PERFORMANCE EVALUATION

TESTS OF DTTB

COORDINATED BY

FACTS SPECIALIST GROUP ADVANCED TRANSMISSION

FIELD TRIALS

FIELD TRIAL DATA PRESENTATION REPORT

FACTS Report for the Australian Field Trials of DVB-T and ATSC DTTB systems conducted in 1997

PREPARED BY AUSTRALIAN COMMERCIAL TELEVISION NETWORKS

[illegible]

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CONTENTS:

NOTE: Annex 1-3 consist primarily of paper based source data which is not available in an electronic document format and so is not included.

SUMMARY

Top

The first DTTB Field Trial for Australia was conducted by FACTS in Sydney in October and November 1997. The European DVB-T 2k-COFDM and the American ATSC 8VSB systems were tested in the environment of Sydney in VHF Band III along side PAL Analogue channels. The report provides the detail of the structure of the Trial, the resultant raw data and presents this data in both table and graphical form. No conclusions are either intended or attempted at this time. Such conclusions for both the choice of the system and the data for planning DTTB will the subject of further analysis and *much* discussion. Comment upon all aspects is the aim of the document and is indeed encouraged to ensure the correct information is used as the input to analysis, discussion and conclusions.

Caution should be exercised when interpreting these results. The measurements relate to those taken using the specific implementations of pre-production (DVB) and prototype (8VSB) receivers. Hence the use of a figure or a result in isolation from it's related context should be avoided.

1 INTRODUCTION Top

The Field Trial in Sydney was conducted for the purpose of the Performance Evaluation Tests of DTTB and was coordinated by the FACTS Specialist Group Advanced Transmission. The Field Trial followed laboratory testing of the systems by the DCA Communications Laboratory.

The Field Trial was conducted in VHF Band III, where three (3) of the eight (8) channels available, are used by CH 7, CH 9, and CH 10 for PAL analogue transmissions.

Sydney has topography that gives many reception conditions in such environments as hilly terrain, beaches, harbours, rivers, large populations of trees, and transmission towards a mountain escarpment over large flat areas ("the Sydney Basin"). The HF transmissions also occurred from within a densely populated area within Sydney. The field trials have endeavoured to expose the DTTB systems to these reception conditions.

The DTTB systems under test are current implementations of the DVB-T compliant COFDM system and the ATSC compliant 8VSB system.

The success of the field trial depended upon the cooperation, supply of equipment and the personnel from the following organisations:

- Australian Broadcasting Authority (ABA)
- DCA Communications Laboratory
- FACTS
- TEN Network
- NINE Network
- SEVEN Network
- NDS (DMV)
- ZENITH Electronics Corp.
- HARRIS Corp.
- Radio Frequency Systems (RFS)
- NEC
- Hewlett Packard
- Rohde & Schwarz

The involvement early in the initial familiarisation section of the trial, of the designers of the COFDM and 8VSB systems, proved very helpful in setting up and honing the procedures for the collection of data in the field. An independent person was hired to collect the data with the aim of providing consistency and credibility of the data collected.

This report is intended to familiarise the reader with the structure of the trial, provides the raw data, and presents the data in both tabular and graphical form. This is designed to allow the quickest and most informed comment. No conclusions are either stated or inferred. All the data presented, in whatever form, is that which was measured in the field over the five or so weeks of field trial.

2 AIMS Top

In a VHF Band III transmission environment record and study:

- Interference of DTTB into PAL analogue receivers on adjacent channel to allow decision on DTTB power for purpose of the trial **only**
- Analogue reception character to allow comparison to DTTB reception
- Coverage of DTTB relative to Analogue VSB
- Robustness of DTTB compared to analogue reception
    - DTTB C/N Threshold variability
    - Overall field strength variability
    - Performance in static environments
    - Performance in dynamic environments
        - Aircraft flutter
        - Moving vehicles in receive path
    - Performance in impulse noise environments

- Translator / gap filler requirements
- Multipath performance

3 FIELD TRIAL RESTRICTIONS Top

The Field Trials will not cover:

- UHF Band IV & V
- Co-channel interference
- Long term propagation variations needed for reception predictions
- Variable weather conditions such as lightning storms etc.
- Performance within active antenna and distribution systems

The available time and availability of DTTB equipment restricted not only the total number of sites, but unfortunately those sites with different reception character. For example those reception sites with dynamic conditions such as impulse noise and “flutter” mechanisms.

4 DTTB MODULATION PARAMETERS: Top

The two systems tested in the Sydney field Trials were:

(A) DVB-T System to ETSI ETS 300 744 using COFDM modulation format

(B) ATSC Digital Television Standard A/53 using 8VSB modulation format

The DVB-T system with its selectable parameters was set up to closely match the transport stream bitrate and the FEC of the ATSC system, giving both systems the same HDTV capacity.

DVB-T System:

The chosen parameters were:

- 7 MHz nominal bandwidth
- 2K carrier mode
- 64QAM modulation (8 levels x 8 phases)
- FEC 2/3
- RS (204,188)
- Guard interval 1/8 (32 uSec)
- Transport Stream Bitrate of 19.35 Mbps
- DMV V1.0 Equaliser software used
- DMV V2.0 System software used

ATSC System:

The parameters were:

- 6 MHz nominal bandwidth
- 8VSB modulation (8 levels)
- FEC 2/3
- RS (207,187)
- Transport Stream Bitrate of 19.39 Mbps
- Equaliser range of 23 uSec
- Co-channel compensation not on.

Note:

1. The 8VSB system under test was optimized for the NTSC environments.

2. The term "Payload Bitrate" is sometimes used in place of "Transport Stream Bitrate", but unfortunately has different definitions in different camps. In the ATSC context, the Payload Bitrate is the Transport Stream Bitrate less the overhead of one sync. Byte (1 in 188), which results in an ATSC Payload Bitrate of 19.28 Mbps.

5 DTTB TRANSMITTER SYSTEM: Top

The DTTB transmitter system was located at TCN-9 Willoughby and was based upon the following main equipment:

(A) NEC DTTB 200 W transmitter, settable to CH 6 and CH 8. Set to CH 6 for trials.

(B) HARRIS 1000 W transmitter, modifiable to CH 6 and CH 8. Set to CH 8 for trials.

(C) RFS CH 6 and CH 8 Combiner.

(D) RFS CH 8 Adjacent Channel Combiner (CU31C6XA)

(E) COMMS. LAB. Transmitter Control system.

The Communications Laboratories Report 98/01 provides the testing and calibration detail for the transmitters. **Annex 3** of this Report provides the results of the in situ tests of the radiated spectrum.

For the **interference testing** the CH 6 and CH 8 Combiner was used with both transmitters. The control system allowed, through the use of a mobile phone in the field and DTMF responder, the alternating of the modulation system between COFDM and 8VSB on CH 6 and CH 8.

For **all other testing** the Adjacent Channel Combiner and the CH 8 transmitter was only used. Again by remote control from the survey vehicle the modulation system could selected between COFDM and 8VSB (but this time only on CH 8.)

Information on the adjacent combiner used for the trials is included in Annex 3.

6 TRANSMISSION PARAMETERS: Top

Transmissions occurred from the Free to Air (FTA) transmission sites at locations of Willoughby and Artarmon. The DTTB transmissions only occurring from Willoughby for the field trials. The combinations involved are defined in “Transmission Scenarios” section.

All transmissions were in Band III VHF (174 to 229 MHz) on 7 MHz channels:

for PAL:	CH 7 with 182.25 MHz Vision carrier
	CH 9 with 196.25 MHz Vision carrier
	CH 10 with 209.25 MHz Vision carrier
for DTTB:	CH 6 174 to 181 MHz channel - centre 177.5 MHz
	CH 8 188 to 195 MHz channel - centre 191.5 MHz

Note: All PAL transmissions used the dual sound carrier system with the “mono” carrier at +5.5 MHz and the right channel carrier at +5.742 MHz from the vision carrier.

The basic parameters of these sites are:

	Willoughby	Artarmon
Geographic Coordinates:	332898E	331505E
	6257074N	6257734N
Site Ground Height:	71.6 m	101.8 m
Tower Height:	233.2 m AGL	203 m AGL
	304.8 m ASL (1000 ft)	304.8 m ASL (1000 ft)
Antenna Array centre:	223 m AGL	192 m AGL
Antenna Array type:	Broadband 4 side x 6 bay	Broadband 6 side x 6 bay
Antenna Gain (nominal):	x 10 Omni-directional	x 10 Omni-directional
Nominal ERP (for PAL):	100 kW	100 kW
Transmitter power (PAL):	10 kW	10 kW

6.1 Transmission Antenna Radiation Patterns Top

Vertical Radiation Pattern (VRP):

The predicted VRP’ for the Willoughby and Artarmon antennas, plotted as field strength versus distance, are attached and indicates:

(a) Reception from main lobe starts at approximately 3.5 km

(b) In area less than 3.5 km the difference between reception F/S from Willoughby and Artarmon is determined by :
- (i) towers being separated by 1.5 km
- (ii) difference in basic VRP’s by up to 10 dB approx.
- (iii) high radial variation in Artarmon antenna’s VRP
- (iv) HRP variations
- (v) terrain and buildings

(c) 97% of the population obtains reception from the main lobe.

Horizontal Radiation Pattern (HRP):

The difference in the free space field strengths beyond about 8 km from the transmission towers is primarily due to the difference in the HRP's. This difference is plotted on the "HRP Comparison" plot attached and shows:

(a) The difference in HRP ripple and orientation, when DTTB and PAL is transmitted from separate towers, should result in +/- 2 dB variation around the nominal difference in transmit powers from the transmission sites. During interference testing where all PAL channels are transmitted from Artarmon and the DTTB transmissions come Willoughby, all PAL channels have the potential of equal interference from the DTTB channel. During the field trials the interference potential is mainly into CH 7 with DTTB on CH 8.

(b) When assessing interference, a bias towards azimuth's 60° and 285° may be wise.

(c) When assessing DTTB performance, the higher ratio between PAL and DTTB transmissions should be at azimuth's 80°, 130°, 260° and 310°.

As the towers are 1.5 km apart the difference in the F/S received from each tower should be higher along the azimuth in line with the towers and decrease from approximately 6 dB at 1.5 km to less than 1 dB at 8 km from the nearest tower. Hence sites on 118°TN azimuth (SSE) from the Willoughby tower (DTTB transmissions) should have transmission ratios with lower values nearer the tower than the HRP comparison plot indicates. Whereas on 298°TN azimuth (NWW) from the Artarmon tower (PAL transmissions) should have transmission ratios with higher values nearer the tower than the HRP comparison plot indicates. This geometric effect of influencing the ratio between PAL and DTTB may help explain some of the observed ratios in the field.

