Supplementary Submission to CASA's 29 October response to my 12 October submission on the ATSB findings of the ditching of the Westwind II VH-NGA off Norfolk Island on 18 November 2009 this report is submitted under Parliamentary Privilege

I thank the Committee for allowing me the opportunity to respond to CASA's response to my 12 October submission.

I thank CASA for responding and I make the following comments on CASA's 29 October submission that I am giving false evidence and misleading the Senate.

5.1.1 In the Executive Summary of Mr Aherne's submission he makes the following statements:

THE ATSB AND CASA NEVER INTENDED THE SPECIAL AUDIT TO BE IN THE PUBLIC ARENA. THE ACCIDENT THEY [DOMINIC JAMES AND KAREN CASEY] WERE INVOLVED IN IS NOW THE VEHICLE TO UNCOVER DELIBERATE OMISSION OF SAFETY CRITICAL INFORMATION BY BOTH THE ATSB AND CASA.

CASA IN TURN, DID NOT RESPOND AS A DIRECTLY INTERESTED PARTY THAT SIGNIFICANT DEFICIENCIES WITH THE OPERATOR AND ITS MANUAL EXISTED AT THE TIME OF THE ACCIDENT. THE CASA SPECIAL AUDIT IDENTIFIES MANY DEFICIENCIES AND BY CASA KNOWINGLY ALLOWING THE ATSB STATEMENTS THAT THE OPERATORS' PROCEDURES AND MANUALS COMPLIED WITH THE REGULATIONS IS INTENTIONAL, DELIBERATE AND HAS OMITTED OVERSIGHT DEFICIENCIES WHICH HAVE AN ADVERSE AFFECT ON SAFETY OF THE TRAVELLING PUBLIC AND THEIR CONFIDENCE IN OUR AVIATION SAFETY ADMINISTRATION.

5.1.2 CASA may comment on Mr Aherne's submissions in relation to these issues in a further appearance before the Committee and/or in a further supplemental submission.

The Special Audit was never meant to be in the public arena. Ms Casey's original request had to be made under Freedom of Information. If it was available in the public arena, Ms Casey would not have to make an FOI request.

One of the many deficiencies I highlighted in my submission is that there was no methodology in the CASA accepted Operations Manual for the operator to meet the regulations, to calculate OEI and depressurisation. This was raised as an RCA. I will be keen to see CASA's written responses to the Directly Involved Party process that CASA informed the ATSB of the ATSB statements that the Operators Procedures complied with the regulations was factually incorrect.

CASA as a Directly Involved Party is obliged to correct factually incorrect statements.

2. Critical Safety Issue

The change of a Critical Safety issue from one of intolerable risk to Minor Safety issue demonstrates both ATSB and CASA agreed in 2010 that the lack of regulation and guidance was intolerable. That it was changed to minor is something only the committee will be able to examine why

5.2.2 Mr Aherne is inferring that it is impossible for the ATSB to change its position. He incorrectly and misleadingly states that CASA agreed with the ATSB's initial classification that the matter was a critical safety issue. This was not the case.

5.2.3 In accordance with the terms of the MOU the ATSB advised CASA of its preliminary view. CASA did not agree with that position and following an exchange of letters and two meetings with CASA Standards Division, CASA understands the ATSB revisited its risk assessment with the result the issue was reclassified.

5.2.4 CASA rejects Mr Aherne's unsubstantiated assertion that there was in any way inappropriate action by CASA in this regard.

CASA at 5.2.2 have incorrectly apportioned inference to my raising this issue. I am not incorrect and I have not mislead the Senate. I refer the author of this CASA response to the ATSB letter below dated 26 February 2010 to CASA which clearly states both CASA and ATSB agreed with the classification.

I expect the CASA author to retract 5.2.2 of their response that I have mislead the Senate.

Australian Government

Australian Transport Safety Bureau

26 February 2010

Accident Investigation Liaison Unit
Civil Aviation Safety Authority
GPO Box 2005
Canberra ACT 2601

Dear

AO-2009-072 – Ditching – 3 NM south-west of Norfolk Island Aerodrome – 18 November 2010 – Westwind, registered VH-NGA - Critical Safety issue

I refer to the meeting between officers of the Civil Aviation Safety Authority (CASA) and Australian Transport Safety Bureau (ATSB) that took place by video conference on 3 February 2010, and agreed that a critical safety issue existed in respect of the lack of regulation or guidance for pilots when exposed to previously unforecast meteorological conditions on long flights to destinations with no nearby alternates. An outcome of that meeting was that a number of the CASA participants indicated that they understood the issue, and that it should be progressed with CASA management.

Subsequently, on 12 February 2010, you rang the investigator in charge of the ATSB safety investigation, and requested a supporting letter that described the critical safety issue and requested CASA's assistance in its resolution. In later telephone calls to me, you suggested that the receipt of this letter would allow you to 'kick-start' CASA's consideration of, and response to the issue.

3. CASA response to the ATSB report

There are significant deficiencies in the regulations and Aeronautical Information Publication (AIP). Regulations only require pilots to hold alternates on forecasts, and the AIP also states forecast whilst en-route NOT on reports or observations. Only at the flight planning stage does the AIP consider forecasts and reports for alternates. Yet, there is NO change being anticipated in CASA's response to the regulations or AIP. (See later discussion for more information)

5.3.2 CASA is aware of the differing views of pilots regarding the planning requirements and the guidance given in the Aeronautical Information Package (AIP) in relation to in-flight diversion. However, Mr Aherne's statement that no change is anticipated in CASA's response to the regulations or AIP is misinformed and incorrect.

5.3.3 Mr Aherne's arguments, like Mr Quinn's, relating to providing for alternates revolve around planning criteria and forecasts. They weave an elaborate web that rests on the premise that at no time during the preparation for or execution of the flight of 18 November 2009 was Mr James required to consider the possibility of planning for or diverting in flight to an alternate.

5.3.4 What Mr Aherne and others have failed to draw to the Committee's attention are the *operational requirements* contained in the AIP, the wording of which has been consistent over a number of years, and reads:

> **DIVERSION TO AN ALTERNATE**
>
> **The pilot in command is responsible for taking appropriate diversion action based on information received. The pilot must provide the latest diversion time from the destination or from a point en-route and, if required the time interval.**

5.3.5 CASA is finalising the new Civil Aviation Safety Regulations and expects these will be completed and made by the end of the first quarter of 2013. Three months before the accident CASA initiated an internal project to examine all aspects of fuel planning and its relationship to inflight decision making. Finalisation of this work is critically dependent on the receipt of associated International Civil Aviation Organization (ICAO0 Standards and Recommended Practices, now expected by the end of November 2012. CASA intends to draft Civil Aviation Orders and guidance material which will include amendments to the AIP.

On CASA's 5.3.3 asserting Mr James did not consider an alternate. The TAF he had for Norfolk Island did not require an alternate and he had a valid TAF for Fiji for the flight period. I would not say this is an elaborate web, it is operational flight planning.

In relation to 5.3.4 Mr James had the Latest Safe Diversion Point for Fiji at around 0840 UTC. He complied with that procedure quoted by the CASA author. CASA continue to fail to comment on the EN ROUTE section of the AIP which only requires IFR flights to have an Alternate if the forecast conditions dictate an alternate needs to carried. Please re-read my first submission and see below:

AIP ENR 73 – *Alternate Aerodromes* section 73.2.12 required the pilot of an IFR *aircraft to provide* for a suitable alternate aerodrome when arrival at the intended destination would be during the currency of, or up to 30 minutes prior ***to the forecast commencement of any*** of the following weather conditions:

d. cloud - more than SCT [4 OKTAS] of cloud below the alternate minimum[39]...; or

e. visibility - less than the alternate minimum[36]; or

f. visibility – greater than the alternate minimum, but the forecast is endorsed with a percentage probability of fog, mist, dust or any other phenomenon restricting visibility below the alternate minimum[36]; or

g. wind - a crosswind or downwind component more than the maximum for the aircraft.

The email circulated by the Senate Comittee on 22 October authored and cc'd in by very senior CASA Officers supports my assertion in my first submission that the AIP is badly written. CASA may also need to look at the CAR which requires alternates be carried only on forecasts.

In response to CASA's statement at 5.3.2, I have not seen any evidence in CASA's response to the ATSB report that the regulations and AIP is being amended. If CASA can find anywhere in their ATSB response the AIP is being amended, I will happily stand corrected.

I also note CASA put out at Notice of Proposed Rule Making in July 2010. I note they acknowledge the lack of regulatory guidance in the CAO 82.0, yet they do not acknowledge how this affected other flights to Norfolk Island as detailed in the ATSB 2004 research paper, or 2009 requirements on Mr James flight.

I also acknowledge CASA's intent to change the regulations in their June 2012 response. Yet the Critical Safety Issue was raised in February of 2010, and nothing has changed. Whilst I publicly acknowledged in my testimony the difficulty CASA has with the Attorney Generals Department Legal Drafting Service backlog, it is not good enough to have intent to change. CASA has a history of this "intent to change" and this is merely a diversionary statement away from what has taken far too long to change.

I have cut and pasted CASA's Safety Action response taken from the ATSB report.

Civil Aviation Safety Authority

Fuel planning and en route decision-making

Minor safety issue

The available guidance on fuel planning and on seeking and applying en route weather updates was too general and increased the risk of inconsistent in-flight fuel management and decisions to divert.

Action taken by the Civil Aviation Safety Authority

During this investigation, the ATSB and Civil Aviation Safety Authority (CASA) have had a number of meetings in respect of the general nature of the available guidance and its possible influence on the development of this accident. In response, in July 2010 CASA issued Notice of Proposed Rule Making (NPRM) 1003OS, section 3.3.4 of which stated:

CASA also intends to review Civil Aviation Advisory Publication (CAAP) 234-1 relating to fuel requirements. This review is being undertaken in two phases: the first to enhance the guidance for fuel planning and in-flight fuel-related decision making on flights to remote destinations (including remote islands); and secondly a holistic review of guidelines for fuel and alternate planning.

In addition, NPRM 1003OS proposed changes to the requirements for the carriage of fuel on flights to remote islands. The proposed changes affected Civil Aviation Order (CAO) 82.0 and included:

- Designating Cocos (Keeling) Island as a 'remote island'.
- Removing the provision that allowed an operator not to carry fuel for diversion to an alternate aerodrome if the operator's operations manual allowed such a procedure.
- Amending the definition of 'minimum safe fuel' to require the calculation of fuel for diversion to an alternate aerodrome in the event of a loss of pressurisation coupled with the failure of an engine, in addition to either of the individual failures.
- A requirement that a pilot in command who is subject to a condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island must nominate an alternate aerodrome.
- Extending the condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island to passenger-carrying aerial work and regular public transport flights.
- Providing for CASA to be able to approve an operator not to comply with a condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island, subject to conditions that would not adversely affect safety.

On 25 June 2012, CASA advised that amendment 36 to International Civil Aviation Organization (ICAO) Annex 6, State Letter AN 11/1.32-12/10 detailed a number of new Standards and Recommended Practices (SARP) in regard to fuel planning, in-flight fuel management, the selection of alternates and extended diversion time operations (EDTO). In this respect, CASA provided the following update:

• CASA intends to review Civil Aviation Advisory Publication (CAAP) 234-1 relating to fuel requirements. The ICAO fuel and alternate Standards and Recommended Practices (SARPs) are the basis of these changes and will be coordinated by CASA project OS09/13. While this project will focus specifically on passenger-carrying commercial flights the project will also be reviewing fuel requirements generally. The project will now be conducted in four phases. The first three phases will involve amendments to the relevant Civil Aviation Order (CAO) applicable Civil Aviation Advisory Publication (CAAP) 234-1 and Civil Aviation Regulation (CAR) 234. The project objectives are as follows:

– Phase 1 will involve amendments to the relevant CAOs and a review of CAAP 234-1 for flights to isolated aerodromes in light of the ICAO amendments. This phase will encompass fuel and operational requirements for flights to isolated aerodromes and will also consider the provision for flight to an alternate aerodrome from a destination that is a designated isolated aerodrome. The CAAP 234-1 will also be expanded to provide guidance and considerations necessary for flights to any isolated aerodrome, in particular when, and under what circumstances, a pilot should consider a diversion.

– Phase 2 will involve amendments to the relevant CAOs and further review of CAAP 234 in light of the ICAO amendments. This phase will encompass regulatory changes related to the implementation of general fuel planning, in-flight fuel management and the selection of alternate aerodromes. This review will include the methods by which pilots and operators calculate fuel required and fuel on-board.

– Phase 3 will involve amendment to CAR 234 to specify that the pilot in command, or the operator, must take reasonable steps to ensure sufficient fuel and oil shall be carried to undertake and continue the flight in safety. In addition, for flights conducted in accordance with Extended Diversion Time Operations (EDTO), CAO 82 and CAR 234 shall be amended to require consideration of a "critical fuel scenario" taking into account an aeroplane system failure or malfunction which could adversely affect safety of flight. It is anticipated that the methods chosen by the pilot-in-command and operator will therefore be sufficient to meet the requirements of CAR 234 to enable a flight to be undertaken and continue in safety.

– Phase 4 will involve the publication of internal and external educational material along with conducting briefings where necessary.

and that:

The amendment to the ICAO Annex 6 standards will be considered, and where appropriate, incorporated into the relevant legislation/advisory publication. In addition it is anticipated that there will be guidance material for operators who can demonstrate a particular level of performance-based compliance. The intent is to provide a bridge from the conventional approach to safety to the contemporary approach that uses process- based methods and Safety Risk Management (SRM) principles.

The ICAO Fuel and Flight Planning Manual are reflected in the SARP to Annex 6. Inclusion of the provisions of the Amendment 36 SARPs will be captured throughout this project. The ICAO SARP becomes effective from November 2012.

CASA will endeavour to make the changes as soon as possible - subject to third party arrangements such as drafting and resource availability. However the timing of the CAR changes will be subject to a timetable that is not necessarily able to be controlled by CASA.

5.3.6 Any inference that flights in the aerial ambulance category are operating at high risk is misinformed and misleading. Immediately following the accident CASA audited all aeromedical operators and confirmed that operations manuals were appropriate for these flights.

5.3.7 In the same section of his submission, at page 7, Mr Aherne makes the claim at point 2:

IF THE OPERATOR HAD TO COMPLY WITH THIS FLIGHT AS A CHARTER, THE OPERATION COULD NOT BE CONDUCTED IN A WESTWIND AS IT IS NOT CAPABLE OF UPLIFTING ENOUGH FUEL TO HOLD AN ALTERNATE FOR NORFOLK ISLAND ON A FLIGHT FROM SAMOA

5.3.8 CASA has examined the operations of Pel-Air Westwind aircraft into and out of Norfolk Island between February 2003 and November 2009. Over that period 78 flights transited Norfolk Island with only four arriving without the fuel on-board to divert to Noumea (Tontouta). Mr James was the pilot-in-command on two of these four occasions, including the flight on which the ditching occurred. Three of the 78 flights departed Apia, and the only pilot-in-command who did not fully fuel the aircraft was Mr James on the night of 18 November 2009.

5.3.9 Given the evidence it is apparent that company pilots were carrying alternate fuel when transiting Norfolk Island. Only Mr James on the night of the ditching considered it unnecessary to fully fuel the aircraft for a flight from Apia to Norfolk Island.

In response to CASA statement at 5.3.6 that flights in the aerial ambulance category are operating at high risk is misinformed and that I have mislead the Senate, I point out the following to CASA:

Descending from LSALT into a black hole using a nite-sun into a non-instrument let down is high risk in any-ones language. Operating on the extremes of an aircrafts performance in marginal weather in pitch black on a no-aid IFR departure might seem low risk to the CASA author in their office, it is nothing other than high risk.

Landing on an unprepared road at night with no fixed road lights in a fixed wing aircraft, with little or no margin for error on some occasions is high risk. Aerial ambulance in aerial work category is subject to high risk. I am not misinformed I have much experience performing these tasks and I have certainly not mislead the Senate and expect CASA to retract that statement.

In response to CASA's statement at 5.3.8, they quote 78 flights, it is actually 77 and they quote 73 <u>irrelevant flights</u> via Norfolk Island from other departure aerodromes and only four applicable flights arriving at Norfolk Island from Samoa.

I made the assertion that it is not possible to uplift the fuel (even at the Flight Planning stage) <u>ex Samoa and arrive at Norfolk Island</u> with <u>enough fuel for an alternate</u>. I Suggest CASA read the submission of Mr Richard Davies and re-read their own findings in the CASA Special Audit, (see below)where the three flights CASA has now quoted, did not carry enough fuel (2363 lbs) to transit to Noumea. Note the September and October fuel figures were almost full tanks ex Samoa and the flights have only 1800 and 1500 lbs not the 2363 lbs required to reach Noumea.

