



TOTAL RADIATION SOLUTIONS

RF EME ANALYSIS REPORT TXA BICKLEY



BICKLEY WA 6076

November 2016

RF EME ANALYSIS REPORT

For

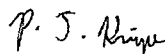
**Tx Australia Pty Limited
255 Welshpool Road East
Carmel, WA 6076**

on

**TXA BICKLEY
Television Road
Bickley, WA 6076**

Assessment Date 16 November 2016

Reference No. 10-5740



Dr. Phillip Knipe
Consultant Physicist
Total Radiation Solutions

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1. Introduction

Tx Australia Pty Limited (TX Australia) proposes to install an additional FM radio service and standby antenna at their site located at Television Road, Bickley, WA, 6076. Consequentially, TX Australia requested Total Radiation Solutions Pty Ltd (TRS) to undertake a radio frequency (RF) electromagnetic energy (EME) assessment of the proposed additions.

The purpose of this assessment is to determine the effect of the proposed additions on the RF EME levels for areas that are accessible to members of the general public.

This report is based on information provided by Tx Australia.

2. Regulatory Exposure Limits

ARPANSA, an agency of the Commonwealth Department of Health has established a Radiation Protection Standard (ARPANSA 2002) specifying limits for continuous exposure of the general public to RF EME transmissions (Table 1). Further information can be gained from the ARPANSA web site.

The Australian Communications and Media Authority (ACMA) mandates exposure limits for continuous exposure of the general public to RF EME. Further information can be found at the ACMA website at <http://www.acma.gov.au>

Table 1 Reference Levels for Time Averaged Exposure to RMS Electric and Magnetic Fields (Unperturbed) (ARPANSA 2002)

Exposure Category	Frequency Range	E-field (V/m)	H-field (A/m)	Power Flux Density (W/m ²)
Occupational (RF Worker)	100 kHz – 1 MHz	614	163/ f	–
	1 MHz – 10 MHz	614/ f	163/ f	1000/ f^2
	10MHz – 400 MHz	61.4	163	10
	400 MHz – 2 GHz	$3.07 \times f^{0.5}$	$0.00814 \times f^{0.5}$	$f/40$
	2 GHz – 300 GHz	137	0.364	50
Non-Occupational (General Public)	100 kHz – 150 kHz	86.8	4.86	–
	150 kHz – 1 MHz	86.8	0.729/ f	–
	1 MHz – 10 MHz	86.8/ $f^{0.5}$	0.729/ f	–
	10MHz – 400 MHz	27.4	0.729	2
	400 MHz – 2 GHz	$1.37 \times f^{0.5}$	$0.00364 \times f^{0.5}$	$f/200$
	2 GHz – 300 GHz	61.4	0.163	10

f is frequency in MHz

3. Calculations

The changes to the measured levels due to the additional service and proposed standby antenna were calculated.

Assumptions:

- For the proposed additional FM service, the increased power would result in a direct effect on the measured levels.
- For the proposed standby antenna, it was assumed that the inverse square law is applicable.
- Both antennas are the same manufacturer and model and would behave the same.

Table 2 Antenna Data

Antenna ID	Manufacturer	Model	Type	Height (m)	Frequency (MHz)	Power (kW)
Main	RFS	828DA-6	Dipole Array	116	92.9	3.5
					98.5	3.5
					100.9	3.5
					100.1	2.5
Standby	RFS	828DA-6	Dipole Array	66	92.9	3.5
					98.5	3.5
					100.9	3.5
					100.1	2.5

4. Calculation Results

Table 4 Calculated RF EME Levels

Description	% of ARPANSA General Public Reference Level		
	Existing configuration at 116m	Existing configuration at 116m with additional service	Proposed antenna at 66m with additional service
Maximum RF EME level measured at ground level outside front entry gate	5	6.19	19.12
Average RF EMR level measured at ground level at the base of the tower, and outside buildings	3.5	4.33	13.39
Maximum RF EME level measured at ground level at the base of the tower, and outside buildings	5.5	6.81	21.04

Notes:

1. Measured RF EME Levels for existing configuration at 116m as per :Kordia Report "RF Hazard Control Document – Bickley – 26647", Version R1, 27-01-2010.

APPENDIX A – References

ARPANSA (2002). Radiation Protection Standard - Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz, Chief Executive Officer of ARPANSA.

AS/NZS (2011). Radiofrequency fields Part 2: Principles and methods of measurement and computation - 3 kHz to 300 GHz. AS/NZS 2772.2:2011. Australia, Standards Australia.

