2. OVERVIEW/ SYSTEM DESCRIPTION

2.1 General System Description

The Weehawken tunnel radio system is designed to amplify various bands of radio frequencies, in either channelised or band selective modes. This unit amplifies all the RF bands to the 'River Portal' area in a band-selective mode with AGC in the uplink direction. All the hardware is built into a standard environmentally protected cabinet which has an IP rating of 65.

The system described in this document is 'stand-alone' and needs no other equipment apart from a +12V DC power supply. Every active module in the entire system has a dedicated alarm and these are series wired within the unit to a relay which gives a volt-free output pair which is wired to a 'krone-block' termination and ultimately to a pair of wires in an external port connector (alarm connector, pins 1 & 2).

3. MULTI-BAND SELECTIVE CELL ENHANCER (RIVER PORTAL)

3.3 Band Selective BDA (55-154901)

3.3.1 Band Selective BDA Description

The band selective BDA which covers the 'River Portal' site carries two downlink paths and one uplink path, all with automatic gain control on the last amplification stage in each path. Cross band couplers are fitted to the input and output to facilitate a low frequency bypass of the 800MHz BDA allowing the lower frequency signals to pass unhindered.
All amplifiers have built-in alarms which are configured as a summary, volt-free relay contact pair terminating at pins 1 & 2 on the 'D' type alarm connector.

3.3.2 Band Selective BDA Electrical Specification

PARAMETER		SPECIFICATION
Frequency ranges:		929-930MHz (Downlink)
		854-869MHz (Downlink)
		806-824MHz (Uplink)
Gain:		>35dB
Gain Adjustment:		0 - 30dB (in 2dB steps)
Uplink power:		>1.0Watts (806-824MHz path)
Downlink power:		>1.0Watts (929-930MHz path)
Downlink power:		>20.0Watts (854-869MHz path)
IP3:	Uplink	+43dBm (806-824 & 929-930MHz paths)
	Downlink	+56dBm (854-869MHz path)
Noise Figure:		<6dB (at maximum gain)
AGC:		Fitted to all paths
DC Power supply:		12V DC (externally supplied)
VSWR:		better than 1.5:1
RF Connectors:		N type, female
Temperature range:	operational:	-10°C to +55°C
	storage:	-40°C to +70°C
Alarms Fitted: (volt-free contacts/TTL)		1 Downlink amplifiers
		2 Uplink amplifiers

3.3.3 Band Selective BDA Mechanical Specification

PARAMETER		SPECIFICATION
Case size	Height:	**620**mm
	Width:	**620**mm
	Depth:	**250**mm
(excluding heatsinks, connectors, handles and feet)		
Fixings:		**4** holes on **670**(w) x **558**(h)mm
Temperature range:	Operational:	**-10°C** to **+55°C**
	Storage:	**-40°C** to **+70°C**
Weight:		**>30**kg
RF Connectors:		**N type female**
Environmental Protection:		**IP65** (with door closed and all ports terminated)
Finish:	Case:	To **RAL 7035**
	Heatsinks:	**Matt black** (where fitted)
	Handles:	**Black technopolymer**
Supply Cable:		Unit supplied with suitable supply input leads with connector and appropriate length of cable

4. ALARMS

4.1 Alarm/Monitor System

4.1.1 Alarm/Monitor Description

The alarm system acts as an alarm concentrator for all the alarms in the unit. Firstly, within each active component, the individually alarmed modules are 'summed together' and presented to the outside world as a volt-free, relay contact pair (pins 1 & 2 in the IP65 alarm connector.

As all the alarms in the system are 'held closed loops', should the power supply fail, the main system alarm will be triggered.

4.1.2 Alarm/Monitor Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		12V (floating earth)
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		25 Way 'D' Connector
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C

5. SUB-UNIT MODULES

5.1 Bandpass Filter (02-004502)

5.1.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of slot coupled, folded combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports.

Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

No adjustments should be attempted without full network sweep analysis facilities to monitor both insertion loss and VSWR simultaneously.

