# Report on RCF Examinations 2009

## Foundation Tally Sheet Analysis and comments on syllabus sections:

As last year the pass rate for the examination showed that the great majority of candidates were able to demonstrate a sufficiently high degree of competency and thus be entitled to a Foundation Licence.

| Syllabus Section | % |
|---|---|
| Nature of Amateur Radio | 90 |
| Licensing conditions | 84 |
| Technical basics | 80 |
| Transmitters and receivers | 76 |
| Feeders and antennas | 84 |
| Propagation | 84 |
| EMC | 83 |
| Operating practices and procedures | 86 |
| Safety | 90 |

%: is the percentage of correct answers shown by analysis of the tally sheets in Foundation Examinations held during 2009.

Although the overall pass rate was good (88%) it has to be borne in mind that the Foundation Examination is just the first stage in obtaining a full licence. The basic principles laid down at Foundation level are there to be built on in future years as the candidate passes through the examination system.

Rather than being content with 'just getting through' perhaps there should be more emphasis on obtaining a higher mark which indicates that learning is both thorough and secure. Having a much clearer picture of the abilities of the candidates sat in front of you is important. It is very disheartening to see from the results for the year that there are candidates getting 10 marks and less in this Foundation examination. Candidates need to be advised of the tutor's opinion of their competency before they decide to enter for the exam. How the tutor arrives at an opinion will be dealt with nearer the end of the report.

### Dealing with elements of the syllabus:

#### Licensing Conditions (84% of answers in this section were correct)

Many candidates did not know that only approved commercial kits could be used for "self-building" projects. Dealing with "pirate" calls also found some candidates struggling for an appropriate answer.

The fact that the Foundation licensee may allow other UK amateurs to operate under their supervision does not seem to have become generally known.

#### Technical basics: (80% of answers in this section were correct)

Perhaps the greatest failing in this section of the examination was the inability by some candidates to handle the conversion of units. For example mV to V and kO to O.

This problem is also seen at Intermediate and at Advanced levels. It is very clear that tutors do need to spend time on this part of the syllabus and make sure that candidates become competent in making these conversions. Being able to handle simple decimal mathematics is important in amateur radio. Tutors and candidates may find the very useful maths primer done by Brian Reay G8OSN to be of help in this matter. It can be found at: http://www.rsgb.org/tutors/advanced/pdf/maths_primer.pdf

Brian's primer goes through the important matter of scaling numbers and how this can be dealt with on an inexpensive calculator.

Other matters coming to light in this section of the examination demonstrated that many candidates were not aware that a filament bulb is not polarity sensitive and 30% of candidates thought that a battery operated radio would work on AC. Some did not know the limits of the HF, VHF and UHF bands.

**Transmitters and Receivers (76% of answers in this section were correct)**

This section of the syllabus still remains the least well answered section in the whole examination. There was, however, no clear pattern of errors emerging to give a clue to where misunderstandings are to be found. Many thought the detector stage picked out the wanted signal.

What is perhaps likely is that candidates at this level try to learn the architecture of transmitters and receivers by remembering the basic building blocks. Being able to understand what the blocks do gives a strong clue to their order. This problem will be addressed later in the conclusion to this report.

**Feeders and Antennas: (84% of answers in this section were correct)**

This section of the examination was one of those that presented most people with few problems. However, there were a number of candidates that did not know which antennas are omni-directional even though this term was defined in the stem of the question.

**Propagation (84% of answers in this section were correct)**

Interestingly one third of candidates thought that at VHF radio waves travelled by ionospheric propagation.

**EMC (83% of answers in this section were correct)**

About half of candidates did not understand what the term "direct pick-up" meant, and a minority did not appreciate the different functions of the mains and RF earths.

**Operating practice and procedures (86% of answers in this section were correct)**

This particular section was well answered and no common pattern of errors was evident.

**Safety (90% of answers in this section were correct)**

Many candidates were aware that high voltages carry the risk of electric shock and even electrocution, a sizeable minority thought that high currents do too, though they realised that they also carry the risk of overheating and fire.

**Intermediate Tally Sheet Analysis and comments on syllabus sections:**

| Syllabus section | % |
|---|---|
| Licences and Callsigns | 82 |
| Licence conditions | 86 |
| Technical basics | 77 |
| Transmitters and Receivers | 70 |
| Feeders and Antennas | 80 |
| Propagation | 78 |
| EMC | 78 |
| Operating practices and procedures | 83 |
| Safety | 91 |
| Construction | 82 |

%: is the percentage of correct answers shown by analysis of the tally sheets in Intermediate Examinations held during 2009.