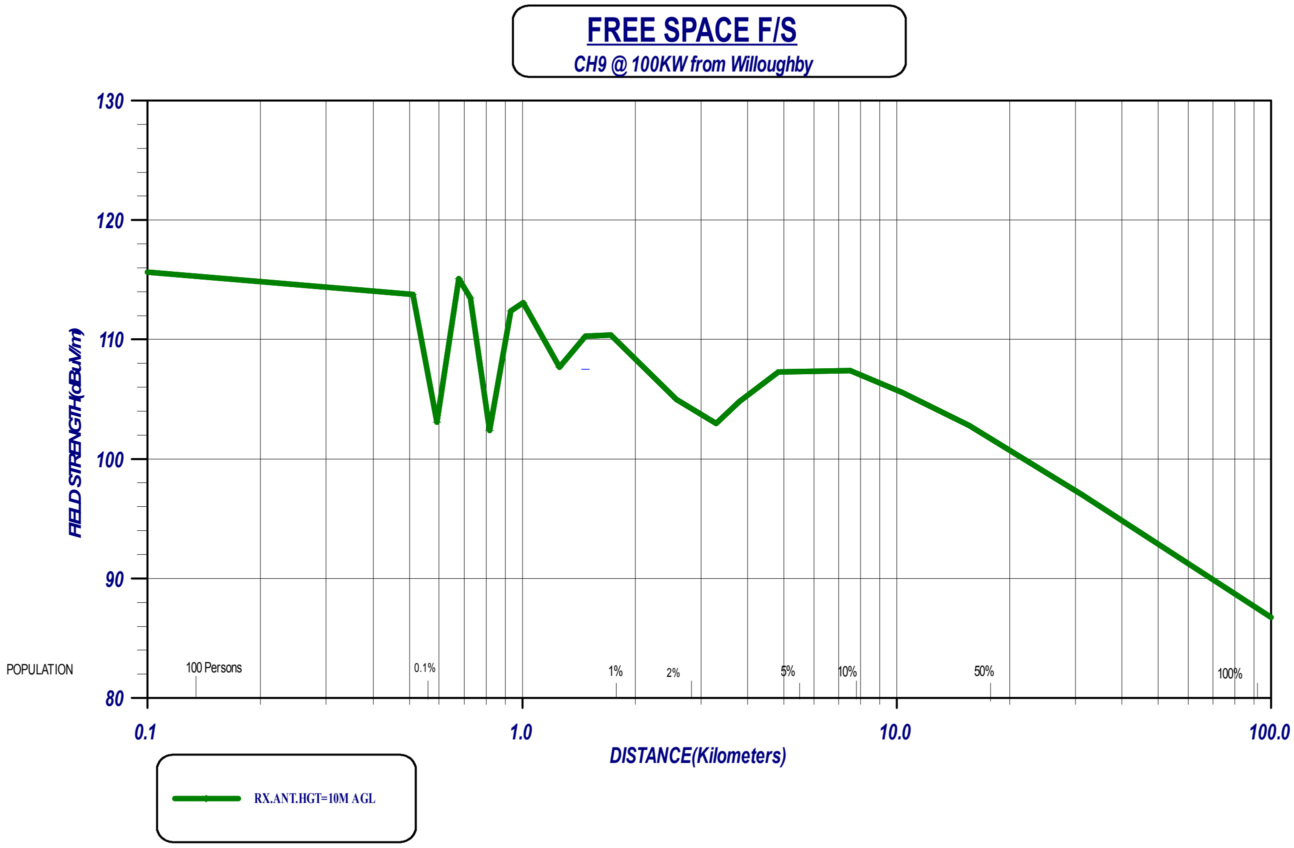
The antenna VRP's and HRP's define the following:

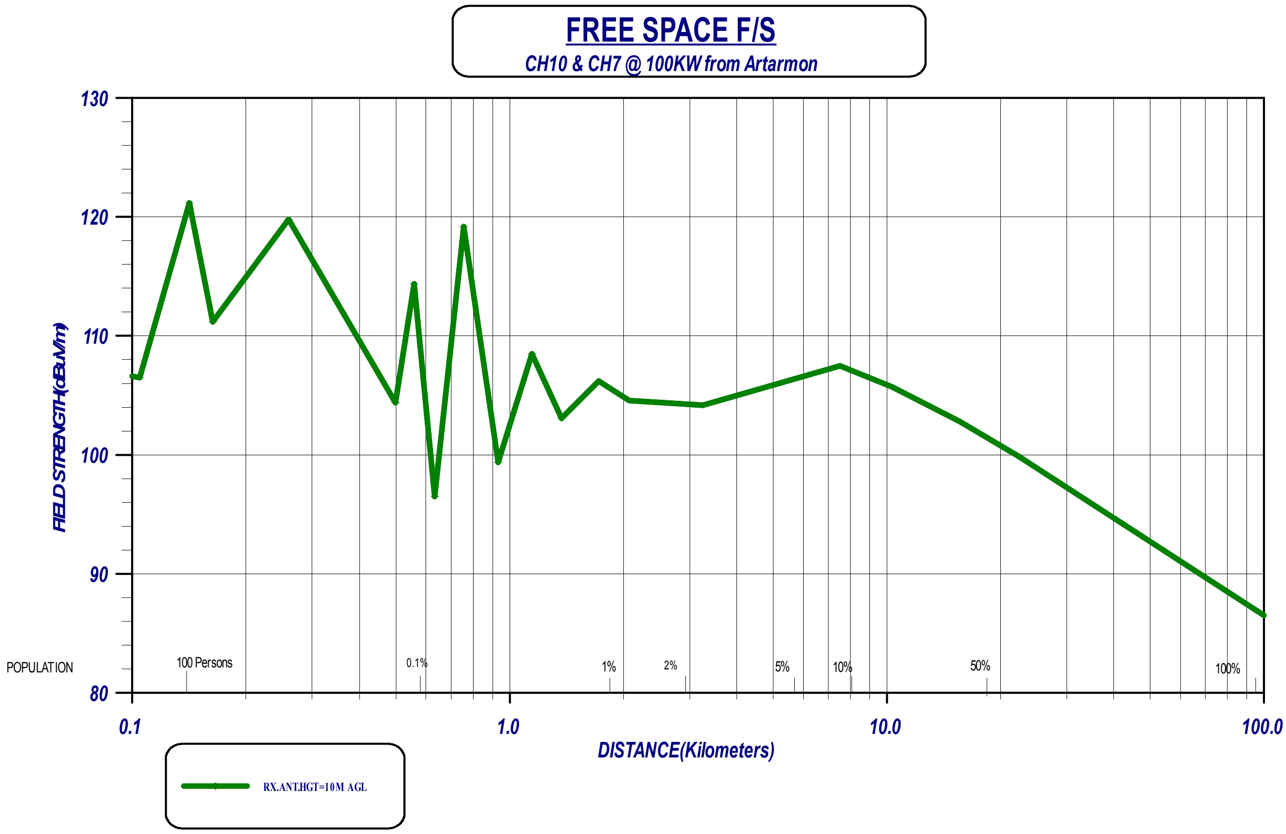
(1) The area covered by the "main lobe" starts approximately 3.5 km radius from the transmission antenna, will be referred to as the "far field" and is dictated substantially by the HRP. 97% of the population receives from the main lobe.

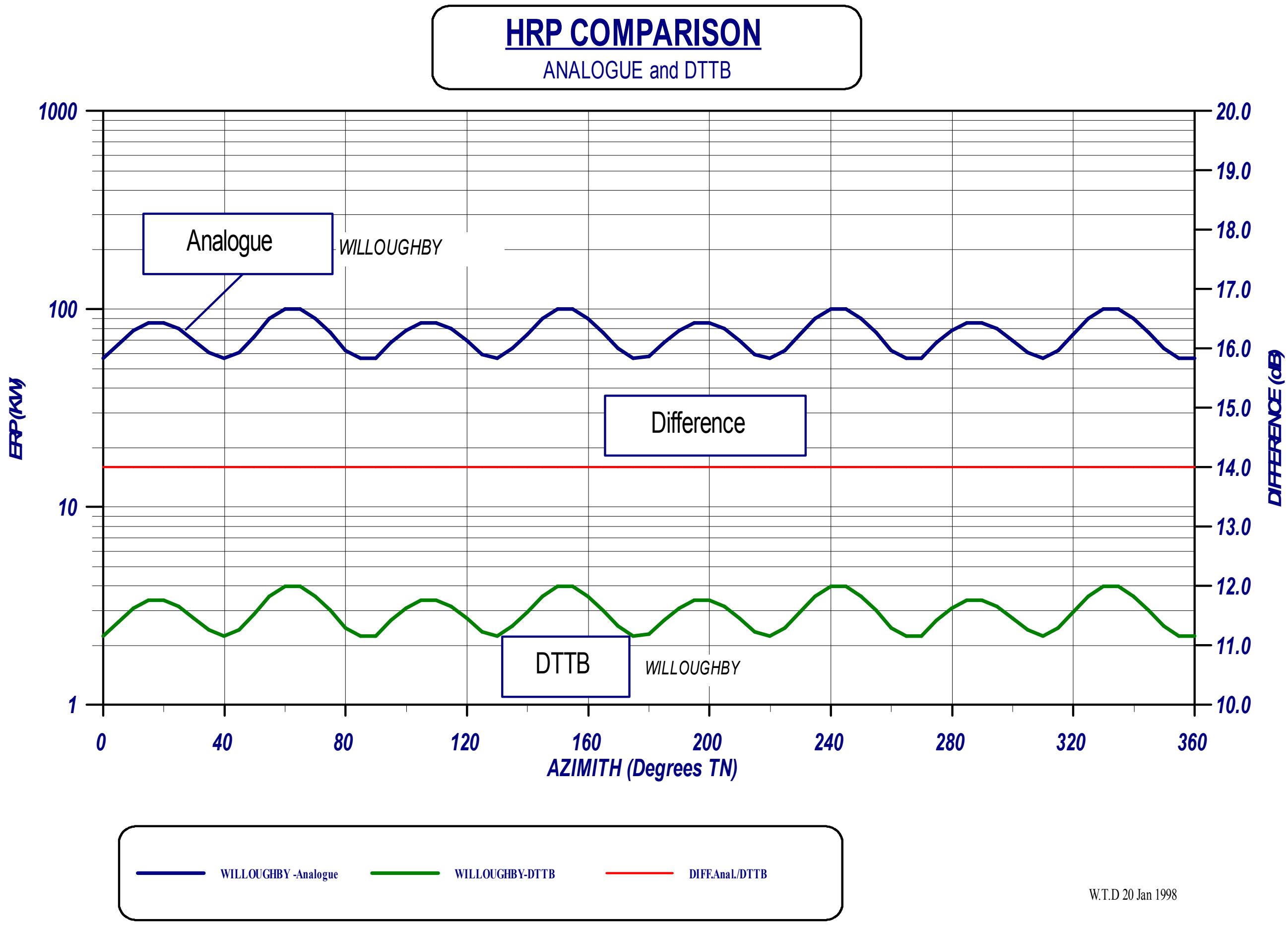
(2) The area enclosed by an area of 3.5 km radius from the transmission antenna is effected by both the VRP and the HRP and will be referred to as the "VRP field". Approximately 3% of the population (approx. 98,000 people/39,000 dwellings) is enclosed in this area.

