF, TBS & DF Applications of the Bathurst Class

The subject of IFF (Identification Friend or Foe) can be complex, but detailed information can be found within the public domain for further reading¹⁰. The early IFF system used by the RAN is recorded as Mk IIA and later the Mk III. The early A290 set



Upper foremast showing reversed BAP/M panel, 253 antenna ASH below crowsnest, and VHF TBS antenna (likely 66016). Minesweeping lamps are fitted with aerial shades.

is likely, but unconfirmed, to have had the IFF interrogator inbuilt and the challenge signal was incorporated within the radar signal. Archived documentation show that the A286P and A286Q sets did send the interrogator signal through the BAP/M or BAP/H flatscreen antenna. The Bathurst class are reported to have had the ABK5 IFF system fitted and later a Type 253 transponder with biconical antenna outfit ASH. This antenna was also used for the Type 242 outfit ASD. A number of other antenna arrays were utilised for Type 242, but none except ASD can be identified fitted to the Bathurst class. Burnie and Toowoomba, fitted with Type 271P set, would have been fitted with Type 242, and images appear to show two biconical antenna fitted (likely one for a Type 242 allround interrogator and the second for Type 253). In most images other than those of high resolution the antenna is difficult to clearly identify or even distinguish.



HMAS *Fremantle* in 1945 showing BAP/M panel, Type 272 lantern, 253 antenna ASH and MDF loop frame coil. The antenna below the flatscreen is an AWA VHF TBS antenna similar to U.S. TBS designation CRV-66016.

TBS (Talk between Ships) was a VHF voice communication system introduced into the RAN in 1943, primarily to enable short-range voice communication between friendly ships (it was limited in range and not for 'over the horizon' communication). The most recognised antenna was the US turnstyle ground plane design, designation CRV-66015. The elements of the antenna were very



¹⁰ A very rough summary is that an IFF set/antenna outfit combination transmits a signal that can be picked up by receiving sets modified to receive and interrogate it – thus indicating to the receiver of the signal that the sender of the IFF signal is friendly.

thin and cannot be discerned in low-resolution images, but its presence in photographs can be distinguished by a small T-shaped column. There are no images nor documentation to confirm that any Bathurst class vessel was ever fitted with that particular system. AWA and Philips designed and manufactured a number of different TBS systems (most notably AMR-100/101 and DR-106) which were installed in the Bathurst class in approximately early/mid-1944. These TBS system aerial designations are unidentified but were of similar appearance to US antenna catalogue numbers and are listed as such in images within this report as a comparison.

At least two ships, Launceston and Ballarat, were fitted with a vertical antenna mounted on the



An AWA VHF TBS AMR-101 set, manufactured for the U.S Signal Corps.



yardarm This aerial looks identical to a Headache VHF outfit QD.

foremast spar below the flatscreen antenna. That particular array resembled a VHF Headache¹¹ antenna, outfit QD, it is unknown if it was that specific system but may also have been used for intercepting enemy transmissions. Images show the antenna was still fitted in modified form on Ballarat in early 1946. A small number of ships by late 1945 were also fitted with VHF system 86M of which the



HMAS Benalla in late 1945, with 86M antenna.



antenna resembled a simple crucifix, listed as outfit APH. It was mounted on an extension bar at the end of the portside signal yardarm.

The DF (Direction Finding) system fitted to the Bathurst class was a medium frequency set, likely to be of AWA manufacture (unverified). Installation of the sets began in approximately late 1943. It was used to measure or determine the bearing of a radio transmission relative to the ship's head¹². The circular frame coil antenna was fitted on the wheelhouse roof either on a centreline block mount above the windows, or on an extended tri

^{11 &#}x27;Headache' was a British system used for intercepting and reading low-grade German radio traffic.

¹² By intercepting and getting the bearing of a radio transmission (including intercepted transmissions from enemy vessels), it could provide an indication of their direction. If two bearings could be determined then these could be triangulated to also provide an indication of the distance to the transmitting vessel.



MDF loop antenna on a Bathurst-class corvette.



The MDF set on museum ship HMAS Castlemaine.

frame projecting forward of the bridge. Its physical dimensions appear to match that of a Marconi MDF-5 antenna but is likely to have been of AWA manufacture also, possible type number R628. This was the only DF system carried by the Bathurst class and not all ships were fitted.

Communication in the early years of the Bathurst class was with the W/T (wireless telegraphy) system whereby Morse code was used on specific frequencies and sent/received via the aerial cables strung between the fore and main masts. In late 1944, the communications system was enhanced by the introduction of R/T (radio telegraphy), which transmitted spoken messages rather than Morse code.

Purpose and sources used

In summary, most if not all electronic equipment fitted to the Bathurst class between 1942 and 1946 was of Australian design and manufacture. This condensed report has been compiled to mesh fragmented/ambiguous documentation into a list of the various electronic systems fitted to the Bathurst class vessels during the Second World War. Its prime objective is to address and correct the misleading or incorrect information concerning these RDF apparatus and the subject of Australian radar research and production, which populates the public domain and has made its way into some publications.