In September 2009 syllabus changes took place that were designed to make the Intermediate Level Examination a more appropriate introduction to work at Advanced Level. Some of the very simple topics on conductors and insulators were moved down to Foundation and there was the introduction of topics dealing with alternating current. Previously AC had to wait until the candidate embarked upon the advanced syllabus. It is too early to comment on whether or not these changes are having an effect on the overall pass rate of the exam or how candidates are coping with the new topics. In 2009 the overall pass rate was 94%, up a little on last year.

**Looking at syllabus items in more detail:**

**Licences and Callsigns: (82% of answers were correct)**

In callsign questions many errors related to the location suffixes. Many answers showed that candidates were confused by /P. However, it has to be said that the drafters of the licence have not helped in using P (which many associate with "portable") for a temporary location. For fixed locations with a postal address /A is used.

In questions on licensing conditions it was clear that beacons and unattended operation caused difficulties. With regard to questions on interference, it was the case that a proportion of candidates took the ethical rather than the limited legal view of this issue, assuming that they should avoid interference to any electrical equipment. In this section the question is looking for the answer given in the Licence which is to avoid undue interference to other wireless telegraphy (clause 7(3).

**Technical basics (77% of answers were correct)**

Candidates are still having difficulties with sub-units ( micro, nano, pico etc) Also the manipulation of quantities having many zeroes associated with them continue to cause problems.

Ohms Law and Power calculations showed that some candidates were confused over when to multiply and when to divide. This shows that basic arithmetical processes are not well understood by more than a few candidates. Clearly answering questions where these fundamental processes are inherent is going to result in wrong answers. Tutors can help here in making sure that their students are happy with these fundamentals. More of this later.

**Transmitters and Receivers: ( 70% of answers were correct)**

The fact that mixers are non linear devices that therefore produce harmonics was not generally well understood by candidates. In fact one has to ask the question "Do candidates really understand what is meant by a non-linear device?" The 'mixing' of different frequencies to produce sums and differences and harmonics does appear to be worth spending some time on. As a topic it comes into so many different aspects of radio that a better understanding of the process would make so many areas of radio science accessible to more candidates.

In questions about harmonics some candidates quite reasonably assume that the first harmonic is the first one up from the fundamental, hence, the fifth harmonic is six times it. Clearly a case where the naming system is at fault, giving the unwary the wrong impression. This needs to be pointed out to candidates.

On the matter of naming, the word 'detector' is often assumed to be the device that detects the radio signal. The better word 'demodulator' does not cause as many problems.

Many candidates are also convinced that the title 'frequency discriminator' is the circuit that selects the wanted frequency from those nearby. Tutors need to be aware of these confusing expressions and be prepared to explain their real meaning to students. Perhaps radio needs to take a leaf out of the chemists' book. They had similar problems with the naming of compounds. Rather than struggling on and putting up with confusion they developed a new logical naming system that is used today. When a chemist names a compound its structure is immediately apparent.

**Feeders and antennas: (80% of answers were correct)**

Generally well answered but a surprising 40% of candidates did not understand the word "concentric" as applied to feeders.

**Propagation: (78% of answers were correct)**

There were no generally applicable comments to make in this section of the examination. Misunderstanding was scattered throughout the topic.

**EMC: (78% of answers were correct)**

Absorption wavemeters seem to be a cause of some confusion. One third of candidates thought they could not be used for detecting harmonics. Also the significance of the word "direct" in ..."direct pick-up of interference..." was not well understood.

**Safety (91% of answers were correct)**

The very high proportion of correct answers to this section of the syllabus is pleasing to see. However, just how far this section of the syllabus is able to discriminate the competency of a candidate as a radio amateur is open to question.

## Advanced Tally Sheet Analysis and comments on syllabus sections:

| Syllabus Section | % |
|---|---|
| Licence Conditions | 87 |
| Technical basics | 61 |
| Transmitters and Receivers | 62 |
| .Feeders and Antennas | 53 |
| Propagation | 68 |
| EMC | 64 |
| Operating practices and procedures | 79 |
| Safety | 80 |
| 10.Electrical measurement | 67 |

%: is the percentage of correct answers shown by analysis of the tally sheets in Advanced Examinations held during 2009.

**Licence Conditions: ( 87% of answers were correct)**

Generally questions were well answered in this section. What were less well answered were questions relating to the power limits for beacons used in "fox-hunts".

**Technical basics: ( 61% of answers were correct)**

Once again the potential divider and questions relating to T= 1/f were poorly answered. Components used in a power supply also caused some confusion in candidates. Again, as in questions set at lower levels it is apparent that a sizeable minority of candidates still have problems manipulating sub-units and quantities with a number of zeroes associated with them.