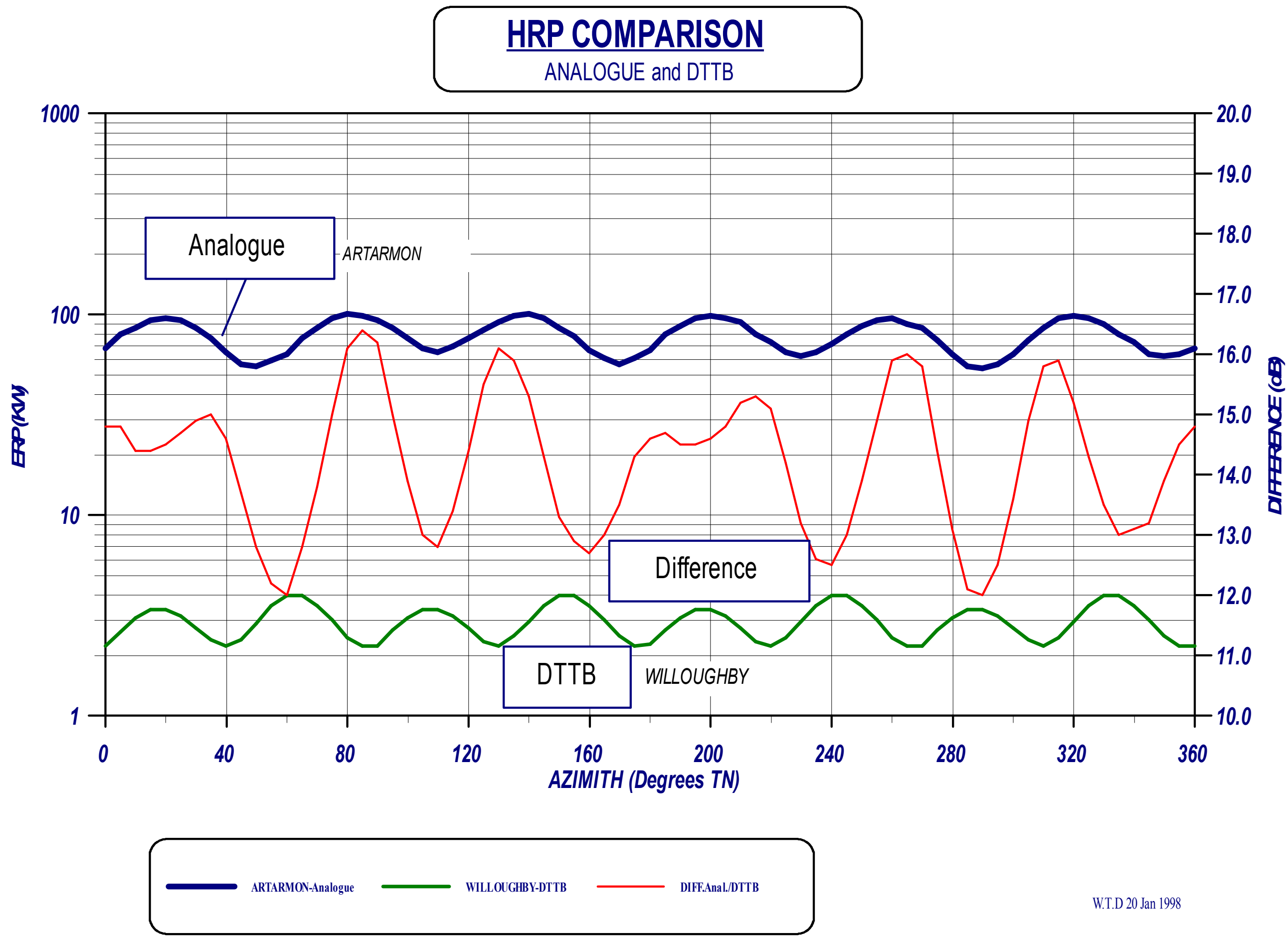
(3) The area enclosed by an area of 2 km radius from the Willoughby tower was specifically investigated for interference into PAL receivers from DTTB transmissions, as predicted by Comms. Lab. Report 96/3. This area will be referred to as the "near field". Approximately 1% of the population (40,000 people) is enclosed in this area, although the area predicted in the report with potential interference is only a segment (estimated to be up to 17500 people/6300 dwellings) of this total enclosed population. The report is also based upon a receiver having a sensitivity to a DTTB to PAL ratio -12 dB (PAL highest) which is around the limit of perceptibility ("LOP" method).

(4) During the interference test period, spot checks over the whole coverage area with the limit defined by the nominal 50 dBuV/m for PAL reception was checked with the knowledge of the HRP, VRP and terrain.


FREE SPACE F/S
CH9 @ 100KW from Willoughby
130
120
110
100
90
80
FIELD STRENGTH (dBuV/m)
POPULATION
100 Persons
0.1%
1%
2%
5%
10%
50%
100%
0.1
1.0
10.0
100.0
DISTANCE(Kilometers)
RX.ANT.HGT=10M AGL


FREE SPACE F/S
CH10 & CH7 @ 100KW from Artarmon
130
120
110
100
90
80
FIELD STRENGTH (dBuV/m)
POPULATION
100 Persons
0.1%
1%
2%
5%
10%
50%
100%
0.1
1.0
10.0
100.0
DISTANCE(Kilometers)
RX.ANT.HGT=10M AGL


HRP COMPARISON
ANALOGUE and DTTB
Analogue
WILLOUGHBY
Difference
DTTB
WILLOUGHBY
ERP (KW)
DIFFERENCE (dB)
AZIMITH (Degrees TN)
WILLOUGHBY -Analogue
WILLOUGHBY-DTTB
DIFF.Anal./DTTB
W.T.D 20 Jan 1998


HRP COMPARISON
ANALOGUE and DTTB
Analogue
ARTARMON
Difference
DTTB
WILLOUGHBY
ERP (KW)
DIFFERENCE (dB)
AZIMITH (Degrees TN)
ARTARMON-Analogue
WILLOUGHBY-DTTB
DIFF.Anal./DTTB
W.T.D 20 Jan 1998

7 TRANSMISSION SCENARIOS: [Top]

The transmission scenarios that were available are listed below. The sites used were the Willoughby and Artarmon locations, both with 1000ft ASL high towers located 1.5 km apart. Both antennas are "omni" broadband arrays covering CH 6 to CH 12 of Band III VHF (174 to 229 MHz) with nominal ERP of 100 kW peak sync. for PAL transmission.

Circumstance and convenience has dictated that the DTTB transmitters were located at the Willoughby TCN site.

The equipment supplied by manufacturers which made this trial possible were:

- (1) DMV COFDM Modulators
- (2) DMV COFDM Demodulator
- (3) DMV MPEG-2 ML@MP Encoders with multiplexer
- (4) ZENITH 8VSB Demodulators
- (5) HARRIS 8VSB Modulators
- (6) NEC 200 W DTTB Transmitter
- (7) HARRIS 1 kW Transmitter
- (8) RFS CH 6/CH 8 Combiner
- (9) RFS CH 8 Adjacent Channel Combiner
- (10) HP VSA real spectrum analyser
- (11) R & S (Advantest) spectrum analyser

Items (1) to (7) have been extensively bench tested by the DCA Communications Laboratory in Canberra and are the subject of Report 98/01.

The following transmissions scenarios could occur conveniently:

(A) **CH 6** with **8VSB** & **CH 8** with **COFDM** @ Willoughby - CH 6/CH 8 Combiner
CH 7, CH 9 & CH 10 PAL @ Artarmon

(B) **CH 6** with **COFDM** & **CH 8** with **8VSB** @ Willoughby - CH 6/CH 8 Combiner
CH 7, CH 9 & CH 10 PAL @ Artarmon

(C) **CH 8** with **COFDM** & **CH 9** PAL @ Willoughby - CH 8 Adjacent Channel Combiner
CH 7 & CH 10 PAL @ Artarmon

(D) **CH 8** with **8VSB** & **CH 9** PAL @ Willoughby - CH 8 Adjacent Channel Combiner
CH 7 & CH 10 PAL @ Artarmon

The control of the DTTB transmission on CH 6 and CH 8, and the reversal of modulation scheme between CH 6 & CH 8, was remotely controlled by phone to provide efficient control during interference testing and the field data collection.

Scenarios (A) and (B) were used when testing for interference.

Scenarios (C) and (D) were used for all other testing.

8 TEST SCHEDULE: Top

(A) Transmission Preparation **18 Sept. to 26 Sept.**

- (i) CH 6 & CH 8 Transmitters check and calibration
- (ii) COFDM and 8VSB modulation check
- (iii) MPEG-2 encoders (for COFDM) check
- (iv) CH 6/CH 8 Combiner check
- (v) CH 8 Adjacent Channel combiner check and associated group delay corrector alignment for CH 9 transmitter (in dummy load).
- (vi) Phone operated control system check
  - individual on/off control of CH 6 & CH 8 Transmitters
  - interchange of modulation scheme between CH 6 & CH 8

(B) Survey Vehicle Calibration **22 Sept. to 26 Sept.**

(C) Adjacent Channel Combiner Test **26 Sept. 2am to 5am**

(D) Survey Vehicle Familiarisation **29 Sept. to 2 Oct.**

29 Sept. **(i)** Start Trial. PAL transmissions only – survey vehicle familiarisation.
30 Sept. **(ii)** DTTB Transmissions at low power (50 W) during daytime hours preferred CH 6/CH 8 combiner.
1 Oct. **(iii)** DTTB Transmissions at low power (50 W) during daytime hours on CH 8 Adjacent channel combiner.
2 Oct. **(iv)** DTTB Transmissions at low power (50 W) during daytime hours on CH 6/CH 8 combiner.
3 Oct. **(v)** Survey Vehicle - general preparation

(vi) **"Test –1" at Site A completed**

(E) DTTB Power adjustment **7 Oct. to 9 Oct.**

7 Oct. **(i)** "Near field" interference check. CH 9 at Artarmon, increase power on CH 6 & CH 8 to 200W - check for interference into PAL CH 7 & CH 9. in Willoughby area.
8 Oct. **(ii)** Continue near field interference check – increase power of CH 8 in steps up to 850 W in location previously chosen as lowest ratio of PAL to DTTB.
8 Oct. **(iii)** With maximum power obtained from "near field" checks, survey sample locations in Sydney.
9 Oct. **(iv)** **Meeting** to agree on transmission parameters and hours of operation.