Bickley (WA) - Structural Analysis & FM Antenna Mount

Steve,

I refer to TXA emails of 29th April, 14th December, 2016 through to 15th February, 2017 regarding your request for the design/drafting of a mounting system for the proposed RFS 828-6DA array and a structural assessment of the Bickley TXA Tower in Western Australia.

BRIEF

The requirement is to design/drafting of a mounting system for the proposed RFS 828-6DA array on the Bickley TXA tower and to undertake a structural assessment of this tower for the current proposed loading arrangement.

SUMMARY

We have undertaken the design/drafting of a mid-face mounted antenna support system for the proposed RFS 828DA-6 array, centred at RL 66.0m on the Bickley tower. This mount is shown on drawings STD-4812 sheets 1 to 9.

We have also undertaken a dynamic wind loading assessment of this tower and find it to have adequate design capacity to support the proposed loading conditions.

Please refer to the attached structural report for details of load levels and further comments.

Should you require further information, please call on (03) 9633-1308.

Regards,



Bruce Cook
B.E. Civil

Structel 

Attach.

Structural Report – Bickley TXA Tower (WA)
Drawings – STD-4812 sheets 1 to 9

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REPORT ON ANTENNA SUPPORT STRUCTURE & ANTENNA MOUNT
145m TXA TOWER, BICKLEY, WA

BRIEF

The requirement is to design/drafting of a mounting system for the proposed RFS 828-6DA array on the Bickley TXA tower and to undertake a structural assessment of this tower for the current proposed loading arrangement.

ASSESSMENT

The design criteria used are as follows:

Structure Site	: Bickley (WA)
Geographic Co-ordinates	: 32° 00' 38.6" S 116° 05' 4.4" E
Site Height	: ~ 345m
Structure Height	: 145m (nominal – AGL)
Region	: A1
Regional Wind Speed	: 46.0m/s (V_{1000}) - tower : 45.0m/s (V_{500}) – antenna mount
Terrain Category	: 3.0
Topographic Multiplier	: 1.04 to 1.1 (at base), varies with wind direction
Wind Direction Multiplier	: 1.0, varies with wind direction
First Mode Frequency	: 0.8Hz
Structure Classification	: Type II
Design Loads	: Dead Loads and Wind Loads on tower, ladder, antennas, mounting steelwork and feeders.
Design Standards	: AS 3995-1994, AS/NZS 1170.2-2011, AS 4100-1998, AS 3600-2009

ANTENNAS/ ANCILLARIES INCLUDED IN ANALYSIS

R.L.	Ref #	Description	Bearing	Feeder	Service
139.0m	ANT1	RFS 653LSS-24D (UPPER)	Omni	Ø3½"-Cu2Y	Channel 6, 7, 10, 11
129.5m	ANT2	RFS 653LSS-24D (LOWER)	Omni	Ø3½"-Cu2Y	Channel 6, 7, 10, 11
116.0m	ANT3	RFS 828DA-6	-	HJ7-50	TXA FM Clients
66.0m	new P	RFS 828DA-6	300°	Ø3½"-Cu2Y	TXA
66.0m	ANT21	RFI BA81-67	270°	AVA6-50	WA Police
63.0m	ANT20	RFI SMD41-67	270°	AVA6-50	WA Police
60.0m	ANT18	RFI COL85-870	270°	AVA6-50	WA Police
60.0m	ANT19	RFI COL85-870	270°	AVA6-50	WA Police
55.0m	ANT17	RFI SMD41-67	270°	AVA5-50	WA Police
51.0m	ANT14	RFS SL1	-	Ø2"-Cu2Y	TxA FM (GNB Standby)
45.0m	ANT6	Ø1.2m GRID PARABOLIC	310°	Ø2"-Cu2Y	6GNB STL
44.0m	ANT7	D-LINK ANT24-1801	-	LMR600	Wireless Bridge
42.0m	ANT9	ANDREW MKP-820B	280°	Ø2"-Cu2Y	6RTR STL
42.0m	ANT12	POLAR GK18	285°	Ø2"-Cu2Y	
41.0m	ANT10	TC-ANT13	-	LMR400	Radio Modem
41.0m	ANT16	COMMSCOPE VHLP2-15	180°	LMR400	WA Police
39.0m	ANT11	ANDREW P8-71GE	310°	EW63	TVW7 STL/TSL (ex NEW10)
38.0m	ANT13	POLAR GA20-08	290°	Ø2"-Cu2Y	PEEDAC STL
35.0m	ANT22	VHLP2-7W	286°	LDF4-50	VERTEL
32.0m	ANT15	COMMSCOPE VHLP2-15	348°	LMR400	WA Police

P Proposed Additional Ancillary – This Analysis

Note: Centreline/ mounting height of antennas/ ancillaries relative to ground level marked on BICK-3001 series drawings provided by TXA in an Email of 14th February, 2017.