5.1.2 Technical Specification

PARAMETER		SPECIFICATION
Response Type		Chebyshev
Frequency Range:		751-862MHz (tuned to spec.)
Bandwidth:		12MHz (tuned to spec.)
Number of Sections:		5
Insertion Loss:		1.2 dB
VSWR:		better than 1.2:1
Connectors:		SMA female
Power Handling:		100W max
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		3 kg (typical)

5.2 Bandpass Filter (02-007206)

5.2.1 Description

The bandpass filters are multi-section designs with a bandwidth dependent upon the passband frequencies, (both tuned to customer requirements). The response shape is basically Chebyshev with a passband design ripple of 0.1dB. The filters are of slot coupled, folded combline design, and are carefully aligned during manufacture in order to optimise the insertion loss, VSWR and intermodulation characteristics of the unit. The tuned elements are silver-plated to reduce surface ohmic losses and maintain a good VSWR figure and 50Ω load at the input and output ports.

Being passive devices, the bandpass filters should have an extremely long operational life and require no maintenance. Should a filter be suspect, it is usually most time efficient to replace the module rather than attempt repair or re-tuning.

No adjustments should be attempted without full network sweep analysis facilities to monitor both insertion loss and VSWR simultaneously.

5.2.2 Technical Specification

PARAMETER		SPECIFICATION
Response Type		Chebyshev
Frequency range:		800 - 950MHz (tuned to spec.)
Bandwidth:		25MHz (tuned to spec.)
Number of sections:		8
Insertion Loss:		1.2 dB
VSWR:		better than 1.2:1
Connectors:		SMA female
Power Handling:		100W max
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		3 kg (typical)

5.3 Crossband Coupler (07-005705)

5.3.1 Description

The purpose of a crossband coupler is to either combine/split transmission signals from different parts of the frequency spectrum.

It basically comprises of a 3 port device, two filters, one a low pass, the other a high pass feeding a common output. In this case, a VHF spectrum signal source is to be combined with a band 2 FM source, (many other combinations are also possible). The couplers are built into a machined aluminium casing having a centre screening wall between the filter sections and lid secured by screws at frequent intervals over its perimeter to obtain a tight seal and to ensure linearity and stability of response.

5.3.2 Technical Specification

PARAMETER		SPECIFICATION
Passband	250 MHz:	70-250MHz
	380 MHz:	380-960 MHz
Power Rating:		50 Watts (CW)
Number of Input ports:		2
Number of Output ports:		1
Insertion loss:		0.5 dB
Isolation:		> 50 dB 70-250MHz > 50 dB 380-960MHz (15 dB typical Return loss 500-960)
Impedance:		50 ohm
Connectors:		SMA- female

5.4 ¼Watt 0- -30 & 0-15dB Switched Attenuator (10-000701 & 10-000901)

5.4.1 General Application

In many practical applications for Cell Enhancers etc., the gain in each path is found to be excessive. Therefore, provision is made within the unit for the setting of attenuation in each path, to reduce the gain.

5.4.2 Switched Attenuators

The AFL switched attenuators are available in two different types; 0 – 30dB in 2 dB steps, or 0 – 15dB in 1 dB steps. The attenuation is simply set using the four miniature toggle switches on the top of each unit. Each switch is clearly marked with the attenuation it provides, and the total attenuation in line is the sum of the values switched in. They are designed to maintain an accurate 50Ω impedance over their operating frequency at both input and output.

5.5 Low Noise Amplifier (11-005902)

5.5.1 Description

The Gallium-Arsenide low noise amplifier used in the unit is a double stage, solid-state low noise amplifier. Class A circuitry is used throughout the units to ensure excellent linearity and extremely low noise over a very wide dynamic range. The active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on these amplifiers, and in the unlikely event of a failure, then the complete amplifier should be replaced. This amplifier features its own in-built alarm system which gives a volt-free relay contact type alarm that is easily integrated into the main alarm system.