Agreement: (see Interference Test Plan section)

Nominal 400 W transmitter power (4 kW ERP) in daytime hours with DTTB on CH 8 ONLY through the adjacent channel combiner. DTTB and CH 9-PAL from Willoughby Tower.

(F) DTTB transmission data collection **9 Oct. to 31 Oct., 10 Nov. to 14 Nov.**

9 FIELD TRIAL PROCEDURES [Top]

9.1 INTERFERENCE TEST PLAN: [Top]

As the Sydney main VHF TV transmission towers are located within a densely populated area in Sydney extensive planning and testing has occurred.

Interference definition:

When the DTTB signal achieves a level on the adjacent channel to the PAL transmissions, to cause interference to the vision and/or the sound of the PAL reception in a particular receiver, an undesired effect is produced leading to the potential that viewer complaint may occur. Hence a search for such interference is required as an input to the decision to the level to set the DTTB power at in the large established analogue receiver population.

Interference levels:

The Communication Laboratory **Report 96/3** predicting the level of interference around the transmission tower region is based upon a **12 dB ratio** between DTTB (lowest) and PAL for the level of DTTB to cause interference into PAL in a test receiver. This suggests the investigation was conservatively towards the LOP (Limit Of Perceptibility) method of subjective assessment.

Acceptable level of interference:

The basic guide for the assessment of interference were the tests conducted in the Communications Laboratory (Comms. Lab.). These tests gave the allowable PAL to DTTB ratios in the frequency domain. In the absence of a complex translation of the tests into the time domain after demodulation, an estimation of the level of interference, which may be acceptable, is thought helpful to assist in the setting of the power for DTTB for the Trial.

VIDEO:

With the expected type of interference to be noise in nature, (and not of a coherent type where discrete patterning is involved), a suggested level of acceptable interference could be for the video S/N not to be degraded to less than **-43 dB unwtd** from any received video S/N of higher than this level.

AUDIO:

Again with the interference to be noise in nature, a suggested level of acceptable interference could be for the audio S/N not to be degraded to less than **-48 dB unwtd** from any received audio S/N of higher than this level.

Note: Compared to the average consumer receiver, as measured in the Comms Lab., the Plisch receiver used to demodulate video and audio in the Trial, is similar on the upper adjacent channel, but is significantly less sensitive (-4 dB as against 4 dB protection ratio-LOP) on the lower adjacent channel.

Interference Test Method:

A search was conducted around predicted locations for the lowest decreased ratio of DTTB power to PAL power from the nominally transmitted ratio. The video and audio S/N was noted as an input to a decision upon the level of DTTB power which may be transmitted for the field trials.

The DTTB power ratio was **initially -17 dB** (DTTB referenced to PAL), that is a DTTB transmitter power of 200 W (10 kW PAL). A search was then undertaken to find a number of worst locations having low ratios, ensuring that the locations are not very isolated examples.

At the representative locations the **video S/N ratio** was measured on the upper and the lower adjacent PAL channels with the DTTB signal on and off. The difference in video S/N was then the indication of interference.

Similarly the **audio S/N ratio** was measured, but this time only on CH 7 right channel (second carrier), with CH 8 DTTB being the interfering signal. To allow the test, ATN was requested to mute the right channel to allow the measurement to occur.

The **subjective method** of looking for interference was unlikely to produce any results especially at the power levels available and the viewing conditions in the survey vehicle. But as a caution a receiver was used to monitor the CH 7 and CH 9 during the investigations for interference.

The interference into PAL, due to both CH 6 and CH 8 was investigated. The DTTB power was limited by the CH 6 transmitter power of a maximum 200 W (-17 dB), with CH 8 having maximum transmitter power of 900 W (-10.5 dB) audio On **both COFDM and 8VSB**, the power was increased to look for any measurable amount of interference into video (vision) and or audio (sound).

9.2 RESULTS OF INTERFERRENCE TESTING [Top]

The operating DTTB power was determined during initial familiarisation and the interference test period of the Trial, which was conducted, with some caution, in the early hours of the morning.

9.2.1 Results

Sites B to G (Tests -2 to -8) were investigated for deterioration of launch ratios and S/N ratios.

Site	Dist. km	Power W	TX Ratio dB	Ratio change ref CH 7	ref CH 9	CH	Mod	Vid. S/N dB unwtd CH 9	Vid. S/N dB unwtd CH 7	AudioS/N dB unwtd CH 7
B	1.8	0	-	-	-	-	-	-48.8	-44.6	-
B	1.8	200	-17	+6.5	+5.9	8	COFDM	-47.7	-42.5	-
B	1.8	200	-17	+5.5	+5.3	8	8VSB	-48.1	-42.6	-
B	1.8	200	-17	+4.3	+3.8	6	COFDM	-	-	-
B	1.8	200	-17	+5.8	+4.9	6	8VSB	-	-	-
C	1.0	0	-	-	-	-	-	-47.2	-48.4	-
C	1.0	200	-17	+0.6	+4.4	8	COFDM	-46.6	-45.2	-
C	1.0	200	-17	+0.6	+4.4	8	8VSB	-46.9	-45.5	-
C	1.0	200	-17	+1.9	+5.7	6	COFDM	-	-	-
C	1.0	200	-17	+2.9	+6.7	6	8VSB	-	-	-
D	1.8	-	-	-	-	-	-	-	-37.1	-
D	1.8	200	-17	+16.7	+9.5	6	COFDM	-	-33.5	-
D	1.8	200	-17	+16.1	+10.7	6	8VSB	-	-33.5	-
E	9.7	0	-	-	-	-	-	-	-	-46
E	9.7	200	-17	-4.1	-3.2	8	COFDM	-48.6	-	-46
E	9.7	200	-17	-4.7	-3.8	6	8VSB	-	-47.9	-46
F	29.8	0	-	-	-	-	-	-27.4	-21.6	-
F	29.8	850	-10.7	-8.3	-9.8	8	COFDM	-27.4	-21.6	-
F	29.8	850	-10.7	-6.9	-8.4	6	8VSB	-27.4	-21.6	-
G	0.4	0	-	-	-	-	-	-45.3	-	-
G	0.4	200	-17	+8.3	+13.9	6	COFDM	-	-37.6	-
G	0.4	200	-17	+6.6	+12.2	6	8VSB	-44.3	-35.8	-
G	0.4	200	-14	+3.7	+9.3	8	COFDM	-42.5	-	1dBhigher
G	0.4	200	-14	+0.6	+6.2	8	8VSB	-	-	1dBhigher

Although the testing and the results represented a small sample, until more extensive testing, the following summary aligned well with general theory and was taken as the current guide:

(A) A maximum deterioration of the transmission ratio of DTTB to PAL was 16.7 dB. This was in a position where the PAL reception was severely effected by multipath.

(B) A common deterioration of the ratio of DTTB to PAL was around 6 dB within the 2 km radius area around the Willoughby Tower. This aligned well with predictions, and particularly around the 1.5 km line out from the Artarmon and Willoughby towers.

(C) With a resultant 10 dB ratio (DTTB on CH 8) the video S/N deteriorated from:
On CH 7 from 44.6 dB unwtd to 42.5 dB unwtd
On CH 9 from 48.8 dB unwtd to 47.7 dB unwtd

(D) At a Video S/N of around 45 dB unwtd and higher the “7 MHz” COFDM signal caused up to 0.5 dB more impact than the “6 MHz” 8VSB signal. Below 45 dB there was insignificant differences of the impact on PAL between COFDM and 8VSB.

(E) With a received ratio of -17 dB and an audio S/N of 46 dB unwtd, there was no measurable impact on CH 7’s right channel (second sound carrier).

(F) With a ratio of –10 dB and an audio S/N of around 43 dB unwtd, there was an impact of 1 dB by both COFDM and 8VSB on the S/N of the right channel of CH 7.

(G) The general consensus, after the testing for interference on CH 7 and CH 9 PAL, was that the receive ratio of –14 dB was safe for the period of the Trials. Taking this a step further, a transmission ratio of –14 dB (400W DTTB TX power) was agreed. Confidence was such, that in general, 24 hr-7 days a week transmission of DTTB occurred for the period of the trials.

(H) At the completion of interference testing it was felt that the future choice of DTTB power could only made after for example :

    (a) Analysis of the received ratios in the Trial.
    (b) Use of more representative receivers
    (c) A greater number of test sites especially in the vicinity of the towers.

9.2.2 Viewer complaints

For the period of the DTTB transmissions, which in general remained “on” over night in peak viewing hours:

(A) No relevant complaints were taken for viewers within a 5 km radius of the towers.

(B) No relevant complaints were taken from viewers for interference into vision.

(C) Four (4) complaints were taken by CH 7 complaining of sound interference on mono and stereo when broadcasting on DTTB (both COFDM or 8VSB). An investigation is occurring and will be the subject of a separate report.

9.3 TEST PROCEDURES: Top

To allow adherence to an underlying trial philosophy and to allow consistency in the data to be collected, the procedures to follow were adopted.

Trial Philosophy:

To investigate, with the available systems of COFDM and 8VSB modulation schemes, the infrastructure requirements for DTTB transmission. The DTTB system is to operate within, and provide equivalent coverage to, an established analogue PAL system. Following the ABA recommendations that the DTTB transmissions should use the adjacent channels within the spectrum and be in BAND III in the capital cities. For the trials in Sydney, two of the adjacent channels, CH 6 and CH 8 (mainly), will be used to provide the data.

Such testing in the field has been preceded by the thorough investigation of both systems on the "bench" by the Communication Laboratories in Canberra.

A desired result would be to be able to define the DTTB power requirements and the number of translators to provide equivalent coverage to the PAL services in Sydney. These FACTS could then allow greater insight into the requirements in other cities in Australia, which will operate in BAND III VHF.