Fuel Policy and Practice
&
Elements of Flight Planning and In-Flight Operations during Changing Meteorological Conditions

A review of the fuel history of flights conducted by Pel-Air Aviation Pty Limited into Norfolk and Christmas Islands was conducted. Pel-Air Aviation Pty Limited provided a print-out of the fuel figures for all flights that had landed at Norfolk and Christmas Islands from 2002 to the time of the audit. This information was spot-checked for accuracy against the aircraft flight records and found to be accurate. Pel-Air Aviation Pty Limited also supplied the fuel required to fly to the nearest alternate. For Norfolk Island this was stated as 2363 lbs and for Christmas Island this was stated as 1842 lbs. No flights to Christmas Island landed with less fuel than that required to divert to an alternate. Since the formation of Pel-Air Aviation Pty Ltd, there were three flights that landed at Norfolk Island with less than alternate fuel as follows:

Date	Type	Rego	Pilot	Depart	Fuel To	Fuel Burn	Fuel on Landing
30/9/09	Westwind	VH-NGA	James	Apia	8700	7200	1500
5/10/09	Westwind	VH-NGA	Meyer	Apia	8700	7000	1800
18/11/09	Westwind	VH-NGA	James	Apia	7200	7200	0

I expect the CASA author to retract the statement I have mislead the Senate.

I have inserted the AAT documents supplied to Mr James by CASA below.

Flight Date	A/C Rego	Captain	Departure Port	Arrival Port	Fuel On Board	Fuel Burn	Fuel Remaining
28-February-2003	VH-AJJ	BATES N	YSSY	YSNF	8710	4100	4600
21-March-2003	VH-NGA	COCKLE D	YSSY	YSNF	8910	4910	4000
27-March-2003	VH-AJJ	BOWLY M	YSSY	YSNF	8000	3600	4400
30-June-2003	VH-AJJ	SPURRS A	YSSY	YSNF	8700	3300	5400
31-December-2003	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3900	4800
20-January-2004	VH-AJJ	SLATTER J	NSTU	YSNF	8700	6700	2000
20-January-2004	VH-AJJ	SLATTER J	YSSY	YSNF	8700	3500	5200
02-April-2004	VH-AJJ	BOWLY M	NFNF	YSNF	8700	3840	3860
02-April-2004	VH-AJJ	BOWLY M	YSSY	YSNF	7100	3300	3800
21-April-2004	VH-AJJ	SPURRS A	YSSY	YSNF	8710	3910	4800
21-May-2004	VH-AJJ	BATES N	YSSY	YSNF	8600	3400	5200
09-July-2004	VH-AJJ	FLEMING D	YSSY	YSNF	8710	3910	4800
19-July-2004	VH-AJJ	MEYER W	YSSY	YSNF	8650	4250	4400
29-July-2004	VH-AJJ	MEYER W	YSSY	YSNF	8700	2900	5800
31-August-2004	VH-NGA	SPURRS A	NFFN	YSNF	8700	4900	3800
15-December-2004	VH-NGA	MEYER W	YSSY	YSNF	8900	4500	4400
28-December-2004	VH-AJJ	SLATTER J	YSSY	YSNF	8610	3210	5400
06-January-2005	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3100	5600
21-January-2005	VH-AJJ	SPURRS A	NFFN	YSNF	8700	4000	4700
25-January-2005	VH-AJJ	SPURRS A	YSSY	YSNF	8700	2000	4700
25-January-2005	VH-NGA	MEYER W	YSSY	YSNF	8700	4300	4400
10-February-2005	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3600	5100
02-March-2005	VH-NGA	SLATTER J	YSSY	YSNF	8900	4200	4700
13-March-2005	VH-AJJ	SLATTER J	YSSY	YSNF	7170	3570	3600
27-March-2005	VH-AJJ	SLATTER J	YSSY	YSNF	7100	3500	3600
12-June-2005	VH-EEB	JACKLIN G	NSTU	YSNF	9000	6500	2500
21-June-2005	VH-NGA	SLATTER J	YSSY	YSNF	8400	3300	5100
24-June-2005	VH-AJJ	BIAL A	YSSY	YSNF	8700	3500	5200
12-August-2005	VH-AJJ	BIAL A	YSSY	YSNF	8710	3710	5000
16-October-2005	VH-NGA	BIAL A	YSSY	YSNF	8700	4000	4700
03-December-2005	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3600	5100
30-December-2005	VH-AJJ	SLATTER J	YSSY	YSNF	7800	3700	4100
05-January-2006	VH-AJJ	MEYER W	YSSY	YSNF	8710	3310	5400
27-February-2006	VH-AJJ	BOWLY M	YSSY	YSNF	8710	3410	5300
20-May-2006	VH-AJJ	BIAL A	YPAD	YSNF	8700	5300	3400
06-June-2006	VH-AJJ	MEYER W	NFNA	YSNF	8700	4400	4300
23-June-2006	VH-SLD	NOWLAND P	YSNW	YSNF	5800	2700	3100
05-July-2006	VH-NGA	MEYER W	YSSY	YSNF	8710	4100	4600
08-July-2006	VH-AJJ	ARNOTT D	YSSY	YSNF	8700	3500	5200
17-July-2006	VH-SLD	MIROW C	NFFN	YSNF	5600	3800	1800
02-October-2006	VH-AJJ	BIAL A	YSSY	YSNF	8710	3500	5200
14-October-2006	VH-AJJ	BIAL A	YSSY	YSNF	8210	3910	4800
24-October-2006	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3500	5200
27-November-2006	VH-AJG	HAILES C	NFTF	YSNF	8200	5600	2600
01-December-2006	VH-AJJ	HAILES C	YSSY	YSNF	7169	3169	4000
02-December-2006	VH-KNU	POWELL B	YSCB	YSNF	8400	3800	4600
14-December-2006	VH-AJJ	MEYER W	YSSY	YSNF	8710	3410	5300
16-December-2006	VH-AJJ	BOWLY M	YSCB	YSNF	8700	3800	4900
16-December-2006	VH-NGA	POWELL B	NFNA	YSNF	8700	4300	4400
17-December-2006	VH-NGA	BOWLY M	YSSY	YSNF	8700	4100	4600
19-January-2007	VH-AJJ	BOWLY M	YSSY	YSNF	8700	3700	5000
25-April-2007	VH-AJG	BIAL A	NSFA	YSNF	8700	6100	2600
26-June-2007	VH-NGA	MEYER W	NFFN	YSNF	8700	4700	4000
18-August-2007	VH-NGA	BOWLY M	YSSY	YSNF	8710	2990	5720
19-October-2007	VH-KNS	POWELL B	YSSY	YSNF	8600	3700	4900
28-October-2007	VH-NGA	BOWLY M	NFNA	YSNF	8700	5000	3700
30-October-2007	VH-AJG	BADHAM S	YSSY	YSNF	7100	3600	3500
15-November-2007	VH-NGA	POWELL B	NFFN	YSNF	8700	5700	3300
28-January-2008	VH-NGA	MEYER W	YSSY	YSNF	7100	3920	3180
03-March-2008	VH-AJV	MEYER W	NFNA	YSNF	8700	4500	4200
15-April-2008	VH-NGA	BADHAM S	YSSY	YSNF	7100	3600	3500
28-June-2008	VH-AJV	MEYER, WALLY	NFNA	YSNF	8700	4500	4200
29-June-2008	VH-AJV	BADHAM, SCOTT	YSSY	YSNF	8700	3500	5200
30-June-2008	VH-SLE	NOWLAND, PAUL	YSNW	YSNF	6000	2900	3100
22-August-2008	VH-AJJ	YOUNG, DEAN	YSSY	YSNF	8700	3400	5300
27-August-2008	VH-AJV	MEYER, WALLY	YSSY	YSNF	8400	3600	4800
21-September-2008	VH-AJV	BADHAM, SCOTT	NFFN	YSNF	8700	4000	4700
03-October-2008	VH-NGA	BADHAM, SCOTT	YSSY	YSNF	8700	3800	4900
10-December-2008	VH-NGA	JAMES, DOMONIC	YSSY	YSNF	8700	3800	4900
18-December-2008	VH-NGA	MEYER, WALLY	YSSY	YSNF	8700	3100	5600
29-September-2009	VH-NGA	JAMES, DOMONIC	YSSY	YSNF	6600	3100	3500
30-September-2009	VH-NGA	JAMES, DOMONIC	NSFA	YSNF	8700	7200	1500
30-September-2009	VH-KNR	MEYER, WALLY	YSSY	YSNF	8800	3300	5500
05-October-2009	VH-KNR	MEYER, WALLY	NSFA	YSNF	8800	7000	1800
07-October-2009	VH-NGA	WINYARD, DAVID	YSSY	YSNF	7200	3500	3700
23-October-2009	VH-NGA	MEYER, WALLY	YSSY	YSNF	8700	3700	5000
19-November-2009	VH-KNR	SANDFORD RICHARD	YSSY	YSNF	8800	4200	4600

The statement by CASA at 5.3.9 is not correct. See Mr Richard Davies submission.

5.3.10 Accordingly, the claim by Mr Aherne is false and misleading, and brings into question the many other claims he makes throughout his submission as to the capabilities of the Westwind aircraft and its suitability to conduct operations in this role.

My claims are true and are supported by Mr Richard Davies extensive fuel calculations using Westwind manufacturers' data and the flight planning requirements of the New Zealand and Fiji AIP procedures for non-RVSM aircraft. If CASA believes the Westwind aircraft is capable of flight-planning outside of RVSM airspace Apia direct to Norfolk Island, then I suggest they carefully examine Mr Richard Davies extensive submission.

I also note the Director of Aviation Safety gave evidence to the Inquiry that:

"I think you would find the Samoan and Norfolk leg has been flown by the Westwind before quite successfully"

To flight plan successfully below the RVSM airspace in place in November 2009 in a Westwind II depart Apia and arrive at Norfolk Island with reserves intact in even moderate westerly winds is impossible.

I do not believe planning a flight contrary to the procedures of Sovereign States AIP is successful. If a flight cannot be planned, it cannot be undertaken.

I expect CASA to retract that I have given false and misleading evidence to the Senate.

5.4.1 On page 10 of Mr Aherne's submission he states:

RECORDS ARE AN INTRINSIC PART OF AVIATION SAFETY, IF THE STATEMENT "THERE WAS NO REQUIREMENT IN THE OPERATIONS MANUAL TO RECORD TRAINING" IS ACCEPTABLE AS EVIDENCE TO THE ATSB, THEN THIS MUST SET A NEW BENCHMARK IN ATSB INVESTIGATIONS AND CASA'S FUTURE AUDITING OF AVIATION OPERATORS WHEREBY OPERATORS CAN JUST CLAIM THE OPERATIONS MANUAL DOES NOT REQUIRE TRAINING TO BE RECORDED, BUT 'PLEASE TAKE OUT WORD THAT THE TRAINING WAS CONDUCTED".

5.4.2 Regulations and Orders specify what documentation an operator is obliged to retain. CASA inspectors routinely audit these records during inspections. Mr Aherne's comment implies that CASA does not or might not audit records appropriately. This is inaccurate and misleading.

In response to CASA's statement at 5.4.2, CASA is misrepresenting what I have stated. I stated that this was acceptable as evidence to the ATSB. The comment reflects that the ATSB have accepted a position that training was not recorded was justified by a statement that there was not a requirement in the CASA accepted Operations Manual for the operator to meet the regulations, to record such training. It demonstrates that the ATSB have accepted a clearly unacceptable practice and that such training should be recorded as required by the Regulations and Orders.

CASA should have alerted the ATSB to that fact in the DIP response.

This statement should be retracted by CASA as I have not mislead the Senate.

5.4.3 In the same section of his submission, at page 11, Mr Aherne makes the statement:

> . . . AS THE CASA SPECIAL AUDIT FOUND THE OPERATOR DID NOT COMPLETE THE IN-FLIGHT NAVIGATION LOGS

5.4.4 This statement is false and misleading. CASA issued the operator with a Request for Corrective Action (RCA) when it found that there were deficiencies in the *retention* of certain documentation not the completion. The completion of the documentation is a crew function.

Regarding CASA's statement at 5.4.4, CASA should read the RCA (below) which was given to Ms Casey via FOI.

Clearly, the RCA was given for crews not completing the in flight navigation log.

I have not made a false statement or mislead the Senate. I expect the CASA author to retract that statement.

Australian Government
Civil Aviation Safety Authority

Request for Corrective Action

Organisation Name:	Pel-Air Aviation Pty Ltd		
ARN:	227573	RCA/Audit Ref #:	321066
Contact Address:	P.O. Box 208 Mascot NSW	Postcode:	1460
Regulatory Reference:	CAR 78 (1) (2)		
Audit Element:	AOC Operations		

Note: *Issue of a Request for Corrective Action (RCA) does not in any way prejudice CASA's prerogative to take at any time such regulatory or other legal action as may be appropriate in the circumstances.*

Details of Deficiency:

A sample of company document packages for international flight was conducted relating to (CAR 78) Navigation Logs. A number of pilots failed to accurately complete a log of such navigational data, retain and/or submit such documents to the company for retention.

Criteria: CAR 78 Navigation Logs (1) (2)

(1) The pilot in command of an aircraft shall keep a log of such navigational data as is required to enable him or her to determine the geographical position of the aircraft at any time while the aircraft is in flight. (2) The log shall be kept in chronological order and, in the case of an Australian aircraft engaged on an international flight, shall include the following information:

Date Issued: 24/12/2009

Response Due: 28/01/2010

Is this RCA linked to a Safety Alert?

☐ Yes ☒ No

CASA Office Address: Sydney Region Office
GPO Box 2005
Canberra ACT 2601

Components as causal factors: (Select only one)

☐ 1 – Management Commitment	☐ 7 – Personnel
☐ 2 – Planning	☒ 8 – Process in Practice
☐ 3 – Management Review	☐ 9 – Internal Audit
☐ 4 – Facility	☐ 10 – Internal Reporting
☐ 5 – Tools, Equipment and Materials	☐ 11 – Investigation
☐ 6 – Data, Information & Records	☐ 12 – Remedial, Corrective and Preventive Action

Signature: ....

Printed Name: ______________

Date :23/12/2009

CASA Office Use Only

File:__________ Folio:__________ Data Entry:__________ Area office:__________

Printed Name:__________ Date Entered: ___/___/___

Signature: __________

5.5 Regulatory Context of the Flight

5.5.1 On page 20 of his submission Mr Aherne states, in relation to the ATSB's conclusion that the Norfolk Island Airport was suitable in all respects, that this is factually incorrect. He then states:

> INFORMATION RECEIVED SUGGESTS THE AERODROME WAS 15 M SHORT OF THE REQUIRED OVERRUN DISTANCE.

5.5.2 This statement is imprecise and misleading and could be taken to mean that the entire aerodrome was below standard in terms of runway overrun.

5.5.3 Norfolk Island Aerodrome is regulated by CASA. The standard for the Runway End Safety Area (RESA) is required under Part 139 of the *Civil Aviation Safety Regulations 1998* to be 90m by 90m from the end of the runway strip. Runway 29 at Norfolk Island can provide a RESA that is 90m wide at the end of the RWY strip and 90m long, but at the far end the corners are tapered inwards.

In relation to the CASA statement at 5.5.2, may I suggest the last audit report of the Norfolk Island Aerodrome be produced and CASA carefully re-read my statement. I did not specify a particular runway (Runway 29) that CASA has quoted, I stated the "Aerodrome was 15m short of the required overrun distance". The ATSB statement is that the Airport was suitable in <u>all respects</u>. The Operators Procedures allowed Mr James to proceed to Norfolk Island as it met its CASA accepted Operations Manual for the operator to meet the regulations requirements of having two independent runways. To use that procedure all runways must meet the overrun distances, not just Runway 29. The information I received indicates non conformity, but will happily stand corrected when CASA can provide the audit.

5.6 Records

5.6.1 On page 22 of his submission, Mr Aherne notes:

> AN OBSERVATION WAS RAISED BY CASA REGARDING THE LACK OF DETAIL IN THE TRAINING FORMS

5.6.2 An Observation is issued by CASA as a means of identifying to the operator that an opportunity for improvement exists. It is not a finding of a regulatory breach. The text of the Observation makes it clear that there was scope to improve the format and content of the relevant Pel-Air form.

In relation to the statement by CASA at 5.6.2 I agree with CASA. It was an observation and I agree with the findings that the training forms do not address all of the training record needs.

5.7 RVSM Procedures

5.7.1 At pages 22-33 of his submission, Mr Aherne argues that, because the aircraft was not RVSM approved, it could not lawfully operate the sector from Apia to Norfolk Island. The merits of this argument were addressed earlier in this document in relation to an identical assertion by Mr Quinn and it will not be re-ventilated here, other than to address Mr Aherne's statement that:

. . . AND THE ABSENCE OF THE REGULATOR TAKING ACTION APPEAR TO BE AN ORGANISATIONAL AND REGULATORY SYSTEMIC ISSUE WHICH WOULD HAVE PREVENTED THIS ACCIDENT. CAPTAIN JAMES WAS DOING WHAT HE WAS TOLD TO AND THIS ROUTE WAS SELECTED BY THE COMPANY ON MANY OCCASIONS

5.7.2 This amounts to a kind of Nuremberg defence. As pilot-in-command of the aircraft, Mr James was responsible for taking into account at the planning stage all pertinent factors that could influence the safe completion of the flight. Had Mr James determined that he had insufficient fuel on-board to complete the flight below RVSM airspace he had other planning options available. Surely Mr Aherne cannot be arguing that Mr James merely acquiesced and proceeded with a flight he knew he could not complete.