SUMMARY OF RESULTS OF STRUCTURAL ANALYSIS

- The existing antenna support structure is a steel lattice tower, of square cross section, nominally 145m in height.
- It is understood that the tower was designed, fabricated and installed by Johns & Waygoods P/L circa 1959. Detail drawings of the tower body are not readily available and as such there accurately defining specific strength measures (e.g. member buckling lengths, etc) is difficult.
- The existing and proposed loadings are as listed.
- All steelwork is presumed to be in good condition, with all connections intact, effectively allowing consideration of full theoretical member capacity.

- The structural analysis of the tower supporting the existing and proposed antenna arrangements was carried out using the procedure outlined in the Dynamic Analysis section of the AS 3995-1994 (*Design of steel lattice towers and masts*).
- We have used GoogleEarth together with the latest wind Code AS/NZS1170.2 amendments to revise the terrain, topographic parameters for critical wind loading on this structure.
- The structure has been assessed and been found to have adequate capacity to support the proposed loading arrangements.
- Maximum loading levels (global), without upgrading of tower to STD-2601 is :

Component	Max Stress
Legs	81%
Braces	97%

Please note that the above loading levels may be global results and may or may not include some local loading effects due to ancillary loads – which have been included in the analysis when known. Consideration of local loading effects can significantly alter the above values.

The above values are those uniquely determined by Structel for this job only, and shall not be used by any other design authority as a basis for ongoing certifications, assessments or comparisons for the same or other sites.

TOWER FOOTINGS

- The installed footings for this tower are assumed to be as per the manufacturer/installer, Johns & Waygoods drawing # 58/1344/3A, which is given as a mass concrete footing of 3.2m width, 3.65m depth and has an undercut toe of 0.3m width/depth/side.
- These footings have been assessed, using empirical resistance properties of 'normal' soil and have been found to be satisfactory for the design loading.

'Normal' soils are considered to have engineering properties that are equivalent to dense sands or stiff to very stiff clays, mildly weathered rock or better.

- However it is considered necessary to obtain geotechnical information on the ground stratum adjacent to the footings before a more reliable evaluation of the footing capacity can be undertaken.

MOUNTING ARRANGEMENTS

- It is proposed to support the RFS 828DA-6 array from the middle of the west face of the TXA Bickley tower at an array centre height of RL 66.0m.

The array power divider and branch feeders are to be supported behind the rear reflector of antennas at a distance of 1100mm from the antenna vertical support pipe.

The layout of the antenna system including dipole spacing is given in RFS handbook # 49.51204.001.

- The proposed mounting system for the above antenna system is given on drawings STD-4812 sheets 1 to 9.
- The main face beams are to be constructed from 150SHS steel sections that are available in stock lengths up to 12m. With this in mind, and in the objective of minimising fabrication and installation costs, we have not detailed any joints in these members, however joints could be added if required.
- The mounting steelwork, as depicted on the above drawings, has been found to have adequate design capacities to support the new loads, when assessed in accordance with relevant Australian Standards.

Should you have any questions regarding the above information, please do not hesitate to contact me on (03) 9633-1308.

Yours Faithfully,



Bruce Cook
B.E. Civil

Structel ▲

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85681/Z31912/1



FM Sidemount Antennas

828DA Series

The 828DA series of FM side mount antennas are designed for FM broadcasting applications which require circular polarization and low wind loads.

These Band II antennas have a nominal gain of -1dBd per plane of polarization and are fitted with a horizontal reflecting element to provide some improvement in the directionality of the horizontal radiation pattern. The stainless steel design ensures that the antenna will give years of trouble free performance in the most hostile environments. The higher power series are pressurized to add further environmental protection. Elements will tolerate a degree of light icing but for more severe environments, radomes are available. Contact RFS for details.

All 828DA series antennas can be arrayed in any number of levels to suit most applications. The parallel feed system facilitates the customization of null fill and beam tilt to suit customer requirements.

The standard 828DA antenna series is for high power applications; for medium power select the 828MPDA series.