General Procedures:

The attached "form" provides an insight into the flow and details of the procedure.

Some important points in the design of the procedures:

(a) The A*nalogue* PAL transmissions on CH 7, CH 9 and CH 10 will provide a reference for both coverage (level) and character (multipath and video S/N) and is called the *Analogue environment profile.*

(b) At each site both COFDM and 8VSB is to be tested on CH 8.

(c) All tests on COFDM and 8VSB are absolute measurements and will be valid in isolation.

(d) The *Spectrum* information is recorded in hard copy to provide spectrum character of the DTTB and PAL signals.

(e) The DTTB *C/N Threshold* measurements will provide the coverage information, and will be taken for both systems after the RS error correction.

(f) The DTTB *C/N Threshold* will be taken under *static* conditions as well under *dynamic* conditions (dynamic conditions being created by such mechanisms as varying level, varying multipath, interference- impulse or other, aircraft or vehicle flutter ie doppler echo, etc.)

(g) The *8VSB Information* from the analysis computer will help to provide the *Digital environment profile.*

(h) The C/N threshold figures collected at sites chosen with the *Site Selection Criteria* section, should provide a strong guide to defining the power required for DTTB. This of course will be enhanced by any data provided by the *Interference Test Plan* section.

(i) DTTB C/N Threshold measurements will be taken by both a conventional scanning Spectrum Analyser (SA) and a real time Spectrum Analyser (HP VSA).

(j) C/N threshold will be created with the aid either :
   (a) Injecting noise from a noise source and adjusting via the *noise attenuator* ie increasing the noise towards the signal.
   (b) Or by reducing the signal towards the noise floor of the measurement system by reducing the input signal via the *system attenuator*.

The general steps:

(A) Check calibration of Vehicle system before leaving compound. Calibration to include level check to each decoder.

(B) Site to be confirmed it complies with needs indicated in the *Site Selection Criteria.*

(C) Record the site details.

(D) Record the Analogue details ensuring by adjusting the "system attenuator" that the Plisch demodulator level does not exceed 80 dBuV on any channel.

(E) Plot from the VM700 lines 17 & 318 for baseband time and frequency domain records of the analogue site character. Record also the video S/N ratio. (unwtd - 5 MHz + Fs/c trap) on CH 9.

(F) Record the spectrum information for CH 7, CH 8, CH 9 & CH 10 by :

- Plotting spectrum – with Res. B/W 300 kHz, Video. B/W with averaging of 30
- Measuring spectral density of the DTTB spectrum – measure near the maximum of the spectrum.

(G) Record the power of the DTTB from the HP VSA. Plot the spectrum both wideband (20 MHz) to provide relationship to the adjacent channels, and CH 8 only (10 MHz) for "tilt" record.

(H) Record the attenuator setting at the Threshold C/N point of the DTTB system by increasing the noise injection attenuator to point just before errors occur – in the picture for COFDM and from the BER meter for 8VSB. Errors to be assessed over 2 minutes. A consistent method is to be developed. For COFDM an extra figure is to be recorded for the "Alarm" light.

(I) Record the Threshold of DTTB system similarly using the "system" attenuator.

(J) Record the 8VSB parameters

Detailed Procedures:

These procedures were the actual procedures followed in the field. The figures were recorded on the form similar to that on Page 21 of this report. The numbers in colour have been added for clarity and to be used in the following stepped procedure.

Site:

1. Time & date of test

2. Site no. and Test no. At one site there may be a number of tests. Typically if surrounding dwellings are likely to have "rabbit ear" reception then two tests, with a standard antenna and a dipole, is recorded.

3. Location – street and suburb

4. GPS co-ordinates with distance and azimuth from transmission point. The distance and azimuth is recalculated on spreadsheet as check of the entry.

5. Location class provides a general description of the site as defined in the "Site Selection criteria" section 11.2.

6. The nominal DTTB transmitter power.

Location interest check:

7. A registration of whether multipath and flutter are present in significant amounts. If not completed the analogue waveforms can be checked for echoes and the comments and dynamic reactions of systems can be checked for flutter presence.

8. A quick check of DTTB threshold. Entry to assist at site only. This entry is not used.

Analogue: *(Analogue environmental profile)*

9. The antenna type: A for standard antenna with gain, B for dipole, C for MATV system. The height is recorded, and determined by the average estimated height of the antennas of the surrounding dwellings.

10. The system attenuator setting. This attenuator reduces the signal and located directly the output of the antenna cable. It is adjusted only for two reasons:

- To reduce the level to a maximum of 80 dBuV into the Plisch demodulator and to other four devices on the output of five way splitter.
- To reduce the signal level for the "System noise" C/N threshold test.

11. Level into Plisch demodulator on CH 7, CH 9 and CH 10. 80 dBuV is to be avoided to ensure no equipment experience overload.

12. The video S/N ratio measured on the Tektronix VM700.

13. Calculation for site purposes only – used to allow awareness of the equivalent F/S without accounting for the system attenuator. Not used.

14. Calculation for site purposes only – used for quick inspection of data sheets for actual F/S. not used.

15. Waveform plots of CH 7, CH 9 and CH 10 to record the reception character as interpreted by analogue reception, for inspection, if required, for the reason for both analogue S/N and DTTB C/N deterioration. The S/N plot on C H9 for noise character record.

Spectrum: *(COFDM)*

16. CH 9 vision level as measured on the Advantest spectrum analyser and the HP VSA. Both use a zero span setting for the measurement.

17. COFDM spectral density with measuring frequency, for conversion in spreadsheet via signals B/W to power. – Plot of spectrum to capture character.

18. COFDM power measured with HP VSA. Both wide band (20 MHz) and narrow band (10 MHz) plots to be used to capture adjacent relationships and the "tilt" of the DTTB spectrum.

Threshold: *("Cliff" C/N)* ***(Static)****(COFDM)*

19. Noise Attenuator setting from the adjustment of noise injection to create a threshold just before the errors that are observed in the picture. A period of 2 to 3 minutes is to be used. This measurement assesses errors after Reed Solomon error correction. The pictures were encoded to a rate of 1.5 Mb/s which makes the picture display particularly sensitive to any errors.

20. At the threshold the analogue video S/N is measured on CH 9.

21. With the COFDM transmission switched off, the noise is measure by the HP VSA.

22. The noise also to be measured on the Advantest spectrum analyser.

23. Quick calculation of threshold at site as a "sanity" check using the VSA measured figures. If it is much less than 19 dB the figures should be rechecked.

24. Record noise attenuator setting where the decoders "alarm" light comes on.

25. System attenuator setting from the adjustment of signal level to a point just before the creation of errors in the pictures.

26. At the threshold the analogue video S/N is measured on CH 9.

27. Record the system attenuator setting where the decoder "alarm" light comes on.

Threshold: ***(Dynamic)****(COFDM)*

28. On a threshold which varying or erratic adjust the noise attenuator to point where no errors are observed.

29. Measure noise on the VSA with the COFDM signal off.

30. Quick calculation at site for interest and a sanity check.

Spectrum: *(8VSB)*

31. 8VSB spectral density with measuring frequency, for conversion in spreadsheet via signals B/W to power. – Plot of spectrum to capture character.

32. 8VSB power measured with HP VSA. Both wide band (20 MHz) and narrow band (10 MHz) plots to be used to capture adjacent relationships and the "tilt" of the DTTB spectrum.

Threshold: *("Cliff" C/N)* ***(Static)****(8VSB)*

33. Noise Attenuator setting from the adjustment of noise injection to create a threshold just before the errors are observed on the BER meter. A period of 2 to 3 minutes is to be used. This measurement assesses errors after Reed Solomon error correction.

34. At the threshold the analogue video S/N is measured on CH 9.

35. With the 8VSB transmission switched off, the noise is measure by the HP VSA.

36. The noise also to be measured on the Advantest spectrum analyser.

37. Quick calculation of threshold at site as a "sanity" check using the VSA measured figures. If it is much less than 15 dB the figures should be rechecked.

38. System attenuator setting from the adjustment of signal level to a point just before the creation of errors in the pictures.

39. At the threshold the analogue video S/N is measured on CH 9.

Threshold: (Dynamic)*(8VSB)*

40. On a threshold which varying or erratic adjust the noise attenuator to point where no errors are observed.

41. Measure noise on the VSA with the 8VSB signal off.

42. Quick calculation at site for interest and a sanity check.

8VSB information: (Digital environmental profile)

43. Record the readouts from the VSB decoder to provide a record of the received signal from the view of the 8VSB decoder's adaptive equaliser.

Antenna mispointing:

44. Rotate the antenna, both clockwise and anti clockwise, and record the angle just before the COFDM picture shows errors.

45. Similarly for 8VSB rotate the antenna, both clockwise and anti clockwise, and record the angle just before BER meter displays errors.

DTTB FIELD TRIALS - SYDNEY *by FACTS*

SITE :

Time :	1	Date :	1
SITE No:	2	TEST No.:	2
Location :	3		
Geographic Co-ordinates : 62	4 E	4 N	
Ref. Willoughby - AZ.	4	4 Km	
Location Classes :	5	DTTB TX Power :	6 Watts on CH8

Location interest check : ---------------------- Threshold(Approx.) ----------------------

Mulltipath :	7	Flutter :	7	COFDM :	8	dB 8VSB :	8	dB Diff.:	8

Analogue : (Analogue enviroment profile) Site Maximum F/S (Calc.)

Antenna type: 9 System Attenuator : 10 dB (A sys) 14 dBuV/m(max+A sys.)