In relation to CASA's argument at 5.7.2 about a "kind of Nuremberg defence", I disagree with that statement, it is more indicative of the practical drift of the operation away from the regulations. I agree with CASA that Mr James is responsible for taking into account at the planning stage all pertinent factors that could influence the safe completion of the flight. It is also the responsibility of the Chief Pilot to authorise each flight and the safe operation of the aircraft within the regulations.

Mr James was not the person telling the medical provider a Westwind II could do this operation in their agreement if there was one. It was the operator.

I am not and have not argued Mr James merely acquiesced, I have put forward the argument that there are other factors involved here. Being on a permanent standby for three days, not knowing if you are flying or not, when you should sleep or not sleep. CASA must agree that permanent standby on that basis is not in the interests of any pilot. Mr James had been awake over 12 hours before flight planning commenced. The company had done this route before, in fact, CASA is ignoring that Mr James raised this very issue via email nearly one year before.

The former Chief Pilot and one other did the route in the documents supplied and whilst Mr James must follow the AIP requirements of New Zealand and Fiji, so must all the other pilots which CASA have neglected to highlight in 5.7.2.

I have provided evidence in my submission in the Annex of this operator penetrating RVSM airspace many times in New Zealand, Fiji, Australia and the United States Oakland flight regions in a one month snapshot of April 2003 in the PARMO study.

Is CASA suggesting Mr James flew all those flights too? He was not employed by the operator until 2008. CASA fail to answer if they received correspondence from any Civil Aviation Authorities regarding these non-approved RVSM flights.

If CASA did anything, why did the flights continue? Why does the operators' CASA accepted Operations Manual for the operator to meet the regulations, have an RVSM procedure in a fleet not approved for RVSM?

5.7.3 It would also be difficult for Mr Aherne to argue that on the day the company applied directive pressure on Mr James as the record shows Mr James had not been able to contact the company prior to the flight.

The author of the CASA response seems to have no understanding of the on the run decision making inherent in EMS aviation operations. EMS operations are dynamic, that is, unplanned and unexpected, they tend to migrate to operate on the fringes of acceptable and unacceptable risk.

I draw CASA's attention to the operators' CASA accepted Operations Manual to allow the operator to meet the regulations. I will quote the relevant chapter from Part A:

2.4 OPERATIONAL CONTROL

2.4.1 Flight Authorisation

2.4.1.1 All Company flights shall be authorised by the CP. Authorisation shall be by:
a) The published roster, including amended versions, issued in accordance with Company rostering procedures; or
b) specific 'one-off' approvals authorised by the Pilot in Command.

If CASA and the ATSB had of asked who actually authorised the flight out <u>to</u> Samoa, it was not Mr James. I suggest CASA check the Annex in my first submission in which the Operator ordered the fuel in advance and check the next destination after Samoa.

In accordance with the CASA accepted Operations Manual for the operator to meet the regulations, a SOP states all flights are authorised by the Chief Pilot.

2.4.2 Pilot Contact with Company Operations

2.4.2.1 To facilitate the co-ordination of the daily flying program, the PIC shall contact Company Operations immediately in the event of any aircraft unserviceability or operational problem.
2.4.2.2 The contact numbers to be used are: (withheld)

Mr James complied with the operations manual CASA accepted as the operator meeting the regulations. He identified an operational problem, attempted to contact the company who did not return his call.

He is authorised under 2.4.1.1 (b) to do specific 'one off' approvals. As Mr Richard Davies demonstrates in his submission, to flight plan under RVSM on that route in the Westwind II is not possible. Mr James elected to fly lighter to attempt to get above it or as high as possible to avoid conflicting traffic.

He still carried enough fuel to go with the good forecast he had. As it was done many times before, and with the medical condition of the patient, it appears he had to make a decision on the run.
I have not said Mr James did not make errors, on the contrary, read my Hansard transcript. The following information is taken directly from the operators fatigue training power point slide:

17 hours of sustained wakefulness equals
"Decrease in performance equivalent to
blood alcohol content of 0.05%"

24 hours of sustained wakefulness equals
"Blood Alcohol Content 0.1%"

• 0.05 % BAC
= *Twice as likely to have an accident*
• 0.1% BAC
= *Seven times more likely to have an Accident*

CASA also fail to acknowledge that Mr James fatigue level was at nearly the equivalent of 0.1% when he arrived at Samoa. It is logical to assume his fatigue level was somewhere between 0.05% equivalent and 0.1% equivalent. One would assume that that correlates to somewhere to twice to seven times more likely to have an accident.

I believe that even CASA would argue that permanent standby is not good for any pilot engaged in on the run ad-hoc ambulance operations. Whilst I agree with CASA to flight plan within the rules, they cannot argue that Mr James attempted to seek operational assistance and as none was received was authorised as the PIC to issue 'one off approvals' in compliance with the CASA approved operations procedures. Seeing as the previous Chief Pilot had done this very sector on 5 October 2009 and landed with no fuel available for an alternate, it appears that the company had a prior history of practical drift outside of the regulations and highlighted in the CASA Special Audit.

5.7.4 On page 33 of his submission, Mr Aherne raises the question of entry into New Caledonian airspace. While he mentions the supposed ban on Pel-Air aircraft (which the French authorities refer to as a restriction), Mr Aherne fails to say that, following modifications to certain company aircraft, VH-NGA being one, the French authorities lifted the restriction insofar as it applied to modified aircraft.

CASA asserts in 5.7.4 that I failed to say about modifications to the aircraft. This is clearly incorrect. Here is the exact extract:

"There is also no mention in the ATSB report that the French Civil Aviation Authority had banned the operator from its airspace prior to the accident. Although the operator fitted this equipment, it was not in the Aircraft Flight Manual as a supplement, or a checklist or SOP and the pilot not trained in their use in accordance with the legislation."

Are CASA suggesting that a pilot who is not trained in the ACAS and EGPWS should assume to flight plan into that airspace when not qualified? Mr James was not aware of any ban (or restriction means the same outcome) being lifted.

5.7.5 Mr Aherne also fails to mention that, although Mr James claims not to have been trained on the newly fitted aircraft equipment, clearly that did not dissuade him from nominating Noumea (Tontouta) as the alternate for Norfolk Island on his flight from Sydney the day before he was forced to ditch VH-NGA on the inbound flight from Apia.

CASA asserts Mr James nominated Noumea as an alternate. I have not seen the flight plan lodged, but have only gone on what he reported and what is in the ATSB report from page 2:

"Alternatively, the aircraft carried sufficient fuel to divert to Brisbane, Queensland in case the weather conditions at Norfolk Island prevented a landing."

I have always been under the impression from the ATSB report that Brisbane was the outbound alternate.

If CASA say the flight plan carried Noumea as the alternate, why did CASA not correct this factual error in the DIP process?

I am willing to stand corrected on that assumption of Brisbane as his alternate.

Mr James claim he was not trained in the equipment in the CASA 5.7.5 statement is correct there is evidence of that in the CASA Special Audit:

> A review of crew records as well as interviews with a number of pilots was conducted to confirm that the required training in Airborne Collision Avoidance Systems (ACAS), Enhanced Ground Proximity Warning Systems (EGPWS), Fatigue Risk Management (FRMS) and Crew Resource Management (CRM) had been conducted or renewed at the required intervals.
>
> ACAS had recently been fitted to Westwind aircraft registration VH-NGA. All crew flying the aircraft were required to have completed training listed in CAO 40.0 Para. 5.1. An *air transport pilot licence holder may act as the pilot in command of an Australian aircraft with an activated ACAS only if he has been assessed by an appropriate person in the Training and Checking Organisation, in accordance with its training and checking manual, as meeting the competency standards mentioned in the ACAS syllabus.* It was accepted by the company that this training had not been conducted for the Westwind crew as ACAS had only recently been fitted. The required training has been provided for the SAAB 340 crew however the training is not documented in the Pel-Air Aviation Pty Limited Training and Checking manuals.
>
> ***RCA 321060 has been issued for failure to comply with CAO 40.0 Para 5.1.***

5.8 Analysis

5.8.1 Throughout his submission Mr Aherne is scathingly critical of the ATSB, characterising what he considers to be factual errors as evidence of bias. On page 40 of his submission Mr Aherne make comments about HF radio communications as follows:

At 5.8.1 CASA states I consider factual errors as evidence of bias. I suggest the author of the CASA report read my submission again. The bias is evidenced by outcome bias and confirmation bias. This author perhaps may have no knowledge of contemporary investigation terminology. Information which is useful to form an outcome or to confirm a belief is only demonstrated. Information which shows otherwise, such as the conversations between Auckland Oceanic and the Unicom, the affect of fatigue on delayed decision making, the obvious regulatory failings of the operator and the safety oversight are deliberately removed. These are not factual errors, but deliberate omissions.

THE SPECI WHICH SHOWED CLOUD AT 1100 FEET MAY NOT HAVE BEEN HEARD BY THE CREW DUE TO THE NOTORIOUSLY DIFFICULT EFFECTS OF HF TRANSMISSIONS AND THE IONOSPHERE. WHAT WAS RECEIVED AND RECORDED BY AUCKLAND'S LARGE AERIAL, AND USED AS THE BASIS FOR ATTRIBUTION OF THE FLIGHT CREW MAY NOT BE THE SAME AS WHAT THE CREW HEARD *BECAUSE OF THE AIRCRAFT WHIP ANTENNA.* [EMPHASIS ADDED]

5.8.2 In the following paragraph Mr Aherne recounts the difficulties he has personally experienced receiving HF transmissions *when flying helicopters* fitted with whip antennas.

5.8.3 VH-NGA was fitted with two HF radio systems and utilised a long wire antenna that ran between the mid upper fuselage to a mounting point approximately three quarters up the vertical stabiliser. Long wire HF antennas are commonly found on fixed wing aircraft.

5.8.4 Reference to the transcripts of the crew's HF contacts with air traffic services does not reveal any apparent communications difficulty and in interviews with CASA Mr James has never expressed that there were any HF communications irregularities. The first CASA became aware of Mr James's supposed HF communications difficulties was when he raised it on the recent *4 Corners* television program.

CASA in 5.8.4 they assert that they had not been made aware of the difficulties on the HF reception that night. Mr James and the co-pilot in their ATSB re-enactment both questioned the ATSB investigator when the SPECI was read out.

I believe this occurred after CASA interviewed Mr James in 2009 and was not raised by the ATSB.

(I have attached at Annex A an Australian Government report on the" Introduction to HF Radio Propagation" by IPS and Space Services).

5.10 Analysis

5.10.1 At page 49 of his submission, Mr Aherne states:

IN THIS ACCIDENT, THE PILOT IS SINGLED OUT AS THE ATTRIBUTOR, BUT CLEARLY THE EVIDENCE THE ATSB AND CASA DO NOT WANT PUBLISHED INDICATES OTHERWISE

5.10.2 It is at this point Mr Aherne moves from attempting to deal with what he identifies as factual and methodological issues needing attention to unsubstantiated claims that CASA does not want certain things published. The ATSB had access to all of CASA's documentation regarding its dealings with Pel-Air and was free to utilise that material as it felt it needed to in its investigation of this accident. CASA rejects any assertion that it has acted to supress or keep from the ATSB any information relevant to the latter's investigation. Once again, CASA categorically rejects any assertion or suggestion that it has colluded in any way with the ATSB.

In 5.10.1 CASA claim that the ATSB was free to use any material CASA supplied to it in its investigation. This accident report must represent the most polarised change of the ATSB and the James Reason model quoted by ATSB and the reference to Prof Reason by CASA in their submission.

Did CASA inform the ATSB of the email communications regarding the 50/50 split of CASA's flying operations inspectors in regard to in-flight decision making regarding changing weather?

THE 2014 PROPOSED CHANGE FROM ARIAL WORK FOR AIR AMBULANCE OPERATIONS IS A VISIBLE SIGN OF REGULATORY INCOMPETENCE. THE INDUSTRY HAS HAD ENOUGH OF THE SAME PERSONNEL IN CASA WHO HAVE SURVIVED UNDER VARIOUS DIRECTOR'S PLACING BARRIERS IN THEIR WAY TO KEEP THEIR OWN AGENDAS' AND WHO HAVE WILFULLY OBSTRUCTED SAFETY IMPROVEMENTS BY BLATANT MISTRUTH'S, AND WHO ARE IN MY OPINION INDIRECTLY ATTRIBUTABLE TO THIS ACCIDENT SEQUENCE.

5.10.4 This allegation indicates that Mr Aherne has little or no knowledge of the history involved. While he may be frustrated at what he perceives to be the slow pace of regulatory reform, his unsubstantiated claims that certain individuals in CASA have wilfully obstructed the program are not tenable. Over the last three years, since the Standards Division was re-established, CASA staff have worked tirelessly to progress regulatory reform. It may be of interest to the Committee to know that elements of the aviation industry are now calling for CASA to slow the pace of change and in some cases stop it all together.

CASA assert in 5.10.4 that I have little or no knowledge of the history involved. See my extracts from the 2003 Cape Hillsboro accident report. That report speaks for itself.

I don't call a 2001 decision to think about putting aerial ambulance operations into Aerial Work and determining over 8 years later not to, only to re-invigorate the idea again in 2012 for a 2014 intent as "Working Tirelessly". If CASA do, then that is remarkable.

THE PUBLIC RESPONSE BY CASA WHICH INDICATED THE POST ACCIDENT SPECIAL AUDIT HAD NO RELATIONSHIP OR LINKS TO THE ACCIDENT IS NOW VERY PROBLEMATIC FOR AVIATION SAFETY

ANY FUTURE REGULATORY ACTION BY CASA AGAINST AN OPERATOR WITH SIMILAR CLASSES OF REGULATORY FAILINGS OR BREACHES OF S28 OF THE CIVIL AVIATION ACT, PUTS THOSE OPERATOR' IN A POSITION TO LEGALLY ARGUE THAT CASA TOOK NO ACTION AGAINST AN OPERATOR NOR DID THEY BELIEVE THOSE FAILINGS OR BREACHES CAUSED AN ACCIDENT SEQUENCE

5.10.6 Mr Aherne's assertions are unfounded and ill-informed. CASA treats each case on its merits, and on the basis of the relevant facts and circumstances.

CASA assert at 5.10.6 that I am unfounded and ill-informed. That is not what people in the legal profession are stating.

CASA DOES NOT EVEN APPEAR IN THIS COMPLEX ORGANISATION ACCIDENT. BY WHOM AND AT WHO'S DIRECTION?

5.10.8 Again Mr Aherne is asserting 'skulduggery'. What can be said is that if this were the case CASA was not involved.

At 5.10.8, CASA calls my question asserting "skulduggery". This must be the first time in the history of the ATSB/BASI since the 1993 Monarch Airline accident that CASA had no input into the regulatory oversight inadequacies of the operator and the operator had no bearing on the accident sequence.

If CASA is asserting that the operator and CASA played no part in this complex accident sequence, I draw CASA's attention to the comments of the ATSB Chief Commissioner in the Inquiry hearing where following the question by Senator Edwards:

"Three years in the making. Mea culpa after mea culpa. Are you proud of this report?"

The Chief Commissioner stated:

"No, I am not proud of this report"

5.10.10 As discussed briefly above in responding to Mr Quinn's similarly convenient invocation of 'just culture', we reiterate here that it is a concept meant to adhere within organisations and has no bearing on the relationship between the regulatory authority and the regulated community. As a regulatory authority, CASA is obliged to respond to a far more rigorous and demanding standard: the rule of law and the principles of natural justice. CASA is publicly accountable for all of its actions at multiple levels, including its many appearances before this Committee. CASA would welcome the opportunity to address these issues in a further supplemental submission and/or in a further appearance before the Committee

5.10.11 In his zeal, Mr Aherne misses a significant point, namely, that CASA has no power or authority to prosecute anyone. Those powers reside exclusively with the Commonwealth Director of Public Prosecutions (CDPP). Acting in accordance with CDPP Prosecution Guidelines, CASA may submit a brief of evidence to the CDPP, with a recommendation that a prosecution be commenced. It is the CDPP's decision whether or not to proceed.

5.10.12 There is much confusion, as Mr Aherne's tendentious remarks demonstrate, about the difference between the safety-related enforcement powers CASA may exercise, all of which are reviewable in the AAT or the Federal Court, and criminal prosecutions mounted by the CDPP. And lest the point be lost, it might be noted here that, in this matter, no one—and certainly not Mr James—has been prosecuted for or charged with any offences.

5.10.13 CASA would welcome the opportunity to discuss these issues, and to clarify the matters about which Mr Aherne appears to be quite confused, in a further supplemental submission and/or a further appearance before the Committee.

