Report to Tutors and Candidates on RCF Examinations in 2008

Foundation and Intermediate Examinations in 2008 showed that the great majority of candidates, judged against the standards of the current examinations, were entitled to apply for an amateur licence. Almost 84% of Foundation candidates passed the examination. At Intermediate Level 92% of candidates achieved a satisfactory standard. The Advanced examination enabled 65% of candidates to obtain a full amateur licence.

However, a more searching inspection of the various syllabus areas reveals underlying weaknesses that have to be balanced against overall success. A pattern does emerge of material at Foundation Level that is misunderstood and then this propagates upwards to Intermediate and Advanced Level. Transmitters and Receivers do appear to be a topic where basic misunderstandings take root at Foundation Level and work their way up the assessment scheme.

Foundation Tally Sheet Analysis and conclusions

Syllabus Section	%	%: is the percentage of correct answers shown by analysis of the tally sheets in Foundation Examinations held during 2008.
Licensing conditions	83	
Technical basics	80	
Transmitters and receivers	77	
Feeders and antennas	82	
Propagation	82	
EMC	82	
Operating practices and procedures	85	
Safety	90	
Overall	82	

Of particular note were the following syllabus areas:

2. Licensing conditions

83% of questions set on this syllabus item were answered correctly. However, it should be made clear to candidates that when the syllabus mentions "personal remarks" it does not mean remarks that are grossly offensive. This misunderstanding lead to a number of candidates choosing incorrect answers.

3. Technical basics

80% of questions were correctly answered in this syllabus item.

However, the examiners did note that a number of candidates were not able to handle decimals. For example it was not always appreciated that 1500mA is the same as 1.5Amp. About one quarter of candidates did not know that a filament bulb is not polarity sensitive. This rather begs the question, do candidates understand what is meant by polarity? It is also

well worth impressing on candidates the need to learn the frequency boundaries between HF and VHF and VHF and UHF.

5. Feeders and Antennas

Another finding that tally analysis revealed was that a number of candidates were not clear on the difference between polarization and a polar diagram of radiation.

7. EMC

Perhaps of more concern is that a number of candidates did not understand the respective functions of an RF earth and a mains earth. Tutors need to satisfy themselves that this distinction has been understood by their candidates.

9. Safety

Regarding safety as a syllabus item in its own right, 90% of questions set on safety at Foundation level in 2008 were answered correctly by candidates. Tutors are obviously working hard pressing home the safety message with their students.

Intermediate Tally Sheet Analysis and conclusions

Syllabus section	%	%: is the percentage of correct answers shown by analysis of the tally sheets in Intermediate Examinations held during 2008.
Licensing	85	
Technical Basics	77	
Transmitters & Receivers	71	
Feeders & Antennas	75	
Propagation	75	
EMC	76	
Safety	87	
Operating practices & procedures	76	
Construction	81	

The overall pass rate was 92%. Again a more detailed look at how the marks were earned does yield some valuable information.

2. Licensing

In spite of the high pass rate some candidates were confused by callsign suffixes, treating /P as indicating mobile operation. Candidates did not appear to be familiar with the non post coded /A. The change in the definition of "at sea" also caught some candidates unaware.

3. Technical basics

Ohms Law questions were well answered unless they required mathematical manipulation that involved zeroes ie., milliamps and kilo ohms. Basic arithmetic rather than Ohms Law

appeared to be the problem here. However, the inability of candidates to cope at Advanced Level with Ohms Law questions involving parallel resistors does suggest that they are merely going through a mechanical application of the formula at Intermediate Level rather than having an understanding of the principles behind Ohms Law.

4. Transmitters and Receivers

The effect of sharply rising and falling CW waveforms was not well understood.

The reasons for having the superhet type of receiver and the contribution made by its various stages to its performance was, in general, not well understood by candidates.