Antenna AGL : 9 metres

		Level (Max. 80dBuV)	Video S/N	Simulated F/S (Calc.)
L17/318 Plot	CH7	11 dBuV	12 dB unwtd	13 dBuV/m (Level-9dB)
15 & S/N sp *L17/318 Plot*	CH9	11 dBuV	12 dB unwtd	13 dBuV/m (Level-9dB)
L17/318 Plot	CH10	11 dBuV	12 dB unwtd	13 dBuV/m (Level-9dB)

Spectrum :

CH9 Vis. Carrier : 16 dBuV VSA - CH9 Vis. Carrier : 16 dBm

---------------- *COFDM* ----------------		---------------- *8-VSB* ----------------	
Average Spectral Density :	17 dBuV/Hz^-2	Average Spectral Density :	31 dBuV/Hz^-2
(50MHz) *Spec.Plot* @	17 MHz	*(50MHz)* *Spec.Plot* @	31 MHz
&		&	
VSA power - CH8 (6.8MHz) :	18 dBm	VSA power - CH8 (6.8MHz) :	32 dBm
(20MHz) *VSA Plot* *Tilt Plot*	*(10MHz)*	*(20MHz)* *VSA Plot* *Tilt Plot*	

8-VSB Information : (Digital enviroment profile) 43

Tap Energy:		I/P S/N :	dB	Diff. S/N :	dB
Frame Noise:		O/P S/N :	dB	*Tap Plot*	*File*

Threshold : **Static**

("Cliff" C/N)

	---------------- *COFDM* ----------------		---------------- *8-VSB* ----------------	
	(just w/o picture errors)		(just < "0x10^-8" BER)	
	Noise Att.	@ Analogue Video S/N(CH9)	Noise Att.	@ Analogue Video S/N(CH9)
Noise inject :	19 dB ---------	20 dB unwtd.	33 dB ---------	34 dB unwtd.
	@ *VSA Plot*	*(20MHz)*	*VSA Plot*	*(20MHz)*
VSA noise :	21 dBm S/a:	22 dBuV/Hz^-2	VSA noise: 35 dBm S/a:	36 dBuV/Hz^-2
Check C/N :	23 (VSA power-VSA noise)(19dB)		Check C/N : 37 (VSA power-VSA noise)(14.5dB)	
Alarm light. :	24 dB			
	System /	@ Analogue Video S/N(CH9)	System	@ Analogue Video S/N(CH9)
System Noise:	25 dB ---------	26 dB unwtd.	38 dB ---------	39 dB unwtd.
	VSA Plot	*(20MHz)*	*VSA Plot*	*(20MHz)*
Alarm :	27 dB			

Threshold : **Dynamic**

("Cliff" C/N)

	---------------- *COFDM* ----------------	---------------- *8-VSB* ----------------
	(just w/o picture errors)	(just < "0x10^-8" BER)
	Noise Att.	Noise Att.
Noise inject :	28 dB	40 dB
VSA noise :	29 dBm	41 dBm
Check C/N :	30 (VSA power-VSA noise)	42 (VSA power-VSA noise)

Antenna mispointing :

COFDM-	44	deg.
+	44	deg.
8VSB -	45	deg.
+	45	deg.

W.T.DICKSON 10 October 1997 DTTBFT.WB3

Signed :

10 SURVEY VEHICLE: Top

10.1 SURVEY VEHICLE TYPE Top

The vehicle was a four-wheel drive Mitsubishi Express 2.4 ECI constructed as a general field survey vehicle supplied by the Australian Broadcasting Authority (ABA). The vehicle was prepared in a cooperative effort between the Communications Labs, TEN Sydney and ATN Sydney. A trailer mounted 5 kVA Onan petrol generator supplied the power.

The telescopic compressed air operated mast was extendable from 2.5 m to 10 m.

The photographs show the vehicle in operation.

10.2 VHF Receive Antenna calibration Top

The high gain VHF Band III antenna (type Y10/6A) used in the Trials was manufactured by HILLS INDUSTRIES LTD. in Adelaide. The antenna was tested on the HILLS antenna test range in Adelaide and provided with a calibration chart, a copy of which is included in ANNEX 3.
The front to back ratio was measured in the field at two locations:

Test 75 (Richmond Airfield)

@ CH 7	12 dB
@ CH 9	12 dB
@ CH 10	17.5 dB

This site was influenced by multipath.

Test 91 (North Head)

@ CH 7	15 dB
@ CH 9	28 dB
@ CH 10	22 dB

This site was virtually free of multipath giving some confidence this measurement represented the actual performance of this antenna.

10.3 Plisch Demodulator Performance Top

The Plisch professional demodulator was used to measure the analogue levels existing within the vehicle system and demodulate to vision and audio. This vision was then recorded at selected times through the Tektronix VM700. The signal presented to the "Plisch" is matched to that on the inputs to the DTTB receivers and the spectrum analysers.

The measured performance showing the video S/N as a function of field strength, including the deduction of the NF, is included in Annex 3. Also indicated on the chart is the performance with the amplifier used in the survey vehicle.

10.4 System Gains Top

The gains measured from the input of the system (antenna output) to input to each DTTB decoder, spectrum analysers, and PAL demodulator are included in Annex 3. The gains were within 0.1 dB and are independent of the required setting of each device.

All cables used were double shielded which to avoid any problems of interference within the vehicle and from outside the vehicle. A FM trap included near the antenna avoid any influence in some the environments were FM could a possibility.

10.5 Amplifier Gain and NF Top

The amplifiers used within the survey vehicle were based upon an IC type MAV11 and was designed and mounted into enclosures by the Comms. Labs. The Comms. Lab. measured the performance, indicating NF, is included in Annex 3. The measured performance indicating gain and overload level is included in Annex 3.

10.6 Measurement System Accuracy's [Top]

A great deal of attention was paid to the facets of accuracy ranging through equipment, connection, test method, operator to overall system. Some of these are mentioned below:

The antenna, the interface from the system to the environment, was calibrated by the antenna manufacturer as described in para. 10.2. The accuracy was suggested to be within +/- 1 dB.

The system wiring with amplifiers and splitter was calibrated within +/- 0.1 dB. All cabling was environmentally stable and double shielded. The whole system was 50 ohms from antenna matching transformer to the measuring equipment inputs.

All measuring equipment along with the system was checked for calibration every day and generally was found to be within +/- 0.5 dB. The calibrating test transmitters could have been the source of some of the inaccuracies.

The individual equipment accuracy depended, in case of the Spectrum Analyser, on the particular test being performed. That is the analogue level measurement through a 1Hz span technique may provide an accuracy of within +/- 0.5 dB, when a spectral density measurement was performed this not only depends upon the operator "eye balling" the correct point but will depend on other conversion factors best known to the spectrum analyser manufacturer. A study of the measured figures in the trial would provide some indication of possible inaccuracies of the spectrum analyser method.

The stability of the noise source, being a Rohde & Schwarz noise source SUF 2 plus up converter, has a stability of better than +/- 0.5 dB.

The accuracy of the operator to judge the point of the DTTB threshold may prove to be the largest inaccuracy of no greater than 0.5 dB.

The data displayed on the plots 13.2.49 to 51 may provide some information, from an analysis, of the accuracy of the measuring instruments, measuring methods and the operator factor.

The PAL calibration was referenced to a Rohde & Schwarz URV 35 Power Meter with a Peak Power Sensor probe NRV-Z 31.

10.7 Peak to Average Ratio of COFDM and 8VSB modulation [Top]

The Peak to Average ratio was checked for both COFDM and 8VSB at the transmission site before and after the combiner by a technique called CDF (Cumulative Distribution Function) which is available on the HP VSA:

For 8VSB	Before	After	- Adjacent Channel Combiner
	CDF @ 90.00% = 3.16 dB	3.20 dB	
	CDF @ 95.00% = 3.95 dB	4.04 dB	
	CDF @ 99.00% = 5.26 dB	5.43 dB	
	CDF @ 99.50% = 5.66 dB	5.87 dB	
	CDF @ 99.90% = 6.39 dB	6.62 dB	
	CDF @ 99.95% = 6.65 dB	6.90 dB	
	CDF @ 99.99% = 7.14 dB	7.36 dB	

For COFDM	Before	After	- Adjacent Channel Combiner
	CDF @ 90.00% = 3.60 dB	3.61 dB	
	CDF @ 95.00% = 4.74 dB	4.76 dB	
	CDF @ 99.00% = 6.59 dB	6.63 dB	
	CDF @ 99.50% = 7.20 dB	7.27 dB	
	CDF @ 99.90% = 8.31 dB	8.41 dB	
	CDF @ 99.95% = 8.74 dB	8.82 dB	
	CDF @ 99.99% = 9.63 dB	9.64 dB	

The Peak to Average Ratio was also checked in the survey vehicle:

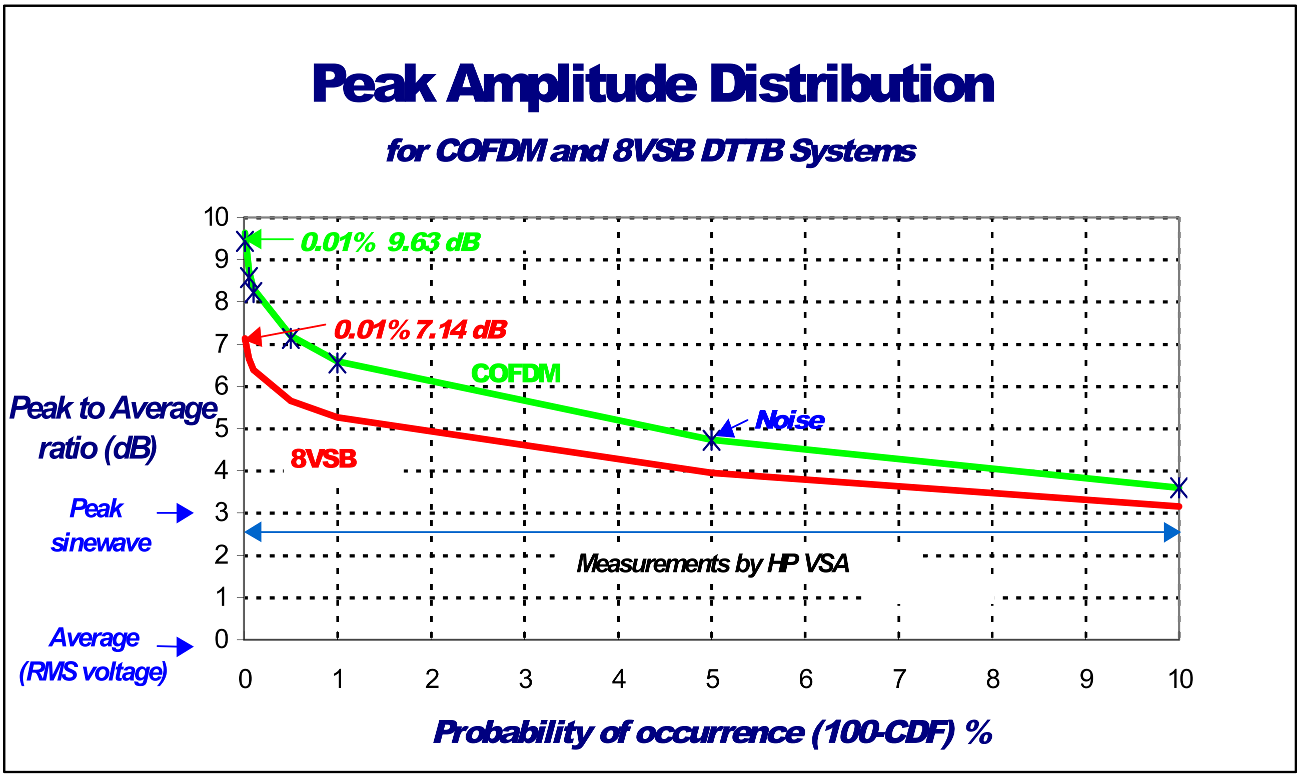
Noise source Peak to Average Ratio:

CDF @ 90.00% = 3.60 dB
CDF @ 95.00% = 4.72 dB
CDF @ 99.00% = 6.55 dB
CDF @ 99.50% = 7.13 dB
CDF @ 99.90% = 8.22 dB
CDF @ 99.95% = 8.57 dB
CDF @ 99.99% = 9.43 dB

Preamplifier noise Peak to Average Power Ratio:

CDF @ 90.00% = 3.60 dB
CDF @ 95.00% = 4.74 dB
CDF @ 99.00% = 6.61 dB
CDF @ 99.50% = 7.21 dB
CDF @ 99.90% = 8.39 dB
CDF @ 99.95% = 8.75 dB
CDF @ 99.99% = 9.66 dB

A graphical representation of the above recorded figures is given below:



Measuring for a CDF @	99.90%	99.95%	99.99%
8VSB	6.5 dB	6.8 dB	7.3 dB
COFDM	8.3 dB	8.7 dB	9.6 dB
Noise	8.3 dB	8.7 dB	9.6 dB

The distribution shows that there is a higher peak to average ratio for **COFDM** compared to **8VSB** varying from **1 dB to 2.3 dB**. The COFDM distribution is near identical to “white” noise.

This test was one of the essential prerequisites before starting the Trial. Also checked was the spectrum skirts of both the 8VSB and COFDM transmitted spectrums. The “skirts” relative to the spectrum centre were lower than –35 dB at all powers used in the Trials.

11 SYDNEY LOCATIONS [Top]

11.1 DEFINED AREA [Top]

The map included at the back of the report shows both the Licensed Service area and the PAL coverage area. The License Service area aligns to the Australian Bureau of Statistics - Sydney Statistical Region. The Coverage area reasonably matches the License Service area and is defined by the 50 dBuV/m curve from the main VHF transmission site.

11.2 SITE SELECTION CRITERIA: [Top]

The selection process was based upon the following criteria, both for the nominal and the “in the field” selection of the sites. The data from these sites will then be used in the analysis of the COFDM and 8VSB systems to be used in the DTTB field trials in Sydney in October to November 1997.

Each site generally had a combination of the following characteristics. An attempt was made to have an adequate sampling of the characteristics to generate statistically accurate results for both systems under test, along with clarity of comparison to the current analogue services in Band III. No testing was carried out on Band IV or V.

Sites representing:

(A) Population concentrations and centres. - Representing population majority.

(B) Rural reception. - Help in setting "free space" coverage power for DTTB.

(C) Urban reception - multistorey residential. - Dispersed multipath examples.

(D) CBD - multistorey offices. - Short multipath examples.

(E) Suburban - houses up to two storeys. - Variable character in terrain and foliage.

(F) Suburban - industrial. - Terrain and foliage variable with impulse noise.

(G) Power line interference. - Impulse noise in both low to high field strength areas.

(H) Existing Translator areas. - Assessment of need for DTTB Translators.

(I) Obscured reception for moderate populations - Assessment of possible need for further DTTB Translators.

(J) Over water reception - eg over Sydney Harbour. - High variable multipath.

(K) Beach area reception - Northern and Southern beaches. - Complex multipath.

(L) Aircraft Flutter. - Fast varying multipath.

(M) Omni-direction antenna reception in urban and suburban environments. - To assess continued popular use of "rabbit ear" antennas.

(N) Reception through distribution systems. Eg residential units, hotels and hospitals.

(O) Reception through vehicle traffic – trucks and buses for example producing flutter and or impulse noise.

11.2.1 Location bias and weighting

With a trial restricted to 27 days and a need to obtain information on all the different types of receive scenarios there was an unavoidable imbalance between the makeup of the trial's reception scenarios and that of makeup of the reception conditions of the viewing population.

Although it was found that the majority of sites were recorded with only around two sites not recorded as reception was next to ideal.

When at site the antenna was never turned to create a reception condition. The antenna's height up to 10 m was determined by the general height of the consumer's antennas. If the consumer's antennas were thought to be "rabbits ears", a dipole antenna was used also to obtain data.

Further will occur to assess if weighting the data would influence results.

11.3 GENERAL SITE STATISTICS Top

The following general statistics provide an idea of the extent of the trial. Future analysis can generate further statistics such as relationships to demographics, population, type of receiving system, etc.

Sydney statistics (approximate):

- 150 square km
- 3.7 million people
- 1.3 million dwellings

Field Trials of 3 October to 14 November 1997

- 27 days of testing
- 108 Sites
- 125 Tests
- 0.4 km to 100 km
- generally distributed around the compass
- 4 kW ERP DTTB with 100 kW ERP PAL (-14 dB ratio)
- Analogue F/S's from 40 dBuV/m to 105 dBuV/m
- DTTB F/S's from 30 dBuV/m to 90 dBuV/m
- Average Analogue F/S of 82 dBuV/m
- Average DTTB F/S of 68 dBuV/m

12 FIELD TRIAL DATA and COMPILATION Top

The Field Trial Data in the "raw" is included in twelve volumes in **Annex 1**. All figures are as written in the field by an independent consultant hired by "FACTS". The corrections, inevitable in such a survey, have been indicated, per page, by a black dot and by a circled figure. The majority were concerned with an error in an entry for a calibration "offset" into the Advantest spectrum analyser. The error was obvious and consistent over a block of tests, only proving to be a nuisance rather than any challenge to the accuracy or credibility of the data. Any other corrections were provided by checking the spectrum plots. The plots of the spectrum and the analogue waveforms provide the insight into character of the reception being reported. On selected tests some analysis data provided by the 8VSB decoder software was recorded to provide some information on the received signal as translated into the digital domain. The "comments" in the "raw data" has been included to complete the picture of the Sydney DTTB field trials.

All the figures were than compiled into a spreadsheet allowing the presentation of data into the graphical form. The compilation is provided in **Annex 2**. The calibration detail for the survey vehicle including such detail of antenna data, gains, NF's, calibration corrections play the required role in the spreadsheet and the resultant presented data, and are included in the compilation.

13 PRESENTATION OF DATA Top

The presentation of the data entered into the compilation in Annex 2 will allow the convenient study of the Analogue PAL and DTTB modulation systems COFDM and 8VSB. The "presentation" in graphical form follows the following explanations.

13.1 Identifiers used on Graphs Top

Before the descriptions of the presented data, a key to the use of the graphical presentation may be helpful.

Each Test, if applicable, has identified:

(A) The measuring instrument used as either :

- "Spectrum Analyser Measurement"
- "HP VSA Measurement"
- "Plisch Demod. Measurement"

For the measurement of video S/N a Tektronix VM700 was used.

(B) The method used to derive the figures :

- "Noise injection method" – to create a C/N ratio by adding noise to increase the noise floor with the signal fixed.
- "System Noise Floor" – to create a C/N ratio by decreasing the signal towards the fixed noise floor.

(C) The System by colour coding :

- COFDM figures are always identified as a green rectangle.
- 8VSB figures are always identified as a red rectangle with a cross
- CH 7 figures – blue cross
- CH 9 figures – red asterisk
- CH 10 figures – green plus

(D) The "Test #" used on the x axis identifies the test number and is used as the index number to all the tables in the compiled data sheets.

The majority of data was obtained from Tests 1 to 113. The axis segment –15 to 0 include tests 1 to 12 in the first week of the trial, which were primarily used for familiarization and to investigate interference. Hence these first week tests have not been used to any significant way or in any averages indicated in the presentation.

13.2 Detailed description of graphs [Top]

The following descriptions are intended to provide both understanding and the source of the presented data.

The graph may be found, for example,
in paragraph 13.2.4, the graph number is " GRAPH 4".

Tests 94, 103, 197, 109, 111 and 113 were carried out without the amplifier in the system in the survey vehicle so the un-amplified signal was presented to the input of the decoder. This test was an experiment to show the role that the decoder NF plays. The only graphs affected by this change to the system are graphs 28, 29, 34 and 35.

LOCATIONS

In the compiled data under "LOCATIONS" the site descriptions may be found. At each site there could be a number of tests carried out, so in this presentation the test number (Test #) has been used as the index function.

13.2.1 Site Location Geometry

This presentation of the locations of the site gives an idea of the distribution across Sydney through distance and azimuth from the Transmitting Tower. The map at back of the report will help locate the sites.

13.2.2 Azimuth to Test # Conversion

By using this plot a Test # or site may be found at a particular azimuth from the Transmitting Tower

13.2.3 Compass Field Strengths

The DTTB field strength distribution can be observed from this plot of both COFDM & 8VSB F/S against azimuth.

ANALOGUE TEST RESULTS

13.2.4 ANALOGUE FIELD STRENGTHS

CH 7, CH 9 and CH 10 F/S are shown plotted against distance from the tower, to show the extent of variation from the free space F/S there is in the typical reception environment. This F/S is calculated using the figures provided from the calibration figures of the Antenna, system gain etc. All calibration detail is provided in Annex 2 – the Compilation of Field Data.

13.2.5 TEST # versus ANALOGUE FIELD STRENGTHS

The plot of Test # against analogue F/S allows the ability to look up a particular F/S perhaps to analyse the figures. This was an analogue demodulator measurement.

13.2.6 ANALOGUE FIELD STRENGTH – CH 9 (on VSA)

The CH 9 F/S was also measured with the HP VSA (VSA) to allow equivalent measurement technique comparison with the DTTB signal. (CH 9 was chosen as it transmitted from the same tower as the DTTB signal and is the closest vision carrier.) The HP VSA was not available for tests 55 to 90.

13.2.7 ANALOGUE FIELD STRENGTH – CH 9 (on SA)

To relate the F/S measurement techniques to familiar and readily available equipment like a standard spectrum analyser, the level of CH 9 was measured using the Advantest Spectrum Analyser (SA).

13.2.8 FIELD STRENGTH versus VIDEO S/N for CH 7

By using the Plisch PAL demodulator with a Tektronix VM700 the video S/N unwtd for CH 7 was measured and plotted against F/S. This plot provides an interesting insight into and is reminder that the S/N is influence by other factors rather than just the F/S.