5.10.11 CASA asserts my zeal to miss a significant point. Whichever way CASA may assert this, the fact is CASA has the ability to submit a brief of evidence for prosecution.

CASA in its zeal was quick to interview Mr James and not caution him that he was giving self incriminating evidence in an interview which CASA had no authority under law (quoted from their enforcement manual)

15.5 Power to Interview

Generally, a person cannot be compelled to talk to an Inspector or to answer any questions put to the person by an inspector. (There are some exceptions to this rule under section 32AJ of the *Civil Aviation Act 1988,* but such exceptions only apply in relation to investigators who are exercising powers under Part IIIA of the Act in accordance with a judicial warrant). Therefore, while every reasonable attempt should be made to conduct an interview in appropriate circumstances, inspectors should not press the matter if a person indicates that he or she does not want to be interviewed

5.10.12 CASA asserts I have made tendentious remarks. Ask Mr James how he feels about CASA's safety related enforcement powers. He couldn't work as a pilot, regardless of how CASA views the situation.

5.10.13 I think it is CASA that is confused. The CASA author should read their own Special Audit findings.

I thank CASA for their response and for the Committee to allow my responses.

Yours sincerely,

Bryan Aherne

Introduction to HF Radio Propagation

1. The Ionosphere

1.1 The Regions of the Ionosphere

In a region extending from a height of about 50 km to over 500 km, most of the molecules of the atmosphere are ionised by radiation from the Sun. This region is called the ionosphere (see Figure 1.1).

Ionisation is the process in which electrons, which are negatively charged, are removed from neutral atoms or molecules to leave positively charged ions and free electrons. It is the ions that give their name to the ionosphere, but it is the much lighter and more freely moving electrons which are important in terms of HF (high frequency) radio propagation. The free electrons in the ionosphere cause HF radio waves to be refracted (bent) and eventually reflected back to earth. The greater the density of electrons, the higher the frequencies that can be reflected.

During the day there may be four regions present called the D, E, F1 and F2 regions. Their approximate height ranges are:

- D region 50 to 90 km;
- E region 90 to 140 km;
- F1 region 140 to 210 km;
- F2 region over 210 km.

At certain times during the solar cycle the F1 region may not be distinct from the F2 region with the two merging to form an F region. At night the D, E and F1 regions become very much depleted of free electrons, leaving only the F2 region available for communications.

Only the E, F1 and F2 regions refract HF waves. The D region is very important though, because while it does not refract HF radio waves, it does absorb or attenuate them (see Section 1.5).

The F2 region is the most important region for HF radio propagation because:

- it is present 24 hours of the day;
- its high altitude allows the longest communication paths;
- it reflects the highest frequencies in the HF range.

The lifetime of free electrons is greatest in the F2 region which is one reason why it is present at night. Typical lifetimes of electrons in the E, F1 and F2 regions are 20 seconds, 1 minute and 20 minutes, respectively.

Because the F1 region is not always present and often merges with the F2 region, it is not normally considered when examining possible modes of propagation. Throughout this report, discussion of the F region refers to the F2 region.

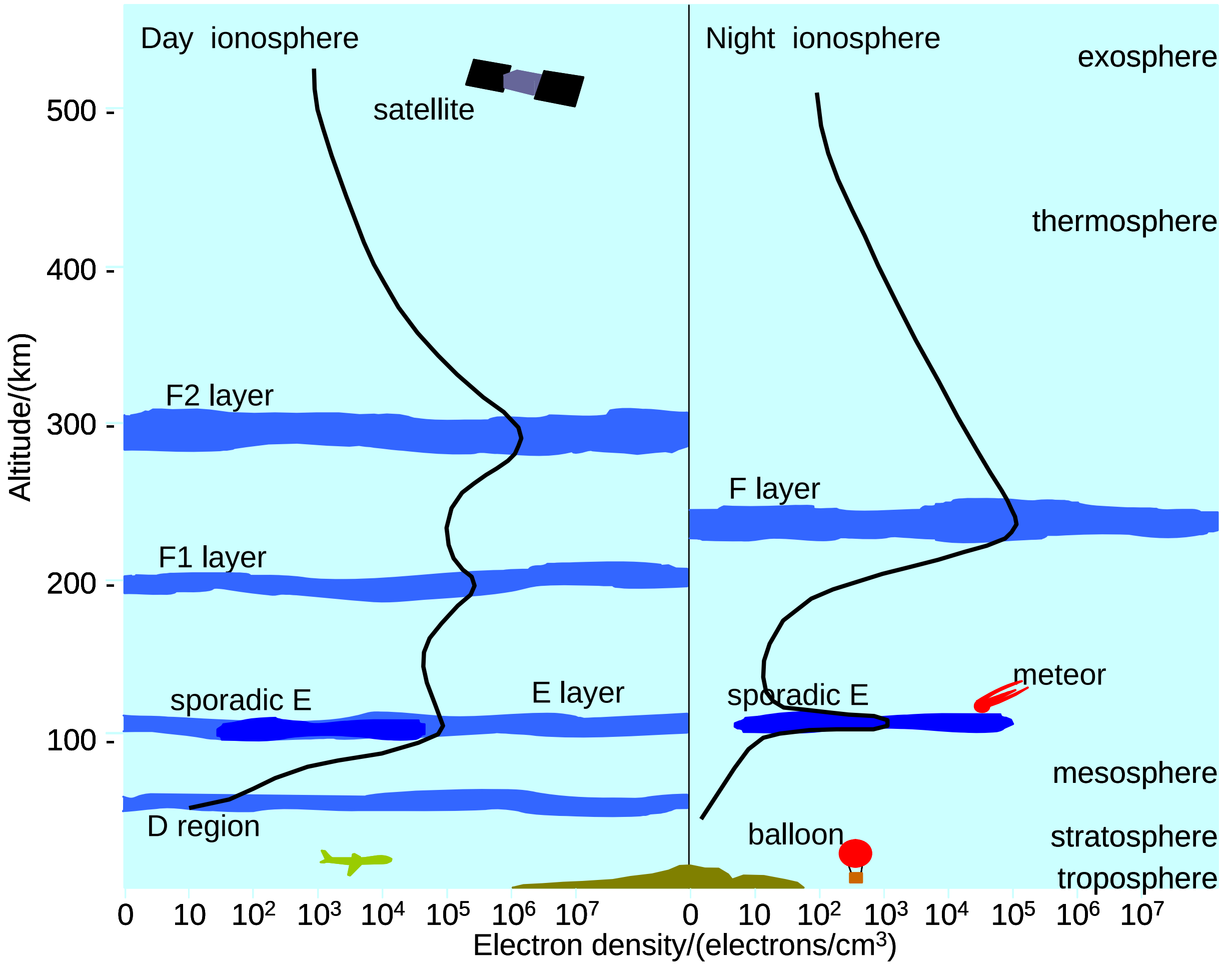

Figure 1.1 *Day and night structure of the ionosphere.*

1.2 Production and Loss of Electrons

Radiation from the Sun causes ionisation in the ionosphere. Electrons are produced when solar radiation collides with uncharged atoms and molecules (Figure 1.2). Since this process requires solar radiation, production of electrons only occurs in the daylight hemisphere of the ionosphere.

Loss of free-electrons in the ionosphere occurs when a free electron combines with a charged ion to form a neutral particle (Figure 1.3). Loss of electrons occurs continually, both day and night.

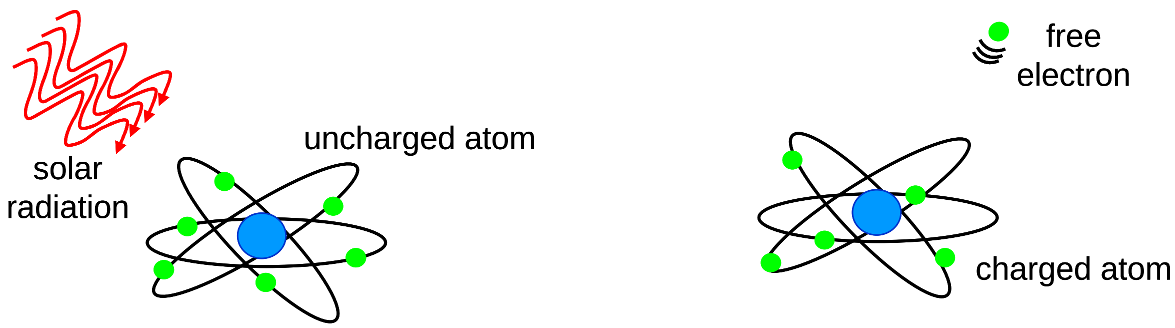

Figure 1.2 *Free electron production in the ionosphere*

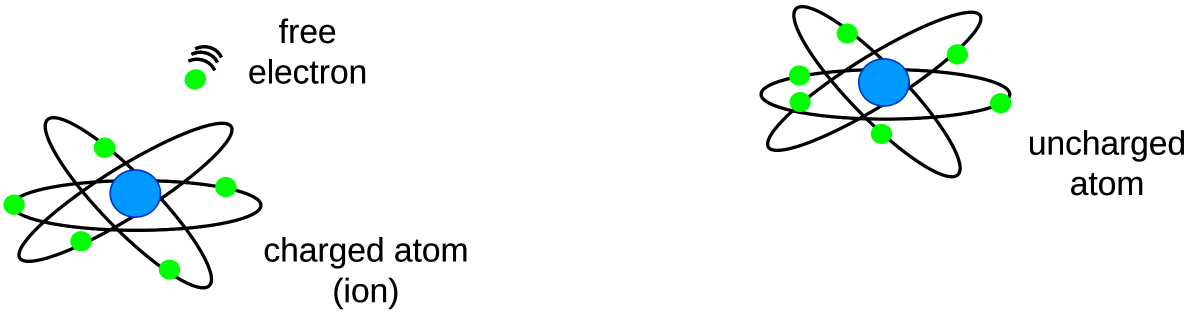

Figure 1.3 *Loss of free-electrons in the ionosphere.*

1.3 Observing the Ionosphere

The most important feature of the ionosphere in terms of radio communications is its ability to reflect radio waves. However, only those waves within a certain frequency range will be reflected. The range of frequencies reflected depends on a number of factors (see Section 1.4).

Various methods have been used to investigate the ionosphere, and the most widely used instrument for this purpose is the ionosonde (Figure 1.4). An ionosonde is a high frequency radar which sends very short pulses of radio energy vertically into the ionosphere. If the radio frequency is not too high, the pulses are reflected back towards the ground. The ionosonde records the time delay between transmission and reception of the pulses over a range of different frequencies.

Echoes appear first from the lower E region and subsequently, with greater time delay, from the F1 and F2 regions. At night echoes are returned only from the F region since the E region is not present.

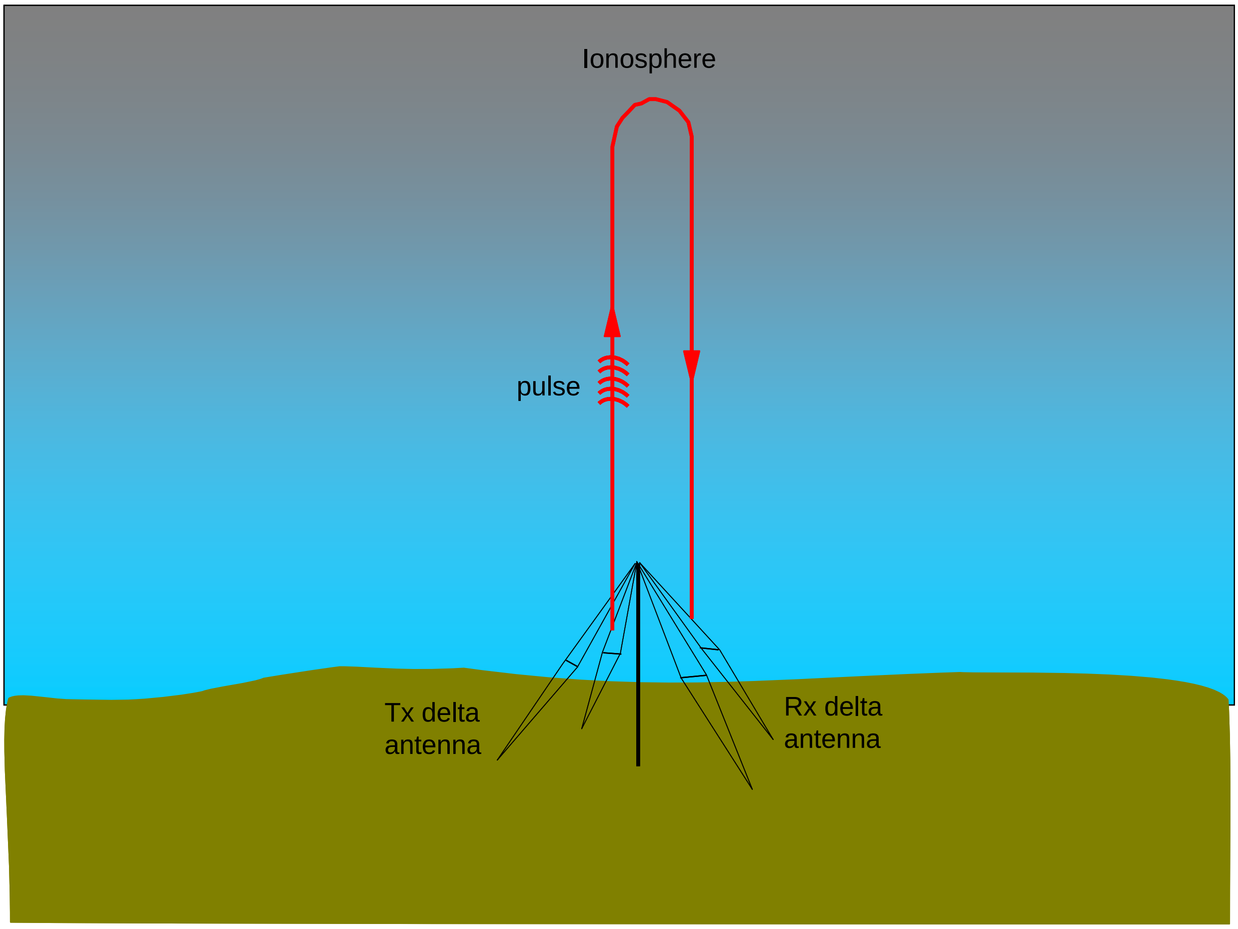

Figure 1.4 *Ionosonde operation.*

Today, the ionosphere is “sounded” not only by signals sent up at vertical incidence but by oblique sounders which send pulses obliquely into the ionosphere with the transmitter and receiver separated by some distance. This type of sounder can monitor propagation on a particular circuit and observe the various modes being supported by the ionosphere (see Section 2.5). Backscatter ionosondes rely on echoes reflected from the ground and returned to the receiver, which may or may not be at the same site as the transmitter. This type of sounder is used for over-the-horizon radar.

1.4 Ionospheric Variations

The ionosphere is not a stable medium that allows the use of the same frequency throughout the year, or even over 24 hours. The ionosphere varies with the solar cycle, the seasons and during any given day.

1.4.1 Variations due to the Solar Cycle

The Sun goes through a periodic rise and fall in activity which affects HF communications; solar cycles vary in length from 9 to 14 years. At solar minimum, only the lower frequencies of the HF band will be supported (reflected) by the ionosphere, while at solar maximum the higher frequencies will successfully propagate (Figure 1.5). This is because there is more radiation being emitted from the Sun at solar maximum, producing more electrons in the ionosphere which allows the use of higher frequencies.