Candidates found difficulties with the notion of the turns ratio and impedance ratio in transformers. The ability to discriminate between these two ideas was not commonly found amongst candidates.

The precise meaning of a filter cut-off frequency was poorly understood. This problem occurred in questions relating to syllabus section 3k.1

i.e. 3k.1 Identify the circuits of low pass, high pass, band pass and band stop (notch) filters and their response curves. Understand the concept of the cut-off frequency.

**Transmitters and Receivers: (62% of answers were correct)**

Compared with last year this section of the examination has shown an improvement. There has been an increase of 5% in questions answered correctly. This is a welcome improvement.

Only two matters emerge as requiring general attention. "Key-clicks" and "chirp" were often confused. Also the purpose of a resistor/choke in the base lead of a PA transistor was not always appreciated.

Although candidates have improved in terms of their success in answering questions relating to this area of the syllabus 38% of questions are not answered successfully. There remains the issue of how this area of the syllabus can be taught more effectively. I would strongly recommend tutors to have a look at the 2008 report on one possible approach to teaching this bread and butter topic.

**Feeders and Antennas (53% of answers were correct)**

Topics that were not well answered included velocity factor in solid coaxial feeder (see note), return loss, SWR, field strength and power flux density.

*Note: the syllabus does require candidates to recall that in the case of a coaxial feeder having a solid polythene dielectric its velocity factor is 2/3.*

It is suspected that wrong answers to questions on "Quad" antennas may have been due to candidates not understanding the meaning of the word "perimeter".

The rest of the syllabus sections did not shed light on any particular sections that were generally not well answered by candidates.

## Overall conclusions on the suite of RCF Radio Communications Examinations

### 1) Knowing the candidate:

Becoming familiar with the strengths and weaknesses of a candidate is important. As remarked earlier in this report there are a number of candidates who seem to be getting results not much better than by randomly guessing the answers. How to gauge the progress of a candidate is something that all tutors no matter how competent need to address. How much learning is actually going on in a class is something that should be monitored continually.

There are three major ways of doing this

- Setting and marking homework: certainly this can be a chore, but the effort put into it by the tutor and students is well rewarded. Opening the next lesson in the teaching scheme with about 10 minutes spent on going through homework is a good idea. Engage the students in discussion about the questions. Try to encourage a frank discussion of the difficulties they have encountered. This period can be very revealing and it is important to listen to what students say. It could be that your teaching of a particular topic was wide of the mark, or there are underlying problems. For example a student may reveal casually that they have difficulty with fractions. "At school I was no good a maths" is a fairly common remark and one that needs to be addressed.

- Asking questions: this is a real skill that tutors have to cultivate. Asking questions of an individual in a class can be quite off-putting for that person. They may feel embarrassed by their own lack of knowledge or ability to express their ideas clearly. Ask more 'open' questions. These can be disguised by the tutor "wondering out loud" For example:

  At Foundation Level you can use the idea of cutting the various sections of a transmitter into paper blocks. Each student is given an envelope that contains all the paper blocks they need to make a transmitter. Set the scene: " A transmitter has to in some way convert the sound waves human beings use to communicate into radio waves that are in some way carrying the sound of their voice over thousands of miles".

  "We are going to need something to change sound waves into an electrical signal"

  "Is there anything inside your envelope that may do that?". Hopefully someone will suggest using a microphone. As they answer look around the class and observe the faces of the rest of the class. You can tell a lot about how your lesson is progressing by looking at the reactions of those in front of you. Are they keen and interested; in which case carry on. Are they bored and disinterested? If so step up the pace, change the subject, ask more direct questions, crack a joke or suggest a break for a cup of tea!

  Also sitting down in front of a class is not a good idea. Stand up, move around, even move to the back of the room to make the students turn around to produce a mild discomfort. All these ploys keep their attention on you and what you have to say.

- Stimulating discussion: This can often be started with saying something that is perhaps mildly contentious. " A mixer: does it really mix or is there more to it than that?" Then pause. Someone may take the bait and proffer an answer. More often there is silence, an unwillingness to proffer an answer that might be seen as 'silly'. Offer further comment "Mixers don't mix like mixing a pudding." Pause again. If that still produces silence then ask for help. "Come on, help me. I am trying to get my head around all this mixing stuff and you sit there watching me struggle!"