The information contained in the report is based primarily on reports of the period (including but not limited to Reports of Proceedings¹³), NAA files, other navy documents, analysis of photographs taken of Bathurst class vessels and information in the book *It's Nothing to Do With Me, I'm Radar!* by P. R. H. Watson. If readers have any further information on this issue that sheds further light on the electronic systems used in the Bathurst Class vessels, please contact the authors.

¹³ Many of these are available online, via the Australian War Memorial's website, awm.gov.au.

Appendix A - Bathurst Class RDF/IFF fit in the Third Quarter of 1944

The listing below shows 58 of the 60 built Bathurst class (*Armidale* and *Wallaroo* having been lost prior to the date of the report), all built for either RAN or RIN service. Those ships noted as RN within the list were funded by the British Admiralty, but were primarily built for service on the Australia Station, commissioned into the RAN and manned by RAN crews.

- E -

PAGE 3. SECRET

E <u>AsiaSa</u> (Australian Station).	NUMBER AND TYPE OF SET /S FITTED.					
	.S A272	C A286	TRANS			
			ABK	253		
1. "ARARAT"	1	10	an	1		
2. "BALLARAT" R.N.	1	12	1/5			
3. "BENALLA"	1	I.P	1/5			
4. "BENDIGO" R.N.	1	10	1.P 2.P	1		
5. "BOWEN"	J.	LB	1/5			
6. "BROOME" R.N.	1	iQ	1/5			
7. "BUNBURY"	1	1.p	1./5			
B. "BUNDABERG"	1	GI.	1/5			
V. "CASTLEMAINE"	<u>1</u>	The second	1/5			
		LP No.				
LI. COULIMONDRA		19 19				
12. "COWRA"	1	lP	1/5	-		
13. "DELORAINE"	1	3.9	De la constante de la constante	1		
14 e "DUBBO"	1	lP	1/5			
1.5. "ECHUCA"	1	:10	1/5			
4.6 "FRIMANTLE"	1	76	100	1		
17. "GTELONG"	1	1.P	10	1		
18. "GL'DSTONE"	1	:LQ	105	1		
19. "GLENELG"	1	19	1/5			
20. "GCULBURN" R.N.	1	13	1/5	1.1.1.1		
21. "GYMFIE"	1	"LP	1/5			
22. "HORSHAM"	1	L ()	1/5			
23. "INVERELL"	1	ŢЪ	1/5	1		
24. "JUNEE"	1	10	m	1		
25. "KALGOORLIE" R.N.	1	:rð	10	1		
26. "KAPUNDA"	1	12	1/5			
27. "KATCOMBA"	1	lP	00	1		
28. "KIAMA"	1	TP	1/5			
29. "LATROBE"	1	1P	1/5			
30. ""LITHGOW"	1	lP	1/5			
31. "MILDURA"	1	75	1/5	1		
32. "PIRIE" R.N.	1	lp	1/5			
34 "BOCKHAMPTON"	1	12	1/5			
35. "STAWEEL"		12	1/5			
36. "SHEPPARTON"	1	lP	1.75			
37. "STRAHAN"	1	12	1-	1		
88. "TOWNSVILLE"	1	lQ		1		
89. "NAGGA"	1	.lp	1/5			
to. "WARRNAMBOOL"	1	19		1		
41. "WHYALLA" R.N.	1	Tb Tb	1/5			

						<u>SECRET</u> ,		
F. A.M.S. (Overseas).	NUMBER AND TYPE OF SEE/S FITTED.							
	173		₩C		INTS	TRAMS		
	271	A272	A286	391	242	253.		
1. "BATHURST" R.N.			1p			3		
2. "BENGAL" R.I.N.	C .					Store 1		
3. "BOMBAY" R.I.N.		0						
4. "BURNIE" R.N.	1.2					Ì		
5. "CAIRNS" R.N.		113	2.02	a.3		I		
6. "CESSNOCK" R.N.	14 10 10 10 10 10 10 10 10 10 10 10 10 10	****	1P		-			
7. "GAWLER" R.N.	10		lF			1		
8. "GERALDTON" R.N.				1	1	2.		
9. "IPSWICH" R.N.			112.4.	-	n1	L		
O. "LAUNCESTON" R.N.	1-2	an Comment of Color		1	1	1		
LI. "LISMORE" R.N.	Pu3		12		•	1		
12, "MADRAS" R.I.N.	6.1		-		6			
13. "MARYBOROUGH" R.N.	•1			1	1			
4. "PUNJAB" R.I.N.	5- 5-	-		1				
L5. "TAM. ORTH" R.N.			12		P	-1		
16. "TOOWOOMBA" R.N.	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1998 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -							
17. "WOLLONGONG" R.N.	-	18	2.92			1		

» Indicates set fitted from Australian stocks,