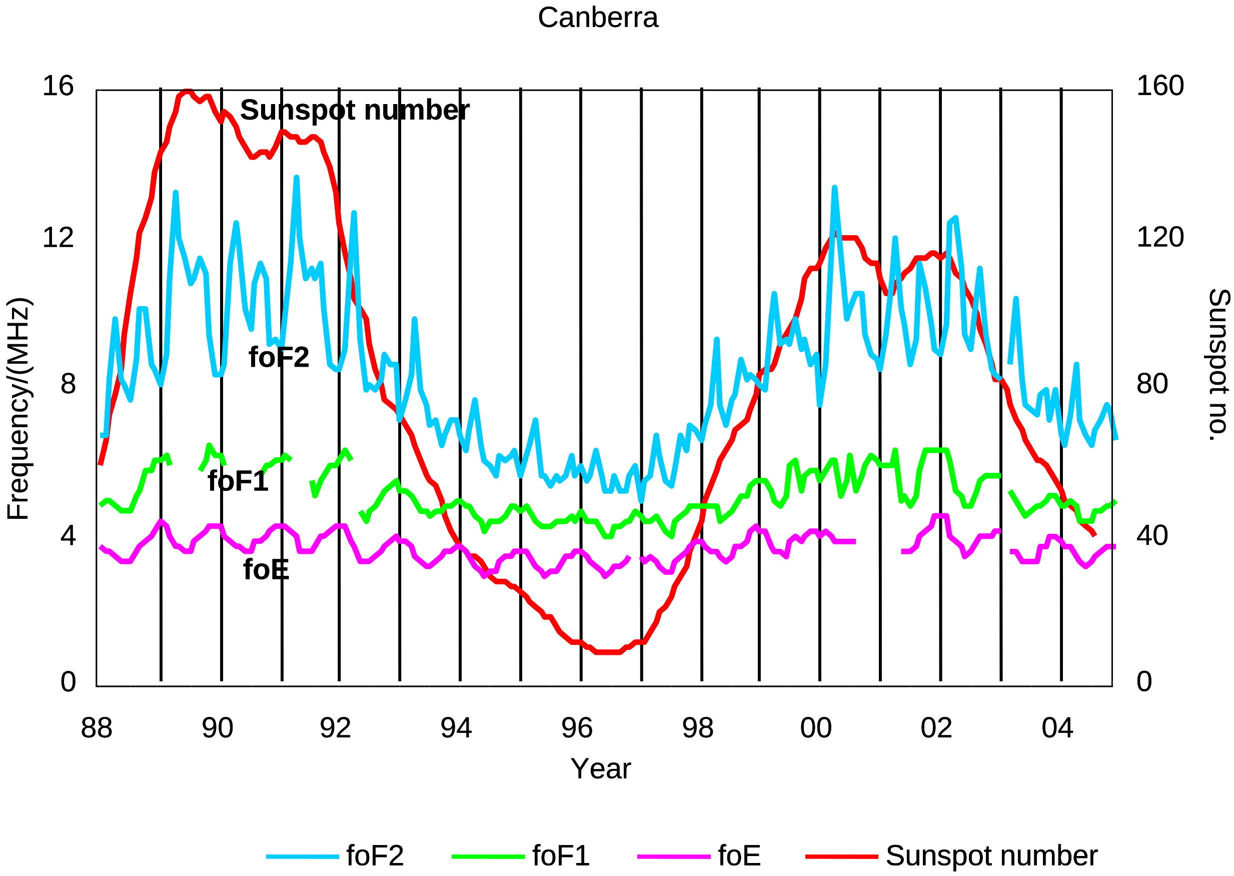

Figure 1.5 *The relationship between solar cycles and maximum frequencies supported by E, F1 and F2 regions. Vertical lines indicate the start of each year. Note also the seasonal variations.*

There are other consequences of the solar cycle. Around solar maximum there is a greater likelihood of large solar flares occurring. Flares are huge explosions on the Sun which emit radiation that ionises the D region, causing increased absorption of HF waves. Since the D region is present only during the day, only those communication paths which pass through daylight will be affected. The absorption of HF waves travelling via the ionosphere after a flare has occurred is called a short wave fade-out (see Section 3.1). Fade-outs occur instantaneously and affect lower frequencies the most. If it is suspected or confirmed that a fade-out has occurred, it is advisable to try using a higher frequency. The duration of fade-outs can vary between about 10 minutes to several hours, depending on the duration and intensity of the flare.

1.4.2 Seasonal Variations

E region frequencies are greater in summer than winter (see Figure 1.5). However, the variation in F region frequencies is more complicated. In both hemispheres, F region noon frequencies generally peak around the equinoxes (March and September). Around solar minimum the summer noon frequencies are, as expected, generally greater than those in winter, but around solar maximum winter frequencies tend to be higher than those in summer. In addition, frequencies around the equinoxes (March and September) are higher than those in summer or winter for both solar maximum and minimum. The observation of winter frequencies often being greater than those in summer is called the seasonal anomaly.

1.4.3 Variations with Latitude

Figure 1.6 shows the variations in the E and F region maximum frequencies at mid-day (Day hemisphere) and mid-night (Night hemisphere) from the pole to the equator. During the day, with increasing latitude, the solar radiation strikes the atmosphere more obliquely, so the intensity of radiation and the daily production of free electrons decreases with increasing latitude. In the F region this latitude variation persists throughout the night due to the action of upper atmospheric wind currents from day-lit to night-side hemispheres (see for example, IPS HF Radio Propagation Course and Manual - http://www.ips.gov.au/Products_and_Services/2/2).

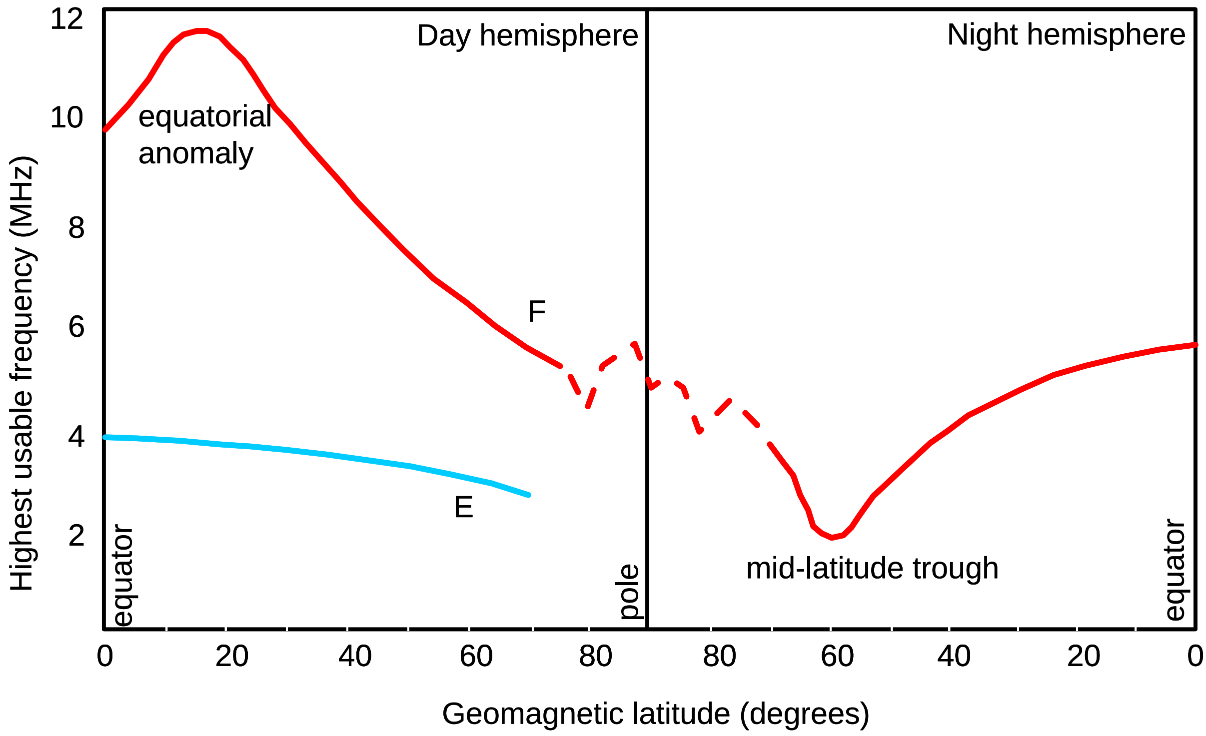

Figure 1.6 *Latitudinal variations.*

Deviations from the general low to high latitude decrease are also apparent. Daytime F region frequencies peak not at the geomagnetic equator, but 15 to 20° north and south of it. This is called the equatorial anomaly. Also, at night, frequencies reach a minimum around 60° latitude north and south of the geomagnetic equator. This is called the mid-latitude trough. Communicators who require communications near the equator during the day and around 60° latitude at night, should be aware of these characteristics. For example, from Figure 1.6 one can see how rapidly the frequencies can change with latitude near the mid-latitude trough and equatorial anomaly, so a variation in the reflection point near these by a few degrees may lead to a large variation in the frequency supported.

1.4.4 Daily Variations

Frequencies are normally higher during the day and lower at night (Figure 1.7). After dawn, solar radiation causes electrons to be produced in the ionosphere and frequencies increase rapidly to a maximum around noon. During the afternoon, frequencies begin falling due to electron loss and with darkness the D, E and F1 regions disappear. Communication during the night is by the F2 (or just F) region only and attenuation is very low. Through the night, maximum frequencies gradually decrease, reaching their minimum just before dawn.

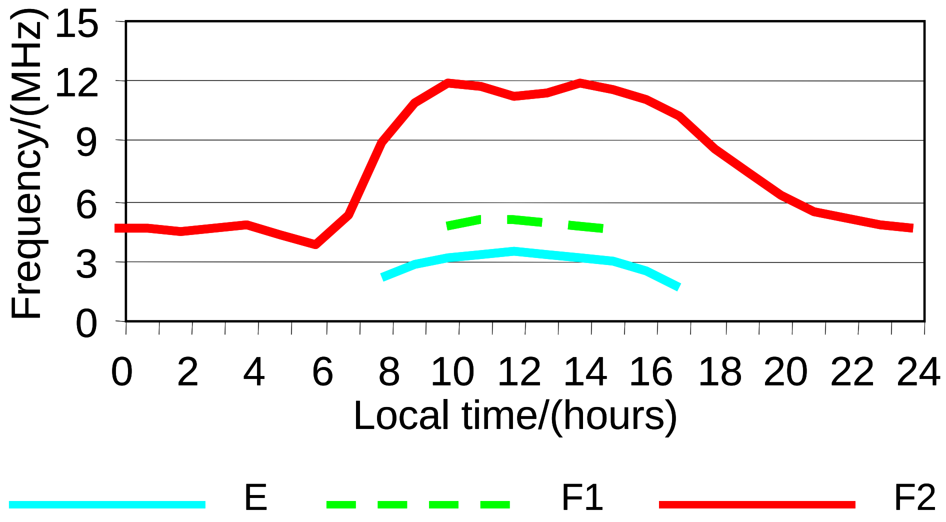

Figure 1.7 *E, F1 and F2 layer maximum frequencies throughout the day.*

1.5 Variations in Absorption

Absorption was discussed in section 1.4.1 in relation to solar flares. Whilst absorption is extremely high during a solar flare, a certain amount of D region absorption occurs all the time. Absorption in the D region varies with the solar cycle, being greatest around solar maximum. Signal absorption is also greater in summer and during the middle of the day (Figure 1.8). There is a variation in absorption with latitude, with more absorption occurring near the equator and decreasing towards the poles. Lower frequencies are absorbed the most so it is always advisable to use the highest frequency possible, particularly during the day when absorption is greatest.

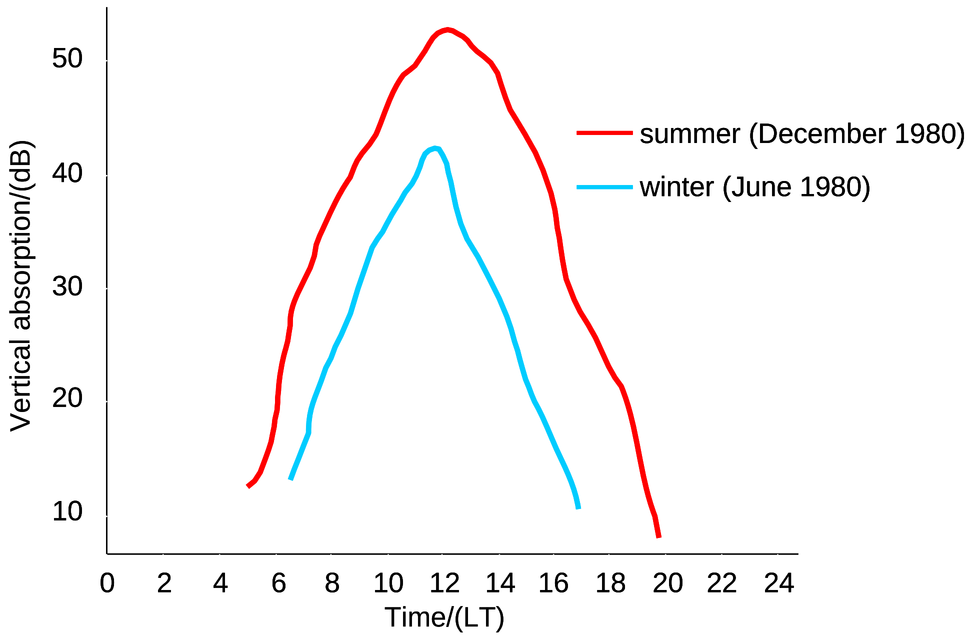

***Figure 1.8** Daily and seasonal variations in absorption at Sydney, 2.2 MHz.*

Sometimes, high energy protons are ejected from the Sun during large solar flares. These protons move down the Earth's magnetic field lines, into the polar regions and cause massive ionization of the polar D region leading to increased or total absorption of HF waves. This effect may last for as long as 10 days and is called a Polar Cap Absorption event (PCA) (see Section 3.2).

1.6 Sporadic E

Sporadic E refers to the largely unpredictable formation of regions of very high electron density in the E region. Sporadic E may form at any time during the day or night occurring at altitudes of 90 to 140 km (the E region). It varies greatly in the area it covers (a few km to hundreds) and the time it persists for (minutes to many hours). Sporadic E can have a comparable electron density to the F region which means it can reflect the sort of high frequencies intended for F region communications. Sometimes a sporadic E layer is transparent and allows most of the radio wave to pass through it to the F region, however, at other times the sporadic E layer obscures the F region totally and the signal does not reach the F region and hence the receiver (sporadic E blanketing). If the sporadic E layer is partially transparent, the radio wave is likely to be reflected at times from the F region and at other times from the sporadic E region. This may lead to partial or intermittent transmission of the signal or fading (Figure 1.9).

Sporadic E in the low and mid-latitudes occurs mostly during the daytime and early evening, and is more prevalent during the summer months. At high latitudes, sporadic E tends to form at night.

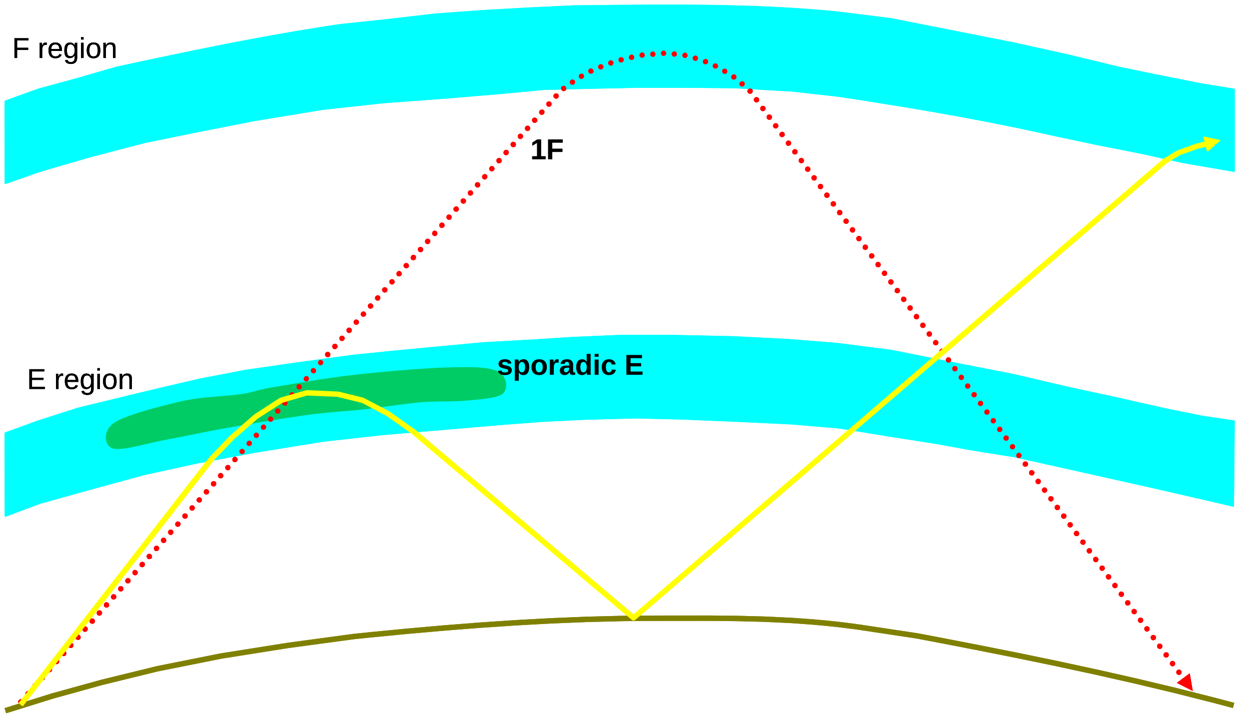

Figure 1.9 *Sporadic E formation (night or day) may result in communications via the F region being interrupted if the sporadic E electron density is high enough to reflect the wave.*

1.7 Spread F

Spread F occurs when the F region becomes diffuse due to irregularities which scatter the radio wave. The received signal is the superposition of a number of waves reflected from different heights and locations in the ionosphere at slightly different times. At low latitudes, spread F occurs mostly during the night hours and around the equinoxes. At mid-latitudes, spread F is less likely to occur than at low and high latitudes and is more likely to occur at night and in winter. At latitudes greater than about 40°, spread F tends to be a night time phenomenon, appearing mostly around the equinoxes, while around the magnetic poles, spread F is often observed both day and night. At all latitudes there is a tendency for spread F to occur when there is a decrease in F region maximum frequencies (reduced electron density). That is, spread F is often associated with ionospheric storms (see Section 3.3).