5.5.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800 – 960MHz
Bandwidth:		<170MHz
Gain:		19.5dB (typical)
1dB Compression point:		21dBm
OIP3:		33dBm
Input/Output Return Loss:		>20dB
Noise Figure:		1dB (typical)
Power consumption:		190mA @ 24V DC
Supply voltage:		10-24V DC
Connectors:		SMA female
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		90 x 55 x 30.2mm
Weight:		0.28kg

5.6 Low Noise Amplifier (11-006702)

5.6.1 Description

The Gallium-Arsenide low noise amplifiers used in the system are double stage, solid-state low noise amplifiers. Class A circuitry is used throughout the units to ensure excellent linearity and extremely low noise over a very wide dynamic range. The active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on these amplifiers, and in the unlikely event of a failure, then the complete amplifier should be replaced. This amplifier features its own in-built alarm system which gives a volt-free relay contact type alarm that is easily integrated into the main alarm system.

5.6.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency Range:		800 – 1000MHz
Bandwidth:		<200MHz
Gain:		29dB (typical)
1dB Compression Point:		20dBm
OIP3:		33dBm
Input/Output Return Loss:		>18dB
Noise Figure:		1.3dB (typical)
Power Consumption:		180mA @ 24V DC
Supply Voltage:		10-24V DC
Connectors:		SMA female
Temperature Range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:		90 x 55 x 30.2mm
Weight:		290gms (approximately)

5.6.3 LNA 'D' Connector Pin-out details

Connector pin	Signal
1	+Ve input (10-24V)
2	GND
3	Alarm Relay O/P bad
4	Alarm Relay common
5	Alarm Relay good
6	No connection
7	TTL voltage set
8	TTL alarm/0V (good)
9	O/C good/0V bad

5.7 20W Power Amplifier (12-018002)

5.7.1 Description

This amplifier is a Class A 20W power amplifier from 800-960MHz in a 1 stage balanced configuration. It demonstrates a very high linearity and a very good input/output return loss (RL). It has built in a Current Fault Alarm Function.
Its housing is an aluminium case (Alocrom 1200 finish) with SMA connectors for the RF input/output and a D-Type connector for the power supply and the Current Fault Alarm Function.

5.7.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800-960MHz
Small signal gain:		30dB
Gain flatness:		±1.2dB
I/O Return loss:		>18dB
1dB compression point:		42.8dBm
OIP3:		56dBm
Supply voltage:		24V DC
Supply current:		5.0Amps (Typical)
Temperature range	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		<2kg (no heatsink)

5.7.3 PA 7-Way Connector Pin-outs

Connector Pin	Signal
A1 (large pin)	+24V DC
A2 (large pin)	GND
1	Alarm relay common
2	TTL alarm/0V good
3	Alarm relay contact (bad)
4	Alarm relay contact (good)
5	O/C good/0V bad (TTL)

5.8 800MHz 1Watt Low Power Amplifier (12-021901)

5.8.1 Description

The low power amplifier used is a triple stage solid-state low-noise amplifier. Class A circuitry is used in the unit to ensure excellent linearity over a very wide dynamic range. The three active devices are very moderately rated to provide a long trouble-free working life. There are no adjustments on this amplifier, and in the unlikely event of failure then the entire amplifier should be replaced.

5.8.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		800-960MHz
Bandwidth:		20MHz (tuned to specificatic
Maximum RF output:		>1.0 Watt
Gain:		15dB
1dB compression point:		+30.5dBm
3rd order intercept point:		+43dBm
Noise Figure:		<6dB
VSWR:		better than 1.5:1
Connectors:		SMA female
Supply:		500mA @ 10-15V DC
Temperature range:	operational:	-10°C to +60°C
	storage:	-20°C to +70°C
Weight:		0.5 kg
Size:		167x52x25mm

5.8.3 LPA 7-Way Connector Pin-outs

Connector Pin	Signal
A1 (large pin)	+24V DC
A2 (large pin)	GND
1	Alarm relay common
2	TTL alarm/0V good
3	Alarm relay contact (bad)
4	Alarm relay contact (good)
5	O/C good/0V bad (TTL)

5.9 Wide Dynamic Range AGC (17-001109, det. & 17-001201, atten.)

5.9.1 Description

The equipment is fitted with a wide dynamic range Automatic Gain Control (AGC) system. This is generally fitted in the Uplink path (not usually needed in the downlink path, as the signal here is at an almost constant level), to avoid overloading the amplifiers (with the associated performance degradation) should a mobile be operated very close to the unit.