5. Feeders and Antennas

The returned tally sheets showed that half the candidates did not know which type of antenna had radials. A third of candidates thought that an ATU tuned the antenna to the correct frequency. This does lead to the conclusion that perhaps ATU should be discouraged and AMU encouraged in our teaching? Nearly half of the candidates thought that a wire wound resistor should be used as a dummy load. Certainly this may be the case if it were non-inductively wound, but the questions were silent on this and so it cannot be assumed. Questions about decibels were not well answered, again perhaps pointing to lack of basic mathematical knowledge. Logarithms do appear to be a dark art to many.

6. Propagation

Questions on propagation revealed that skip distance and skip zone questions were not well answered. UHF ducting and Sporadic E were also not understood by some candidates.

7. EMC

Absorption Wavemeters, perhaps because they have fallen out of fashion, were not able to detect harmonics according to some candidates. Some candidates also seemed unaware of the meaning of "direct pick-up" and confused it with mains-borne interference.

Conclusions.

What is not apparent from the returned tally sheets is that there are wide and obvious gaps in candidates' knowledge and understanding at Intermediate Level. Or if there are, the current examination questions are not picking them up. In view of some of the misunderstandings revealed at Advanced Level this certainly could be the case.

Advanced Tally Sheet Analysis and conclusions

Syllabus Section	%	%: is the percentage of correct answers shown by analysis of the tally sheets in Advanced Examinations held during 2008.
2. Licence Conditions (subsections 2a,2d,2e,2j)	81 (90)	
3.Technical aspects	61	
4.Transmitters and Receiver	57	
5.Feeders and Antennas	61	
6.Propagation	84	
7.EMC	58	
8.Operating practices and procedures	67	
9.Safety	82	
10.Electrical measurement	70	

During the period from December 2007 to October 2008 there were six examinations on set dates. These were taken by a total of 307 candidates. In addition home examinations were provided for two blind candidates. 64.9% of candidates achieved a pass result.

Looking at the various sections of the Advanced syllabus using data from returned tally sheets it is clear to see the strengths and weaknesses of this years candidates. However, it has to be remembered that a poorly answered question is defined as a question where the number of incorrect answers were equal to, or greater than the number of correct answers. Also the sample of both candidates and questions is relatively small. Individual questions tend not be asked very often, so establishing their merit is only possible by calculating their facility value over a long time scale.

2. Licence conditions

As is usually the case this section was very well answered, in fact for syllabus subsections 2a, 2d, 2e and 2j the percentage correct was slightly over 90%.

Tutors may, however, like to note that areas that did cause candidates a few problems were:

- some confusion between "home address" and "main station address",
- significance of the ban on third party traffic was not fully appreciated,
- callsign consequence of permanent emigration as opposed to a short visit,
- response to incoming calls on non-UK amateur frequency,
- 25Watt limitation for beacons.

3.Technical aspects

No questions were asked on section 3a.1 of the syllabus which is unfortunate as it is the section that introduces the concept of EMF.

Areas of the syllabus that did cause candidates some problems are mentioned below:

- resistors in parallel produced 30% of answers that were incorrect

- questions based on the concept of power ie $W=I^2R$ were poorly answered
- the potential divider questions are still resulting in poor answers ie., 22% were incorrect
- capacitor breakdown were poorly answered
- on the matter of inductance almost half the questions answered were incorrect, concepts such as back EMF and turns spacing being misunderstood by candidates
- questions about RMS values were not well answered
- questions involving phasor diagrams were not well answered
- many candidates were of the opinion that a crystal only had one resonant frequency
- almost half the candidates thought the impedance ratio between the primary and secondary of a transformer was the inverse of the turns ratio
- conversion of voltage ratio to dB was poorly answered
- the topic of peak inverse voltage resulted in incorrect answers from many candidates.