2. HF Communications

2.1 Types of HF Propagation

High Frequency (3 to 30 MHz) radio signals can propagate to a distant receiver, Figure 2.1, via the:

- **ground wave**: near the ground for short distances, up to 100 km over land and 300 km over sea. Attenuation of the wave depends on antenna height, polarisation, frequency, ground types, terrain and/or sea state;
- **direct or line-of-sight wave:** this wave may interact with the earth-reflected wave depending on terminal separation, frequency and polarisation;
- **sky wave:** reflected by the ionosphere; all distances.

2.2 Frequency Limits of Sky Waves

Not all HF waves are reflected by the ionosphere; there are upper and lower frequency bounds for communications between two terminals. If the frequency is too high, the wave will pass straight through the ionosphere. If it is too low, the strength of the signal will be very low due to absorption in the D region. The range of usable frequencies will vary:

- throughout the day;
- with the seasons;
- with the solar cycle;
- from place to place;

The upper limit of frequencies varies mostly with the above factors, while the lower limit also depends on receiver site noise, antenna efficiency, transmitter power, E layer screening (Section 2.6) and absorption by the ionosphere.

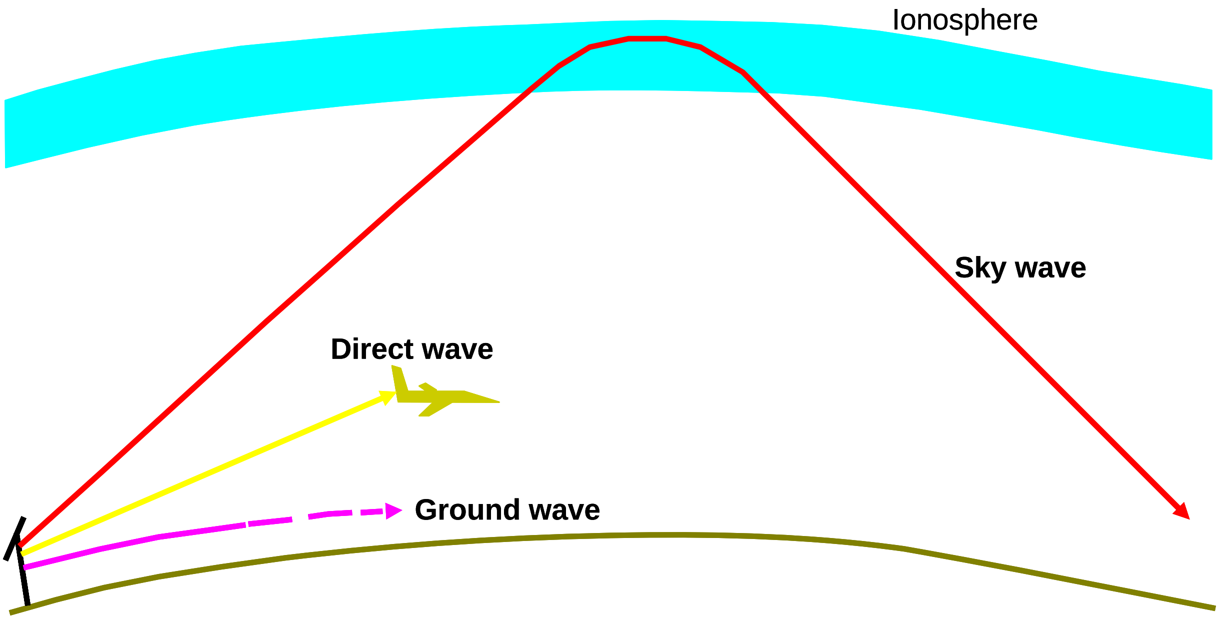

Figure 2.1 *Types of HF propagation.*

2.3 The Usable Frequency Range

For any circuit there is a Maximum Usable Frequency (MUF) which is determined by the state of the ionosphere in the vicinity of the reflection points and the length of the circuit. The MUF is reflected from the maximum electron density within a given layer of the ionosphere. Therefore, frequencies higher than the MUF for a particular region will penetrate through that region entirely. During the day it is possible to communicate via both the E and F layers using different frequencies. The highest frequency supported by the E layer is the EMUF, while that supported by the F layer is the FMUF.

The F region MUF in particular varies greatly throughout the day, seasonally and with the solar cycle. Historical data collected over many years displays the full range of these variations for a given location. The historical data is averaged and organised to give a MUF for every hour of the day (24 values), for each month of the year. These can also be adjusted for the solar cycle. MUFs are quoted as a statistical range with the “lower decile” (also called the Optimum Working Frequency OWF) working 90% of the time, the “median” MUF working 50% of the time and the “upper decile” MUF working just 10% of the time. IPS predictions usually cover a period of one month, so the OWF for a given hour, should provide successful propagation 90% of the time or 27 days of the that month. The median MUF should provide communications on 15 days of the month and the upper decile MUF on just 3 days of the month. The upper decile MUF is the highest frequency of the range and is most likely to penetrate the ionosphere, thus only working 10% of the time (Figure 2.2).

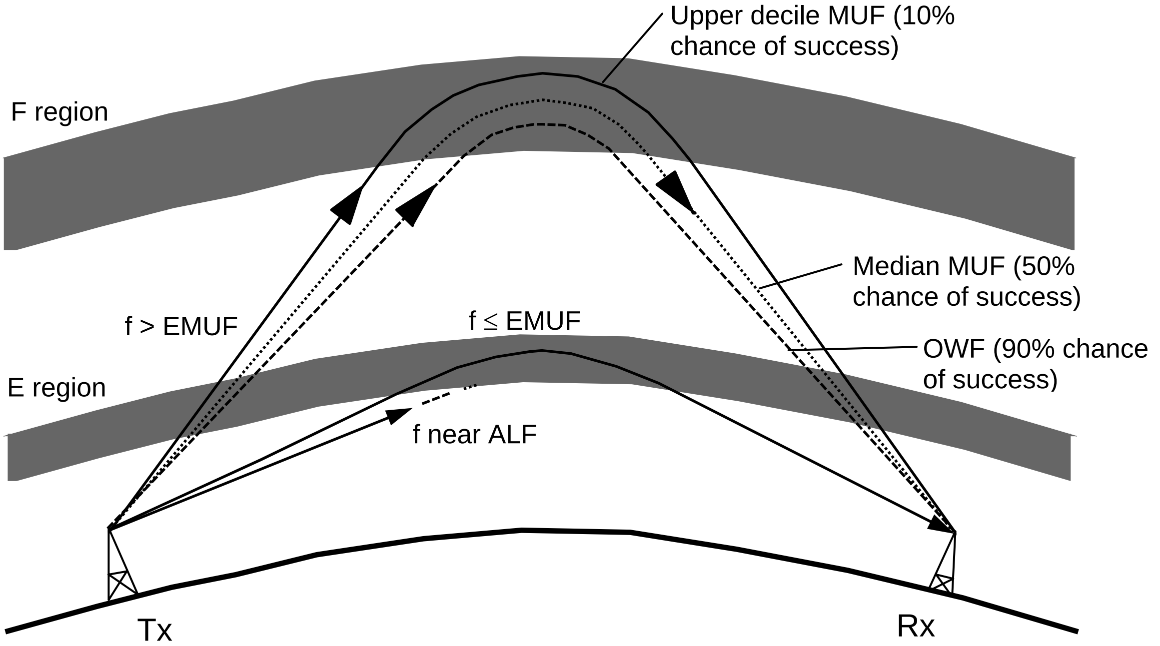

Figure 2.2 *Range of usable frequencies. If the frequency, f, is close to the ALF then the wave may suffer absorption in the D region. If the frequency is above the EMUF then propagation is via the F region. Above the FMUF the wave is likely to penetrate the ionosphere.*

The statistical MUFS described above correspond to “quiet background” conditions. With short-term variations in solar activity however, away from quiet background levels, usable frequencies change. This needs to be reflected in MUF predictions and one of the roles of the Australian Space Forecast Centre (ASFC) at IPS is to modify the historical MUFS to reflect the real-time observed space-weather conditions. Sophisticated techniques have been developed at IPS over many years to combine the effects of observed space-weather conditions with historically averaged data to provide detailed and accurate predictions of ionospheric conditions.

D region absorption of HF radio waves increases rapidly with decreasing frequency. The D region thus places a lower limit on the frequencies which can be used for ionospheric propagation. This limit is called the Absorption Limiting Frequency (ALF). The ALF is significant only for circuits with reflection points in the sunlit hemisphere. At night, the ALF falls to zero, allowing frequencies which are not usable during the day to successfully propagate.

2.4 Hop Lengths

The hop length is the ground distance covered by a radio signal after it has been reflected once from the ionosphere and returned to Earth (Figure 2.3). The maximum hop length is set by the height of the ionosphere and the curvature of the Earth. For E and F region heights of 100 km and 300 km, the maximum hop lengths are about 1800 km and 3200 km, respectively (corresponding to an elevation angle of around 4°).

Distances greater than these will require more than one hop. For example, a distance of 6100 km will require a minimum of 4 hops by the E region and 2 hops via the F region. More hops are required again with larger antenna elevation angles.

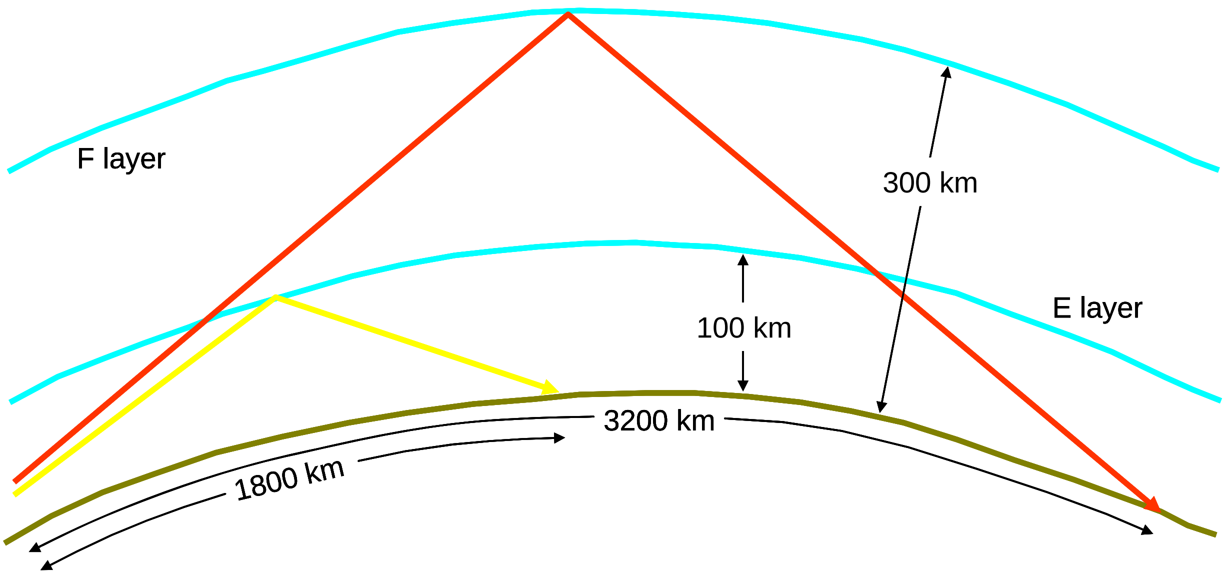

Figure 2.3 *Hop lengths based upon an antenna elevation angle of 4° and heights for the E and F layers of 100 km and 300 km, respectively.*

2.5 Propagation Modes

There are many paths by which a sky wave may travel from a transmitter to a receiver. The mode reflected by a particular layer which requires the least number of hops between the transmitter and receiver is called the first order mode. The mode that requires one extra hop is called the second order mode, and so on. For a circuit with a path length of 5000 km, the first order F mode has two hops (2F), while the second order F mode has three hops (3F). The first order E mode has the same number of hops as the first order F mode. If this results in a hop length of greater than 2050 km, which corresponds to an elevation angle of 0°, then the E mode is not possible.

Simple modes are those propagated by one region, say the F region. IPS predictions are made only for these simple modes (Figure 2.4). More complicated modes consisting of combinations of reflections from the E and F regions, ducting and chordal modes are also possible (Figure 2.5).

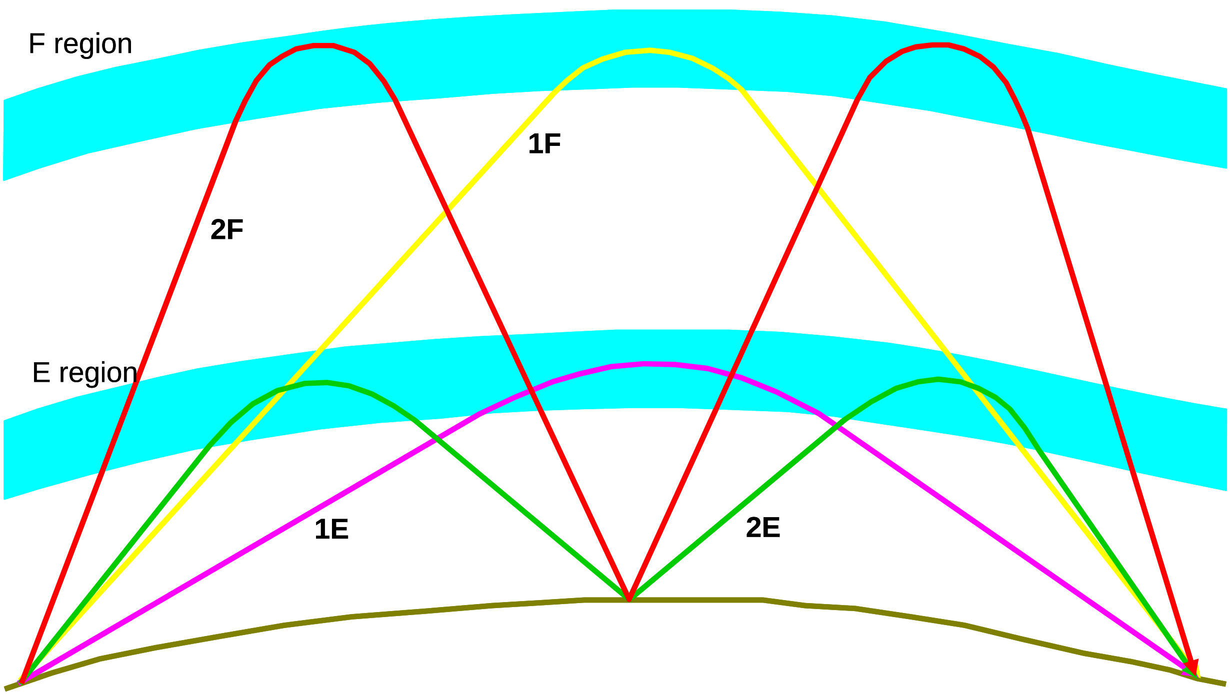

Figure 2.4 *Examples of simple propagation modes.*

Chordal modes and ducting involve a number of reflections/refractions from the ionosphere without intermediate reflections from the Earth. There is a tendency to think of the regions of the ionosphere as being smooth, however, the ionosphere undulates and moves, with waves passing through it which affects the refraction of radio signals. When ionospheric layers tilt chordal and ducted modes may occur. Ionospheric tilting is more likely near the equatorial anomaly, the mid-latitude trough and in the sunrise and sunset sectors of the globe. When these types of modes occur, signals can be strong since the wave spends less time traversing the D region or being attenuated by ground reflections.