All this may seem pointless and nothing to do with radio. Yet it is how people learn. Learning is not a passive process but highly dynamic. You have to engender a feeling of confidence in your students and get them to understand that perhaps they can teach you something if they play along and take a part in the discussion. Over the duration of the course this will grow and your teaching will be more rewarding and your students more successful.

Take care to avoid the situation when someone answers a question and the answer is completely wrong. Always avoid saying "No" or "That's not right" Certainly pick up on the wrong answer and sensitively explain the reason why it is wrong. Invite the person to think again, and invite a further answer.

**2) Setting the pace:**

Sometimes tutors are forced into a situation where material has to be covered in limited time. Foundation courses that are run over the course of a weekend may suit tutors and some candidates. What is less certain is how much time can be spent on key topics such as technical basics. Yes the candidate may well emerge on Sunday afternoon with 20 out of 25 in the exam, enough to qualify for a licence. But how much have they really understood and can build on as they move up the system towards the eventual goal of a full licence?

It may well be that there is simply no option for many, it's that or nothing. In such circumstances forward planning is vital. Apart from the mundane arrangements for the exam itself, catering arranging the venue etc there is the matter of planning the course. Who will teach what, for how long, what are the key ideas, how will the time be broken up? Building time in for discussion and revision is important. Remember that the syllabus is simply a list of what will be examined. A scheme of work is much better in determining the order in which things are taught.

The idea behind a scheme of work should perhaps be explained. The order in which material is taught is most important. It would not be a good idea, for example, to teach Ohm's Law without first making sure that your students understood the ideas of potential difference, current and resistance. Earlier in the report mention was made of the mixer and the fact that it behaves as a non-linear device. Clearly at Intermediate Level the syllabus makes no mention of a "non linear device". Yet to appreciate the mixer even a basic understanding of what the term "non-linear" means and how it can produce harmonics would be most helpful to the student. A very simple optical analogy of a non linear device is a magnifying glass. Placed at the correct distance away from a newspaper the letters are enlarged yet retain their clarity. Move the glass a little further away to gain even greater magnification and the image becomes distorted introducing non linearity. Certainly not a perfect model, you can no doubt think of better examples, yet it does give something of the flavour of the problem and the student is not left in a void wondering how these harmonics can come about in a mixer.

A scheme of work would have the basics of a non linear device built into it before dealing with mixing. This way candidates get a fuller picture and are more likely to be able to answer questions dealing with mixing more confidently and accurately.

**3) Useful teaching aids:**

Imagine the scene.

The tutor sits at the front of the class, lolls back in his chair and speaks in a monotone voice. One whiteboard behind him is used to show PowerPoint slides, the other remains unused. His voice drones on and from time to time he points to a slide with a laser pointer. This lasts for half an hour and then the class disperses. Fortunately his class are well behaved and a riot doesn't take place. With a bit more thought the tutor could have been more effective:

Power Point: certainly up to a point.

Power point does not teach anything: you do that! It should only be used to summarise the main ideas. Using other people's presentations is not always a good idea. What is on the slide is what they want to say; not what you want to say. That is an important difference. Use slides sparingly and make them yourself if possible. Your teaching style is unique; don't let slides etc dominate it.

Using a whiteboard: yes.

Make full use to write down ideas, quick diagrams, etc Make notes short and to the point

Refer to a textbook: yes.

Use it as a source for homework. Read the text book and do the questions on the sheet.

Demonstrations: yes.

A quick simple demonstration of a principle is a powerful learning tool because not only does it demonstrate the point you want to emphasise and explain it is very useful for generating discussion. While you demonstrate, watch the class and listen to their comments. Pick up on their comments to reinforce or correct their ideas.

Finally:

There does seem to be a problem with the mathematical aspects of amateur radio. Being familiar with decimal values and being able to manipulate them does cause a considerable number of candidates a problem. Assuming time permits both at Intermediate and Advanced levels a complete teaching session spent on mathematics is not wasted. Being able to deal with fractions, as in parallel resistors etc is important. Similarly being able to manipulate equations, moving quantities from one side of the equals sign to the other is important. It is well worth investing time in finding out exactly what mathematical ideas your students really do understand. Another reason for having a discussion with your class! At least you then have a baseline from which to start. Some tutors don't see this as their role. However, by taking it on you may be doing that student a real service that can boost their confidence not only in amateur radio but in other aspects of their life.

A report on examinations does beg many questions. Perhaps what tutors would really like to know is what the RCF as the awarding body could do better to help them teach their students more effectively? A more knowledgeable amateur is much more likely to stay in amateur radio as they will have the tools to satisfy their own curiosity by reading, thinking and experimenting; all good reasons for having a radio amateur licence and perpetuating this amazing hobby.