4. Transmitters and Receivers

Topics in this section of the syllabus that were not well answered were:

- the part played by a transistor in a VFO circuit
- the nature of direct digital synthesis
- multiplication to get a final frequency
- bandwidth of FM transmissions
- use of resistor/choke to suppress parasitics
- result of overdriving an external power amplifier
- pre-amp reducing dynamic range
- relation between 2nd channel frequency and IF frequency
- source of AGC voltage
- which circuits are shared in a transceiver

5. Feeders and Antennas

Poorly answered subjects were:

- velocity factor
- dimensions of quad antenna
- calculation of SWR from forward and reverse voltages
- return loss

6. Propagation

Questions in this section were generally well answered by candidates but a few topics did give trouble to some:

- Field strength variation with distance from source

- power flux density and its variation with distance from source
- seasonal variation of MUF
- behaviour of D layer
- attenuation of ground wave

7. EMC

Considering that candidates are perfectly entitled to use up to 400Watts of RF assuming they pass this examination, the relatively low value of 58% of correct answers for this section of the syllabus does suggest that more needs to be done in this area by candidates working with their tutors.

Poorly answered topics in this section were:

- sources of second channel interference
- second harmonics in the TV band
- source of direct pick-up in TV video stages
- ferrite rings on hi-fi speaker leads
- passive intermodulation products
- use of ferrite rings on mains leads
- using cigarette lighter sockets as a power source
- whom to consult about interference on a BT phone

8. Operating practices and procedures

The only badly answered questions in this section of the syllabus were:

- the significance of the IARU

9. Safety

There were no significantly badly answered sections in part of the syllabus.

10. Electrical measurements

Poorly answered were:

- Multiplier resistors
- frequency checking devices
- crystal calibrator frequency

Overall conclusions concerning the suite of RCF examinations:

As mentioned earlier in this report one topic that does seem to attract more than its fair share of wrong answers is that of Transmitters and Receivers. Why should this be so; could it be that the topic could be taught in a more effective way?

Both transmitters and receivers bring together a number of concepts that must be understood before their application can be appreciated by the learner. As an example we might take the transmitter:

When considering how to teach something there is a temptation to look at the text book and proceed as it is laid out on the page. This makes the assumption that the learner has a style of learning that matches the book. This is usually not the case, and it is not the fault of either the book or the learner. Also the book may be perceived by the learner to be unclear in certain areas; it may assume that the learner is totally familiar with a particular point, but if this is not the case then learning is hampered and the whole topic is in jeopardy. The learner gives up and trusts to luck that the topic will not affect their chances in the exam too adversely.

Perhaps a more interactive style of learning may suit a greater number of candidates. At Foundation Level, for example, the familiar block diagram of the transmitter could be enlarged and each block separately pasted onto card. Outline to the class the nature of the problems that a transmitter design has to solve:

Very briefly:

- It must generate an electromagnetic wave that will propagate maybe for hundreds or thousands of miles
- Only relatively high frequency e/m waves will propagate for any significant distance. 50Hz is nowhere nearly enough
- Speech frequencies are also far too low to propagate effectively and speech is carried by pressure waves in the air ie., they are not e/m waves
- A way has to be found of launching the e/m wave efficiently (thus introducing feeders and antennas).

Now get the class to consider the various blocks in the transmitter.

- How do we generate an e/m wave? By using an alternating current.
- How do we get an AC of sufficient frequency? By use of an oscillator that works at these relatively high frequencies (ie., one of the blocks).
- How do we convert a pressure wave in air into an electrical signal? By use of a microphone.
- This microphone signal still has a frequency that is far below that required for effective e/m wave propagation
- Is it possible to impress one signal onto another, ie., in some way add the low frequency voice signal from the microphone onto that much higher frequency oscillator signal. Introduce the mixer block.
- However, we can't simply add two signals together and hope for the best. The signal from the microphone is simply at too low a level to make much impression on the carrier, so it (the signal from the microphone) needs to be amplified. Yet another of the blocks.
- To ensure the signal propagates it has to be given more energy and launched properly hence the RF amplifier, feeder and antenna.

Clearly the above is just a brief sketch of one possible approach. By involving the students in making decisions about how to perform the various functions in a transmitter it makes the

whole process more understandable. Simply saying "Learn the diagram in the book", is not enough for most people, I would suggest, to really appreciate what is going on. Understanding RF circuits, particularly, if one has been brought up entirely with DC, is not easy and it needs careful planning to explain properly.

It is hoped that tutors may be able to build on these remarks and give their students the understanding needed to fully enjoy amateur radio.