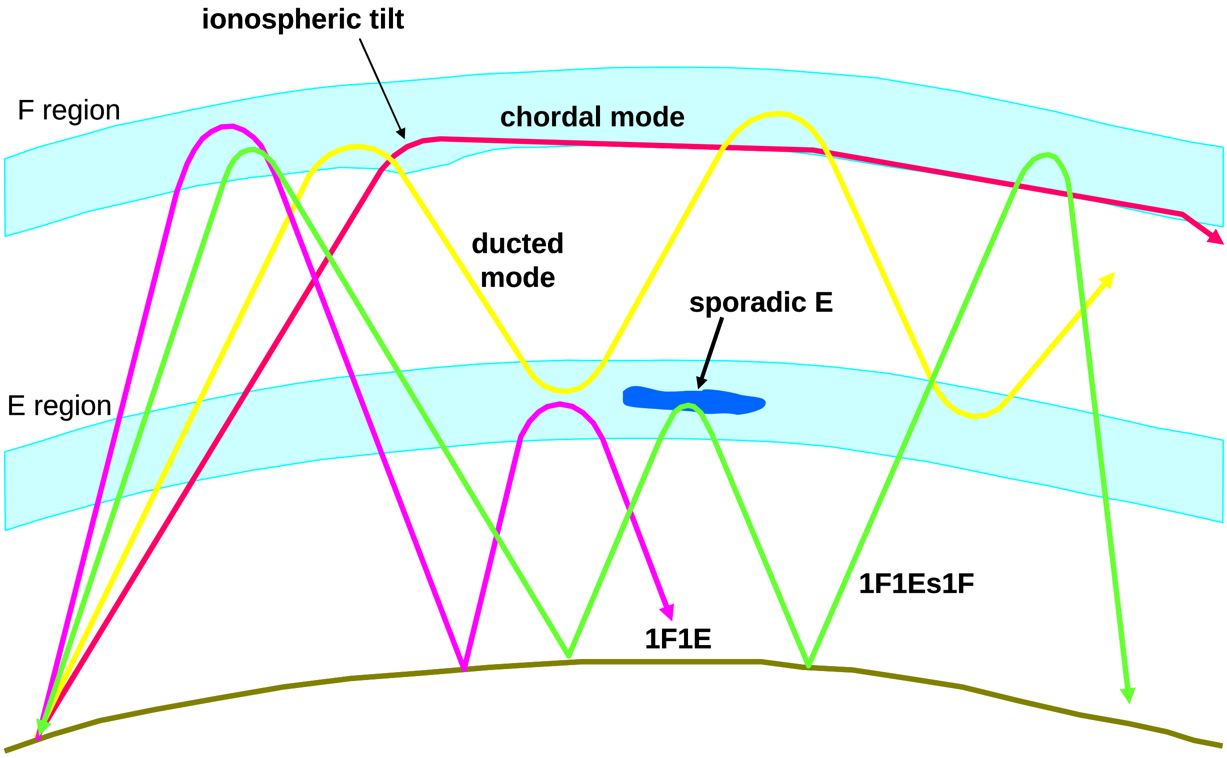

Figure 2.5 *Complex propagation modes.*

Because of the high electron density of the daytime ionosphere around 15° from the magnetic equator (near the equatorial anomaly), trans-equatorial paths can propagate on very high frequencies. Any tilting of the ionosphere in this region may result in chordal modes (see Figure 2.5) which produce good signal strength over very long distances.

Ducting may also result if tilting occurs and the wave becomes trapped between reflecting regions of the ionosphere (see Figure 2.5). This is most likely to occur in the equatorial ionosphere, near the auroral zone and mid-latitude trough. Disturbances to the ionosphere, such as travelling ionospheric disturbances (see Section 2.9), may also initiate ducting and chordal modes.

2.6 E Layer Screening

For daytime communications via the F region, the lowest usable frequency via the one hop F mode (1F) is dependent upon the presence of the E region. If the operating frequency is below the two hop EMUF, then the signal will propagate via the 2E mode rather than the 1F mode (Figure 2.6). This is also because the antenna elevation angles of the 1F and 2E modes are similar.

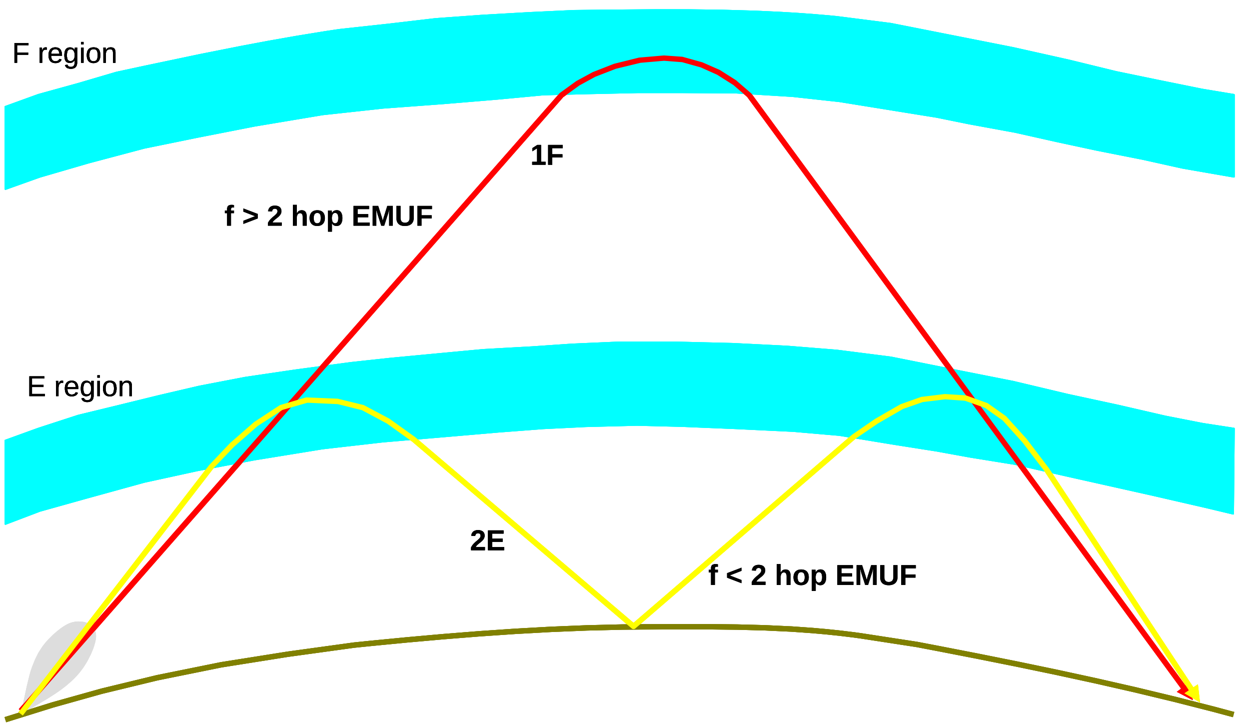

Figure 2.6 *E layer screening occurs if communications are intended by the 1F mode but the operating frequency is close to or below the EMUF for the 2E mode. Note that the 2 hop E mode travels twice as many times through the D region.*

A sporadic E layer may also screen a HF wave from the F region. Sometimes sporadic E can be quite transparent, allowing most of the wave to pass through it. At other times it will partially screen the F region leading to a weak or fading signal, while at other times sporadic E can totally obscure the F region with the result that the signal does not arrive at the receiver (Figure 1.9).

2.7 Frequency, Range and Elevation Angle

For HF propagation path, there are three dependent variables:

- frequency;
- range or path length;
- antenna elevation angle.

The diagrams below illustrate the possible changes to the ray paths when each of these is fixed in turn.

Figure 2.7: Elevation angle fixed:

- As the frequency is increased toward the MUF, the wave is reflected higher in the ionosphere and the range increases; paths 1 and 2
- Exactly at the MUF, the maximum range is reached; path 3
- Above the MUF, the wave penetrates the ionosphere; path 4

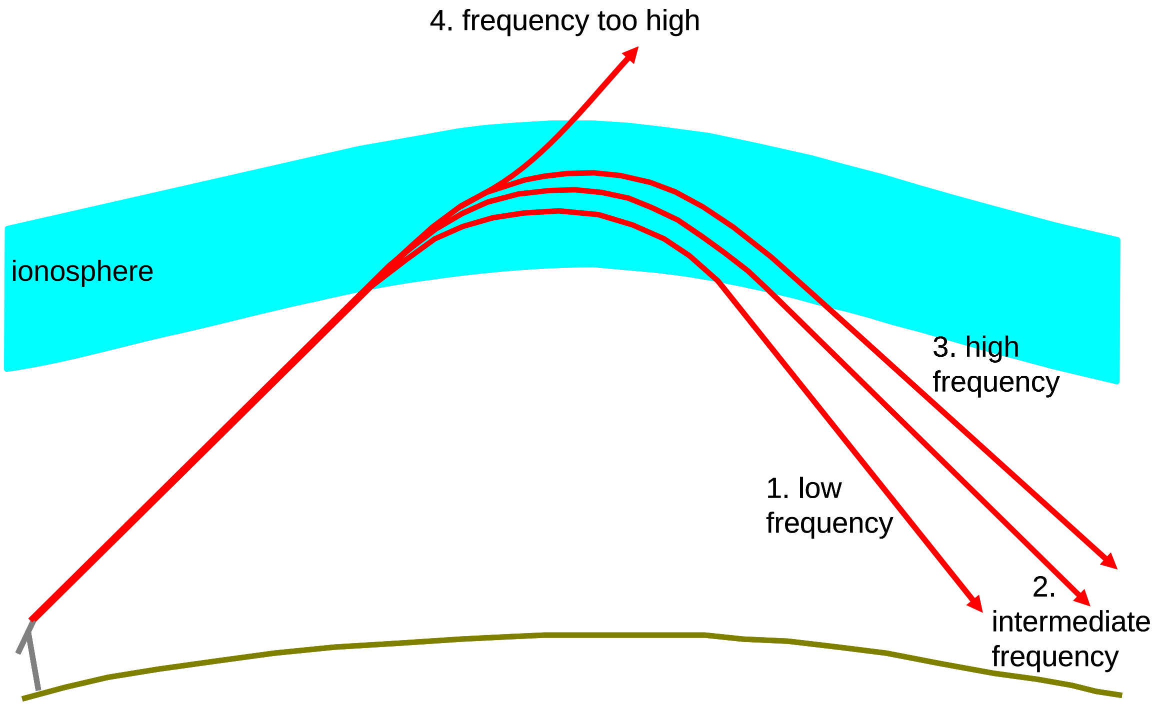

Figure 2.7 *Elevation angle fixed.*

Figure 2.8: Path length fixed (point-to-point circuit):

- As the frequency is increased towards the MUF, the wave is reflected from higher in the ionosphere. To maintain a circuit of fixed length, the elevation angle must therefore be increased (paths 1 and 2)
- At the MUF, the critical elevation angle is reached (path 3). The critical elevation angle is the highest elevation angle for a particular frequency.
- Above the MUF, the ray penetrates the ionosphere (path 4).

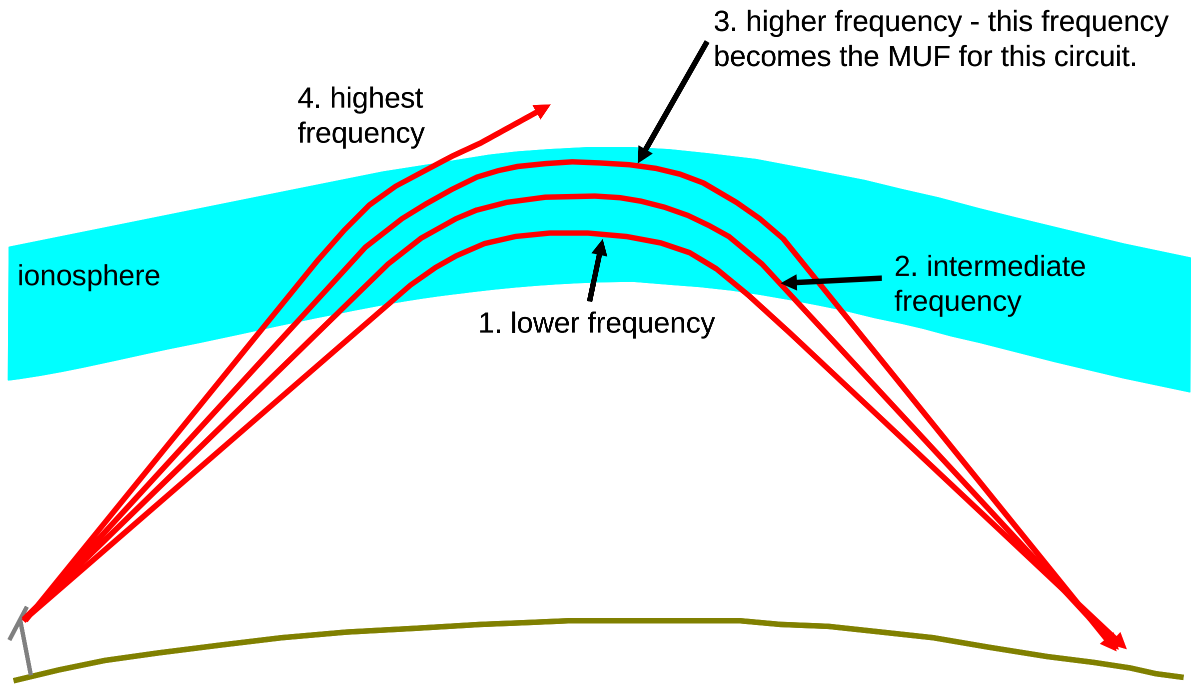

Figure 2.8 *Path length fixed.*

<u>Figure 2.9: Frequency fixed</u>:

- At low elevation angles the path length is greatest (path 1);
- As the elevation angle is increased, the path length decreases and the ray is reflected from higher in the ionosphere (paths 2 and 3);
- If the elevation angle is increased beyond the critical elevation angle for that frequency then the wave penetrates the ionosphere and there is an area around the transmitter within which no sky wave communications can be received (path 4). To communicate within this so called “skip zone”, the frequency must be lowered.
- If a signal of a certain frequency is reflected when vertically incident on the ionosphere, then there is no skip zone. The vertically incident maximum frequency is referred to as **f0F2** and is a key ionospheric parameter.

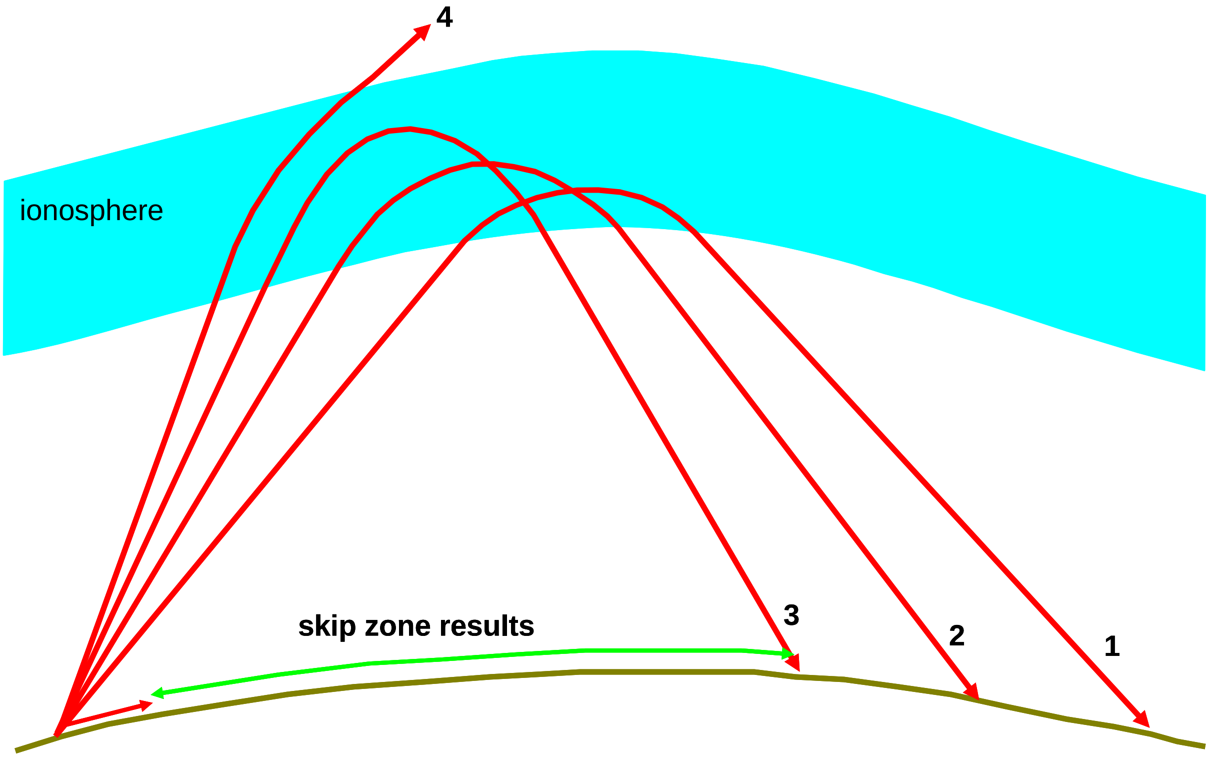

Figure 2.9 *Frequency fixed.*

2.8 Skip Zones

Skip zones can often be used to advantage if it is desired that communications are not heard by a particular receiver. Selecting a frequency which puts a receiver in the skip zone and out of reach of the ground wave makes it unlikely that it will receive the communications. However, factors such as sidescatter, where reflection from the Earth outside the skip zone results in the wave transmitting into the skip zone may affect the reliability of this.

Skip zones vary in size during the day, with the seasons, and with solar activity. During the day, solar maximum and around the equinoxes, skip zones generally are smaller in area. The ionosphere during these times has increased electron density and so is able to support higher frequencies.

2.9 Fading

Multipath fading results when a number of modes propagate from transmitter to receiver, which have variations in phase and amplitude. See for example, Figure 2.4. The signal travels by a number of paths simultaneously which may interfere at the receiver, causing fading.