Both series have 3 models designed for bandwidth of 10MHz. Additional factory tuning is available to achieve superior return loss specifications.

A wideband series of the 828DA antenna, the 828HPDA covers the entire FM band from 88 to 108MHz and utilizes half wavelength spacing. The 828HPDA series antennas are high power arrays.

The wide variety of possible configurations ensures that this antenna range meets the needs of most users on both price and performance.

FEATURES / BENEFITS

- ➔ Directional horizontal radiation pattern
- ➔ Low downward radiation
- ➔ Rugged stainless steel construction for maximum corrosion protection
- ➔ Various power ratings available
- ➔ Mixed polarization
- ➔ Broadband operation to facilitate antenna sharing
- ➔ 828DA and 828HPDA models pressurized
- ➔ 828MPDA series designed specifically for un-pressurized operation
- ➔ Optional optimal array tuning
- ➔ Low windload to minimize tower or mast costs
- ➔ Radomes are an available option for all 828DA series
- ➔ Temperature range -40 to +60 degrees C available.

Technical Features

STRUCTURE

Product Line		Antenna Radio
Product Type		Band II (VHF) 828-6DA FM Sidemount Antennas

ELECTRICAL SPECIFICATIONS

Frequency Range	MHz	88 - 108
Operating Frequency Ranges	MHz	88 - 98 94 - 104 98 - 108
Polarization		Circular
Gain per Plane of Polarization	dBd	7.32
Return Loss	dB	20 Note 1
Power Rating	kW	30
Input/Power Rating Comment		Power ratings are for single input models. Dual input cavity versions can provide higher power ratings. Contact RFS for details. Connector types and impedance may be varied to suit customer requirements, contact RFS for details.
Impedance (unbalanced)	Ω	50

MECHANICAL SPECIFICATIONS

Number of Levels		6
Input Connector		Single element 7/8" EIA Array 7/8" EIA 1-5/8" EIA 3-1/8" EIA
Mounting (Standard)	mm (in)	Brackets for 60mm (2-3/8") pole mount
Effective Area Front (full antenna)	m ² (ft ²)	0.05 (0.54) Single Bay
Effective Area Side (full antenna)	m ² (ft ²)	0.19 (2.04) Single Bay
Pressurization Operational	kPa (psi)	10 - 25 (1.5 - 3.6)



FM Sidemount Antennas 828DA Series

Pressurization Test	kPa (psi)	100 (15)
Weight	kg (lb)	12 (27) Single Bay

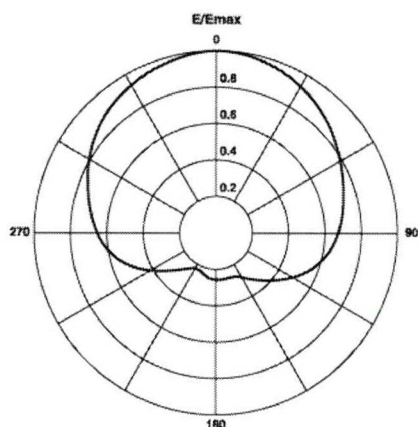
External Document Links

Notes

Note 1 Arrays are factory tuned for a broadband performance and a return loss of 20dB across the specified bandwidth is achieved. Optional factory tuning for optimum narrow band performance will achieve a 30dB return loss over +/- 1MHz from the specified frequency. Arrays may be supplied un-tuned with a resulting return loss of 14dB.

Note 2 Array power ratings are limited by the radiator and power divider input connectors used. Typical limits are : 7-16 DIN 3.5kW, 7/8" EIA 5kW, 1-5/8" EIA 10kW and 3-1/8" EIA 40kW.

Note 3 Mechanical specifications: For 828MPDA and 828DA the single bay Effective Area Front is 0.05 sq m (0.54 sq ft), Effective Area Side is 0.19 sq m (2.04 sq ft). For 828HPDA, single bay Effective Area Front is 0.06 sq m (0.65 sq ft), Effective Area Side is 0.25 sq m (2.35 sq ft).