The AFL wide dynamic range Automatic Gain Control system consists of two units, a detector/amplifier and an attenuator. The logarithmic detector/amplifier unit is inserted in the RF path on the output of the power amplifier, and the attenuator is situated in the RF path between the 1st and 2nd stages of amplification.

Normally the attenuator is at minimum attenuation. The detector/amplifier unit monitors the RF level being delivered by the power amplifier, and when a certain threshold is reached it begins to increase the value of the attenuator to limit the RF output to the (factory set) threshold. Therefore overloading of the power amplifier is avoided.

The factory set threshold is 1dB below the Enhancer 1dB compression point. Some adjustment of this AGC threshold level is possible, a 10dB range is mostly achieved. It is not recommended under any circumstances to adjust the AGC threshold to a level greater than the 1dB compression point as system degradation will occur.

The detector comprises of a 50Ω transmission line with a resistive tap which samples a small portion of the mainline power. The sampled signal is amplified and fed to a conventional half wave diode rectifier, the output of which is a DC voltage proportional to the RF input signal.

This DC voltage is passed via an inverting DC amplifier with integrating characteristics, to the output, which drives the attenuation control line of the corresponding AGC attenuator. This unit is fitted at some earlier point in the RF circuit.

The unit contains a 12V DC regulator in the detector module, which supplies stabilised voltage to the DC amplifier and via an external cableform to the AGC attenuator.

For small signals, below AGC onset, the output control line will be close to 12V and the AGC attenuator will have minimum attenuation. As the signal level increases the control line voltage will fall, increasing the attenuator value and keeping the system output level at a constant value.
The AGC onset level is adjusted by the choice of sampler resistor R1 and by the setting of potentiometer VR1, (factory set @ time of system test) do not adjust unless able to monitor subsequent RF levels.
The attenuator comprises a 50Ω P.I.N diode, voltage-variable attenuator with a range of 3 to 30dB. The attenuation is controlled by a DC voltage which is derived from the associated AGC detector unit.

5.9.2 Technical Specification

PARAMETER		SPECIFICATION
Frequency range:		up to 1000MHz
Attenuation range:		3 to 30dB
Attenuation steps:		continuously variable
VSWR:		better than 1.2:1
RF Connectors:		SMA female
Power handling:	attenuator:	1W
	detector/amp:	>30W (or as required)
Temperature range:	operation:	-10°C to +60°C
	storage:	-20°C to +70°C
Size:	attenuator pcb	50 x 42 x 21mm
	detector/amp pcb	54 x 42 x 21mm
Weight:	attenuator:	90gm
	detector/amp:	100gm

5.10 12V Single Relay Board (80-008901)

5.10.1 Description

The General Purpose Relay Board allows the inversion of signals and the isolation of circuits. It is equipped with a single dual pole change-over relay RL1, with completely isolated wiring, accessed via a 15 way in-line connector.

The relay is provided with polarity protection diodes and diodes for suppressing the transients caused by "flywheel effect" which can destroy switching transistors or induce spikes on neighbouring circuits. It's common use is to amalgamate all the alarm signals into one, volts-free relay contact pair for the main alarm system.

Note that the board is available for different voltages (12 or 24V) depending on the type of relay fitted at RL1.

5.10.2 Technical Specification

PARAMETER		SPECIFICATION
Operating voltage:		8 to 30V (floating earth)
Alarm Threshold:		Vcc - 1.20 volt ±15%
Alarm output relay contacts:		
Max. switch current:		1.0Amp
Max. switch volts:		120Vdc/60VA
Max. switch power:		24W/60VA
Min. switch load:		10.0µA/10.0mV
Relay isolation:		1.5kV
Mechanical life:		>2x10^7 operations
Relay approval:		BT type 56
Connector details:		Screw terminals
Temperature range	operational:	:-10°C to +55°C
	storage:	:-40°C to +70°C