Disturbances known as Travelling Ionospheric Disturbances (TID), may cause a region to be tilted, resulting in the signal being focussed or defocused (Figure 2.10). Fading periods of the order of 10 minutes or more can be associated with these structures. TIDs travel horizontally at 5 to 10 km/minute with a well defined direction of travel and affect higher frequencies first. Some originate in auroral zones following an event on the Sun and these may travel large distances. Others originate in lower atmospheric weather disturbances. TIDs may cause variations in phase, amplitude, polarisation and angle of arrival of a radio wave.

Polarisation fading results from changes to the polarisation of the wave along the propagation path with the receiving antenna being unable to receive parts of the signal. This type of fading can last for a fraction of a second to a few seconds.

Skip fading often occurs around sunrise and sunset when the ionosphere is at its most unstable. If the operating frequency is close to the MUF and the receiving antenna is positioned close to the boundary of the skip zone then signal will fade in and out with fluctuations in the ionosphere.

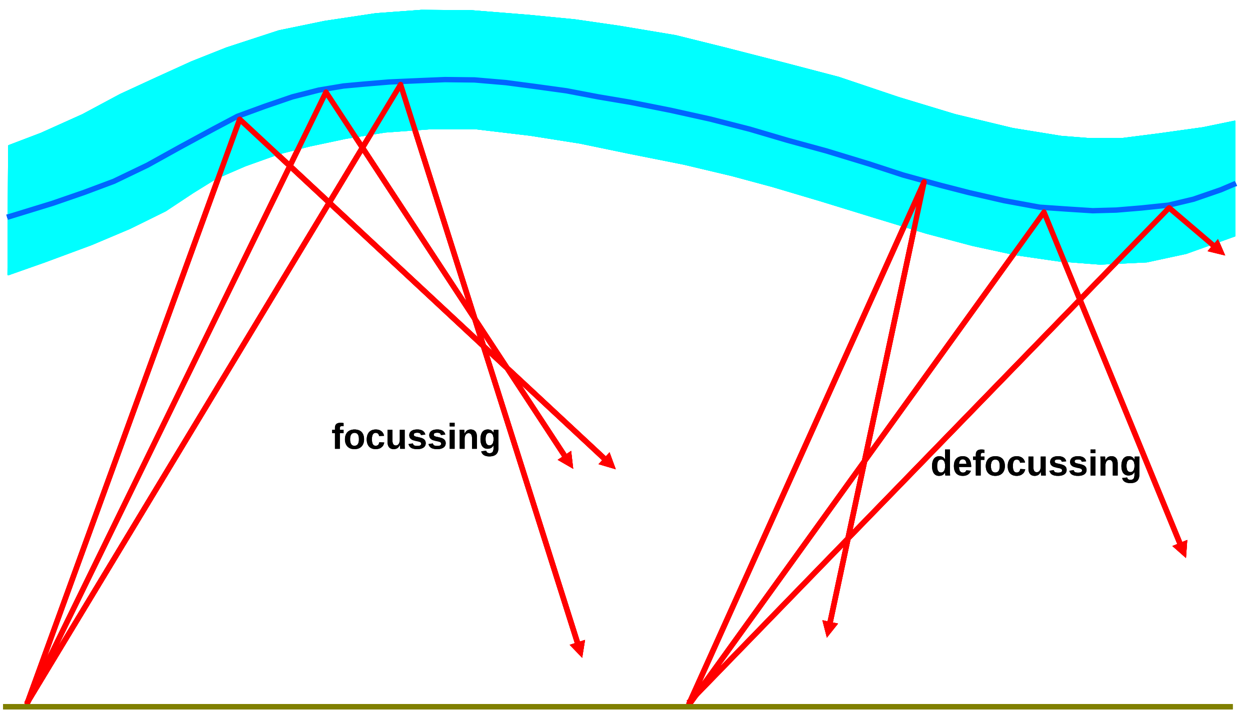

Figure 2.10 *Focussing and defocussing effects caused by travelling ionospheric disturbances (TIDs).*

2.10 Noise

Radio noise arises from internal and external origins. Internal or thermal noise is generated in the receiving system and is usually negligible for a good quality receiver when compared to external sources of noise. External radio noise originates from natural (atmospheric and galactic) and man-made (environmental) sources.

Atmospheric noise, which is caused by thunderstorms, is normally the major contributor to radio noise in the HF band and will especially degrade circuits passing through the day-night interface. Atmospheric noise is greatest in the equatorial regions and decreases with increasing latitude. Its effect is also greater on lower frequencies so is usually more of a problem around solar minimum and at night when lower frequencies are needed.

Galactic noise arises from our galaxy. Since only the highest frequencies will pass through the ionosphere (from above) galactic noise only effects high frequencies.

Man-made noise results from any large currents and voltages such as ignition systems, neon signs, electrical cables, power transmission lines and welding machines. This type of noise depends on the technology used by the society and its population. Interference may be intentional (jamming), due to propagation conditions or the result of others operating on the same frequency.

Man-made noise tends to be vertically polarised, so selecting a horizontally polarised antenna may help in reducing man-made noise. Using a narrower bandwidth, or a directional receiving antenna (with a lobe in the direction of the transmitting source and a null in the direction of the unwanted noise source), will also aid in reducing the effects of noise. Selecting a site with a low noise level and determining the major noise sources are important factors in establishing a successful communications system.

2.11 VHF and 27 MHz Propagation

VHF and 27 MHz are used for line-of-sight or direct wave communication, for example, ship-to-ship or ship-to-shore. The frequency bands are divided into channels and one channel is usually as good as the next. This is in contrast to medium frequency (MF: 300 kHz to 3 MHz) and HF where the choice of a frequency channel may be crucial for good communications.

Because VHF and 27 MHz operate mainly by line-of-sight, it is important to mount the antenna as high as possible and free from obstructions. Shore stations are usually on the tops of hills to provide maximum range, but even the highest hills do not provide coverage beyond about 45 nautical miles (80 km), because of the Earth’s curvature.

Antennas for VHF and 27 MHz should usually concentrate radiation at low angles (towards the horizon) as except when communicating with aircraft, radiation directed at high angles will pass over the receiving antenna. VHF and 27 MHz do not usually suffer from atmospheric noise except during severe electrical storms. Interference mainly results from many users wishing to use the limited number of channels, and this can be a significant problem in densely populated areas.

27 MHz and the lower frequencies in the VHF band can, at times, propagate over large distances, well beyond the normal line-of-sight limitations. There are three ways that this can take place:

- around solar maximum and during the day, the ionospheric F region will often support long range sky wave communications on 27 MHz and above;
- sporadic E layers can often support 27 MHz and lower frequency VHF propagation over circuits of about 500 to 1000 nautical miles (1000 to 2000 km) in length. This kind of propagation is most likely to occur at mid-latitudes, during the daytime in summer;
- 27 MHz and VHF can also propagate by means of temperature inversions (ducting) at altitudes of a few kilometres. Under these conditions, the waves are gradually

bent by the temperature inversion to follow the curvature of the Earth. Distances of several hundred nautical miles can be covered in this way.

2.12 Medium Frequency (MF) Sky Wave Propagation

Both the MF (300 kHz to 3 MHz) and HF bands can be used for long distance sky wave communications at night. During the night the D region disappears, so absorption falls to very low levels. This is why radio broadcast stations operating in the MF and 4 MHz bands can be heard over long distances only at night.

2.13 Ground Wave MF and HF Propagation

It is possible to communicate up to distances of several hundred nautical miles on MF/HF bands at sea by using ground wave propagation.

The ground wave follows the curvature of the Earth and its range does not depend upon the height of the antenna. However, the range does depend upon the transmitter power and also upon the operating frequency. Low frequencies travel further than high frequencies. Thus under ideal (midday, during winter) low noise conditions, it is possible to communicate over distances of about 500 nautical miles at 2 MHz by using a 100 W transmitter. At 8 MHz, under the same conditions and using the same transmitter power, the maximum range is reduced to about 150 nautical miles.

Note that ground wave propagation is much less efficient over land than it is over sea because of the much lower conductivity of the ground and other factors. Consequently, ranges over land are greatly reduced compared to ranges over sea water.

Ground wave communications vary daily and with the seasons. The greatest communication ranges are achieved during the daytime in winter because background noise levels are lowest at these times.

Successful ground wave communications over hundreds of nautical miles can only be achieved if the transmitting and receiving antennas are chosen to direct and receive radiation at low angles. Tall whips are ideal for this purpose.

2.14 Universal Time

Unless communications are always with another communicator on the same time standard, it is considered more convenient to work in universal (UT) or Zulu (Z) time since in many cases the transmitter and receiver are operating in different local time zones. Universal time is the same as the Greenwich Mean Time (GMT) and 0000 UT (0000 Z) is midnight at Greenwich, UK. For eastern Australia, operating on Eastern Standard Time (EST), 10 am EST equals 0000 UT. Western Australia is 8 hours ahead of Greenwich, UK, so 0800 WST = 0000 UT, and central Australia is 9.5 hours ahead of Greenwich (0930 CST = 0000 UT).

3. Summary of the Effects of Solar Disturbances

3.1 Short Wave Fade-outs (SWFs)

Radiation from the Sun during large solar flares causes increased ionisation in the D region which results in higher absorption of HF radio waves (Figure 3.1). If the flare is large enough, the whole of the HF spectrum can be rendered unusable for a period of time. Fade-outs are more likely to occur around solar maximum than at solar minimum. The main features of SWFs are:

- Only circuits with daylight sectors will be affected;
- Fade-outs usually last from a few minutes to a few hours, with a fast onset and a slower recovery. The duration of the fade-out will depend on the duration of the flare;
- The magnitude of the fade-out will depend on the size of the flare and the position of the Sun relative to the point where the radio wave passes through the D region. The higher the Sun with respect to that point, the greater the amount of absorption;
- Absorption is greatest at lower frequencies, which are the first to be affected and the last to recover. Higher frequencies are normally less affected and may still be usable (Figure 3.2).

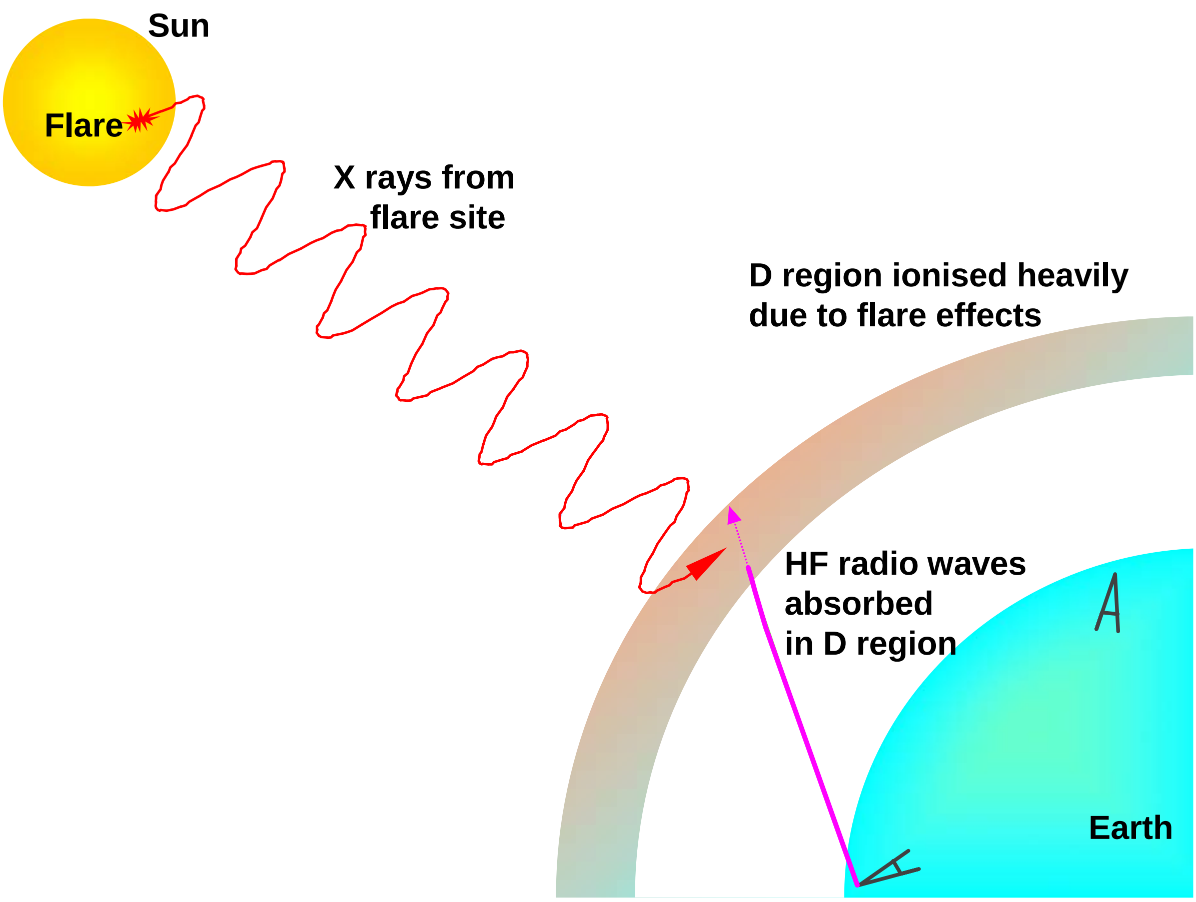

Figure 3.1 *Fade-outs affect propagation of HF waves on the day-lit hemisphere.*

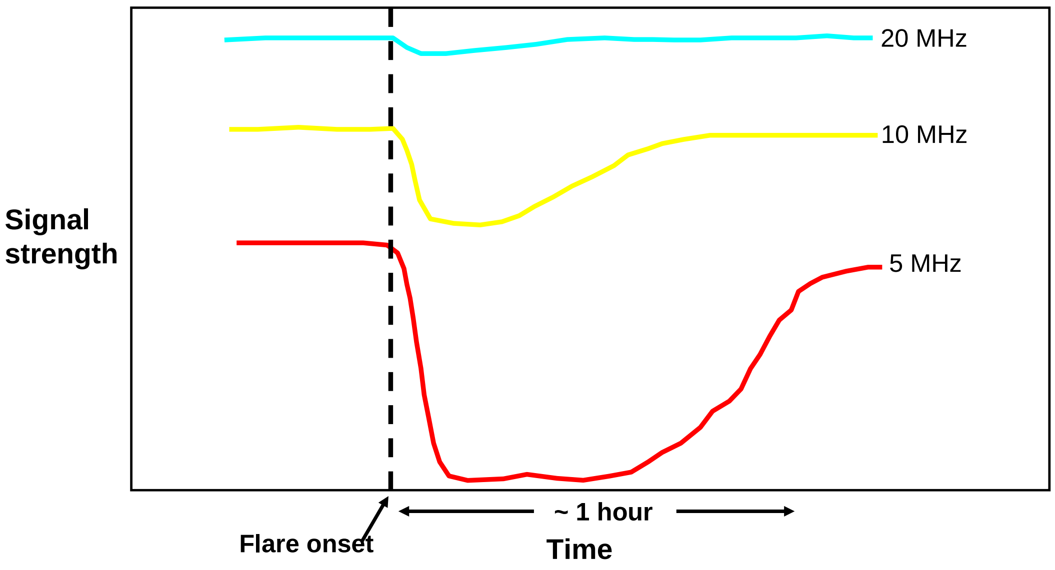

Figure 3.2 *Fade-outs affect lower frequencies the most and these are the last to recover. Higher frequencies are least affected and sometimes unaffected by smaller flares.*

Short-wave fadeouts are also called daylight fade-outs or sudden ionospheric disturbances (SID).

3.2 Polar Cap Absorption Events (PCAs)

PCAs are attributed to high energy protons which escape from the Sun when a large flare occurs and move along the Earth's magnetic field lines to the polar regions. There they ionise the D region, causing very high absorption of HF waves.

PCAs may commence as soon as 10 minutes after a flare and last for up to 10 days. Even the winter polar zone (a region of perpetual darkness) can suffer the effects of PCAs since the ionised D region is formed by protons rather than sunlight.

The effects of PCAs can sometimes be overcome by relaying messages on circuits which do not require polar reflection points.

PCAs are most likely to occur around solar maximum, however, they are not as frequent as fade-outs.

3.3 Ionospheric Storms

Due to events on the Sun, sometimes the Earth's magnetic field becomes disturbed. The geomagnetic field and the ionosphere are linked in complex ways and a disturbance in the geomagnetic field can often cause a disturbance in the ionosphere.

These disturbances, called ionospheric storms, sometimes begin with increased electron density allowing higher frequencies to be supported, followed by a decrease in the electron density leading to only low frequencies being supported by the ionosphere. An enhancement will not usually concern the HF communicator, but the depression may cause frequencies normally used for communication to be too high with the result that the wave penetrates the ionosphere.

Ionospheric storms may last a number of days and higher latitudes are generally affected more than low latitudes. Unlike fade-outs, higher frequencies are most affected by ionospheric storms. To reduce the effects on communications of an ionospheric storm, a lower frequency should be used where possible.