Horizontal Radiation Pattern for Combined Horizontal and Vertical
Polarisation

Bickley (WA) - Structural Analysis & FM Antenna Mount

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Structural Report – Bickley TXA Tower (WA)
Drawings – STD-4812 sheets 1 to 9

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145m TXA TOWER, BICKLEY, WA

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Structure Height	:	145m (nominal – AGL)	
Region	:	A1	
Regional Wind Speed	:	46.0m/s (V_{1000}) - tower	
	:	45.0m/s (V_{500}) – antenna mount	
Terrain Category	:	3.0	
Topographic Multiplier	:	1.04 to 1.1 (at base), varies with wind direction	
Wind Direction Multiplier	:	1.0, varies with wind direction	
First Mode Frequency	:	0.8Hz	
Structure Classification	:	Type II	
Design Loads	:	Dead Loads and Wind Loads on tower, ladder, antennas, mounting steelwork and feeders.	
Design Standards	:	AS 3995-1994, AS/NZS 1170.2-2011, AS 4100-1998, AS 3600-2009	

ANTENNAS/ ANCILLARIES INCLUDED IN ANALYSIS

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32.0m	ANT15	COMMSCOPE VHLP2-15	348°	LMR400	WA Police

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FM Sidemount Antennas

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- ➞ Low downward radiation
- ➞ Rugged stainless steel construction for maximum corrosion protection
- ➞ Various power ratings available
- ➞ Mixed polarization
- ➞ Broadband operation to facilitate antenna sharing
- ➞ 828DA and 828HPDA models pressurized
- ➞ 828MPDA series designed specifically for un-pressurized operation
- ➞ Optional optimal array tuning
- ➞ Low windload to minimize tower or mast costs
- ➞ Radomes are an available option for all 828DA series
- ➞ Temperature range -40 to +60 degrees C available.

Technical Features

STRUCTURE

Product Line		Antenna Radio
Product Type		Band II (VHF) 828-6DA FM Sidemount Antennas

ELECTRICAL SPECIFICATIONS

Frequency Range	MHz	88 - 108
Operating Frequency Ranges	MHz	88 - 98 94 - 104 98 - 108
Polarization		Circular
Gain per Plane of Polarization	dBd	7.32
Return Loss	dB	20 Note 1
Power Rating	kW	30
Input/Power Rating Comment		Power ratings are for single input models. Dual input cavity versions can provide higher power ratings. Contact RFS for details. Connector types and impedance may be varied to suit customer requirements, contact RFS for details.
Impedance (unbalanced)	Ω	50

MECHANICAL SPECIFICATIONS

Number of Levels		6
Input Connector		Single element 7/8" EIA Array 7/8" EIA 1-5/8" EIA 3-1/8" EIA
Mounting (Standard)	mm (in)	Brackets for 60mm (2-3/8") pole mount
Effective Area Front (full antenna)	m² (ft²)	0.05 (0.54) Single Bay
Effective Area Side (full antenna)	m² (ft²)	0.19 (2.04) Single Bay
Pressurization Operational	kPa (psi)	10 - 25 (1.5 - 3.6)



FM Sidemount Antennas 828DA Series

Pressurization Test	kPa (psi)	100 (15)
Weight	kg (lb)	12 (27) Single Bay

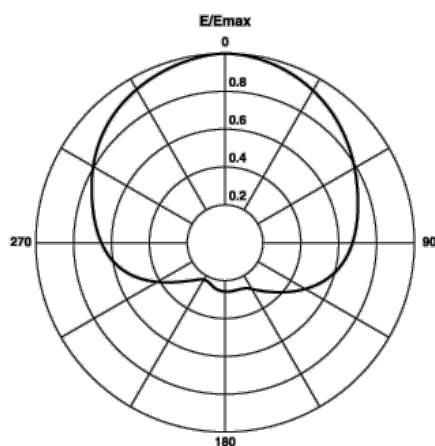
External Document Links

Notes

Note 1 Arrays are factory tuned for a broadband performance and a return loss of 20dB across the specified bandwidth is achieved. Optional factory tuning for optimum narrow band performance will achieve a 30dB return loss over +/- 1MHz from the specified frequency. Arrays may be supplied un-tuned with a resulting return loss of 14dB.

Note 2 Array power ratings are limited by the radiator and power divider input connectors used. Typical limits are : 7-16 DIN 3.5kW, 7/8" EIA 5kW, 1-5/8" EIA 10kW and 3-1/8" EIA 40kW.

Note 3 Mechanical specifications: For 828MPDA and 828DA the single bay Effective Area Front is 0.05 sq m (0.54 sq ft), Effective Area Side is 0.19 sq m (2.04 sq ft). For 828HPDA, single bay Effective Area Front is 0.06 sq m (0.65 sq ft), Effective Area Side is 0.25 sq m (2.35 sq ft).



Horizontal Radiation Pattern for Combined Horizontal and Vertical
Polarisation