Both the "transmitted video S/N" and the video S/N dictated by the "truck" system performance are plotted as a check of validity of the figure taken. The "truck" performance is dictated by, at the lower levels, the system amplifier NF of approximately 4 dB and at the higher levels, by the attenuation required to limit the input level to the equipment to avoid overload (a maximum of 80 dBuV per channel of analogue levels was allowed). The "transmitted video S/N" is a combination of the transmitted S/N, the feed method (link or fibre) video S/N, and at especially at the lower F/S's, what thermal noise allows.

13.2.9 FIELD STRENGTH versus VIDEO S/N for CH 9

As above but for CH 9

13.2.10 FIELD STRENGTH versus VIDEO S/N for CH 10

As above but for CH 10

13.2.11 TEST # versus VIDEO S/N for CH 7

Relates a Test # with a particular video S/N for CH 7.

13.2.12 TEST # versus VIDEO S/N for CH 9

As above but for CH 9

13.2.13 TEST # versus VIDEO S/N for CH 10

As above but for CH 10

13.2.14 ANALOGUE PICTURE QUALITY

Provides knowledge of the levels of PAL picture quality covered in the trial. Also allows an index to check how DTTB reception may reacts in particular PAL quality environment.

DTTB F/S

13.2.15 DTTB FIELD STRENGTHS (VSA)

The COFDM and 8VSB F/S, the power being measured by the HP VSA (VSA), are displayed against the distance from the tower. Such information such as range of F/S's will be useful for planning.

13.2.16 **DTTB FIELD STRENGTHS** (SA)

As above the level measured with the Advantest Spectrum Analyser (SA). Spectral Density was measured, than the F/S was calculated using B/W, as related to the system under test, the other conversion factors for F/S.

13.2.17 **TEST # versus DTTB FIELD STRENGTHS** (VSA)

This plot provides both the distribution statistics and the capacity for an index to other components of a particular test. The measurement was performed with the HP VSA which unfortunately was not available for period fro Test 55 to 90.

13.2.18 **TEST # versus DTTB FIELD STRENGTHS** (SA)

As for above but test performed with the Advantest spectrum Analyser.

13.2.19 **VARIATION from DTTB to PAL (CH 9) RATIO** (VSA)

The ratio between CH 9 peak sync. vision carrier power and DTTB power was assessed by level measurement with the HP VSA. These levels were than compared and normalised to the nominal launch ratio of 14 dB. The average difference between COFDM and 8VSB was calculated from these figures as 0.74 dB with 8VSB the higher.

13.2.20 **VARIATION from DTTB to PAL (CH 9) RATIO** (SA)

As above but measured with the Advantest SA. This technique provided a similar average of 0.7 dB with 8VSB the higher.

DTTB C/N THRESHOLDS

13.2.21 COFDM THRESHOLD C/N (Noise/VSA)

The COFDM threshold C/N has been plotted against the Test #, allowing the distribution and the character to readily sited along with allowing linking to other tests. The Noise Injection method has been along with measurement via the HP VSA.

13.2.22 **COFDM THRESHOLD C/N** (Noise/SA)

As above but measured with the Advantest SA.

13.2.23 **8VSB THRESHOLD C/N** (Noise/VSA)

As in 13.2.21 but with 8VSB modulation.

13.2.24 **8VSB THRESHOLD C/N** (Noise/SA)

As in 13.2.22 but with 8VSB modulation.

DTTB C/N THRESHOLD COMPARISONS

13.2.25 COFDM & 8VSB THRESHOLD C/N (Noise/VSA)

To allow convenient comparisons both COFDM and 8VSB have been plotted together. The Noise Injection method was used along with measurement by HP VSA.

13.2.26 COFDM & 8VSB THRESHOLD C/N (Noise/VSA att.)

When the Threshold C/N became high the noise injected was low hence the measurement via the HP VSA with its relative higher noise floor had the potential of influencing the measurement. Please refer "Noise Measurement Method" plot for COFDM and 8VSB, which will show the potential influences, although not substantial. The noise derived from the measurement of the noise level at a high level, was used to obtain the threshold C/N.

13.2.27 COFDM & 8VSB THRESHOLD C/N (Noise/SA)

Again for convenient comparison 13.2.22 and 13.2.24 has been combined to show the Threshold C/N of both COFDM and 8VSB modulation systems when measured with a Spec. Anal. With the noise injection method.

13.2.28 COFDM & 8VSB THRESHOLD C/N (System/VSA/COFDM Dec.NF=4.6 dB)

With the use of the System noise method for determining threshold C/N and measurement the HP VSA both threshold C/N are shown. With a number of tests being without the system amplifier it was noted that the NF of the COFDM decoder did not align to that measured in the Comms Lab. as these Threshold carrier to noises did not equate to the values found by other measurement techniques.

13.2.29 COFDM & 8VSB THRESHOLD C/N (System/VSA/COFDM Dec.NF=10.7 dB)

Following from the above test, showing a lack of alignment with the COFDM decoder NF = 4.6 dB with other reliable methods the NF of the COFDM decoder was adjusted when calculating to a NF of 10.7 dB. This then provided alignment. The 8VSB decoder NF was found to agree closely with the Comms Lab. Assessment of decoder NF.

13.2.30 COFDM & 8VSB THRESHOLD C/N (System/SA/COFDM Dec.NF=4.6 dB)

As for 13.2.28 but Spec. Anal. Measurement method used.

13.2.31 COFDM & 8VSB THRESHOLD C/N (System/SA/COFDM Dec.NF=10.7 dB)

As for 13.2.29 but Spec. Anal. Measurement method used.

13.2.32 DTTB Decoder NF

The field tested threshold C/N's of both COFDM and 8VSB are plotted for the pairs of thresholds relating to the tests with amplifiers in and out, against the relevant noise floors.

COFDM & 8VSB DIFFERENCE

13.2.33 **COFDM versus 8VSB – THRESHOLD C/N** (Noise)

A direct comparison was made by taking the difference between COFDM and 8VSB Threshold C/N's and displaying them against the Test #. This provides a very convenient way of choosing the tests of interest and going to the raw data to investigate the character further. The threshold C/N was measured using the noise injection method.

13.2.34 **COFDM versus 8VSB – THRESHOLD C/N** (System)(COFDM Dec. NF=4.6 dB)

As above but using the system noise method. For COFDM the decoder NF was entered for calculation at a NF = 10.7 dB. The threshold differences align well with other methods.

13.2.35 **COFDM versus 8VSB – THRESHOLD C/N** (System)(COFDM Dec.NF=10.7 dB)

As above but with a COFDM decoder NF = 10.7 dB. The thresholds related well with other tests.

13.2.36 **NOISE & SYSTEM ATTENUATOR DIFFERENCE** (All corrections)

By cautiously studying the difference in the noise attenuator settings, measurement inaccuracies could be minimised. With a correction for both the inequality of COFDM and 8VSB launch powers and a correction for the inequality of noise presented to each decoder (due to the difference in bandwidth between the decoders), the plot provide the difference between the DTTB modulation systems

13.2.37 **NOISE & SYSTEM ATTENUATOR DIFFERENCE** (power correction)

As above but only with correction for power inequality.

13.2.38 **NOISE & SYSTEM ATTENUATOR DIFFERENCE** (no corrections)

As above but with no corrections.

COFDM & 8VSB Differences in Dynamic Thresholds

13.2.39 COFDM & 8VSB DYNAMIC THRESHOLD C/N

The dynamic thresholds of both COFDM and 8VSB, measured by the noise injection method, were plotted against the Test #, again providing an index to other data for further analysis. The spectrum analyser figures were used in the absence of the HP VSA.

13.2.40 DIFFERENCE BETWEEN STATIC & DYNAMIC THRESHOLD C/N

To provide clarity to an analysis the variation or difference to static threshold is plotted. Again the noise injection method figures are used with the HP VSA being the measuring instrument except for Tests 55 to 90.

COFDM & 8VSB Decoder robustness

13.2.41 DTTB Environmental Robustness

By plotting all the cases in the field trial where the decoders either were not able to decode (ie no decoding of transport stream) or was constantly producing errors (ie unwatchable pictures), some idea of the extent of this effect can be obtained. Although this is a relatively small sample, discussion is a very worthwhile result of this presentation of the field results.

13.2.42 DTTB Dynamic Environmental Robustness

By plotting all the tests, which showed deterioration of the static threshold, by some dynamic condition, with reported cause marked, an idea can be provided of the extent of this condition. The term robustness is used, as the variation from the static threshold, threatens the safety of the static threshold level, if this level were used for planning.

13.2.43 ANALOGUE F/S @ DTTB decode failure

The analogue F/S with the index function of the Test # is displayed for the Tests where the DTTB decoder failed to decode at all. AS the signal level is limited to 80 dBuV/m for analogue the System attenuator setting has been noted. This is provided so when analysing whether the decoder was starved of level or whether another effect existed.

13.2.44 ANALOGUE PICTURE QUALITY @ DTTB FAILURE

This displays the state of the analogue (CH 9) via its picture quality at the sites where the DTTB was not able to decode.

13.2.45 DTTB Antenna Pointing Robustness

Graph 45 illustrates the antenna pointing accuracy margin.

ANALOGUE to DTTB comparisons

13.2.46 PAL VIDEO S/N @ DTTB THRESHOLDS (Noise)

The PAL video S/N, when the DTTB C/N has been adjusted to point of threshold, is plotted against the index function of Test #. Both COFDM and 8VSB are displayed showing PAL picture quality at the DTTB threshold. This is valuable for ascertaining relative coverage information between PAL and DTTB. The Noise Injection method figures have been used.

13.2.47 PAL VIDEO S/N @ DTTB THRESHOLDS (System)

As above but with the use of figures produced by the System Noise method.

13.2.48 PAL VIDEO S/N @ DTTB DYNAMIC THRESHOLD

As for 13.2.46, but with the dynamic threshold C/N's being used. This is also valuable in ascertaining relative coverage information between PAL and DTTB.

Survey Vehicle measurement methods

13.2.49 Analogue level (CH 9) within Survey Vehicle

The levels applicable to CH 9 vision carrier are displayed together for three measurement methods to allow accuracy comparisons to occur. Also the tests are indicated where both the DTTB decoders was unable to lock and hence decode.

13.2.50 Noise Measurement Methods - COFDM

The three measurement methods used for the measurement of noise in the noise injection method are plotted together so that their relative accuracy's may be compared. Those figures used in determining the COFDM threshold C/N were plotted.

13.2.51 Noise Measurement Methods – 8VSB

As above but related to 8VSB.

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13.3 Selected Graphs

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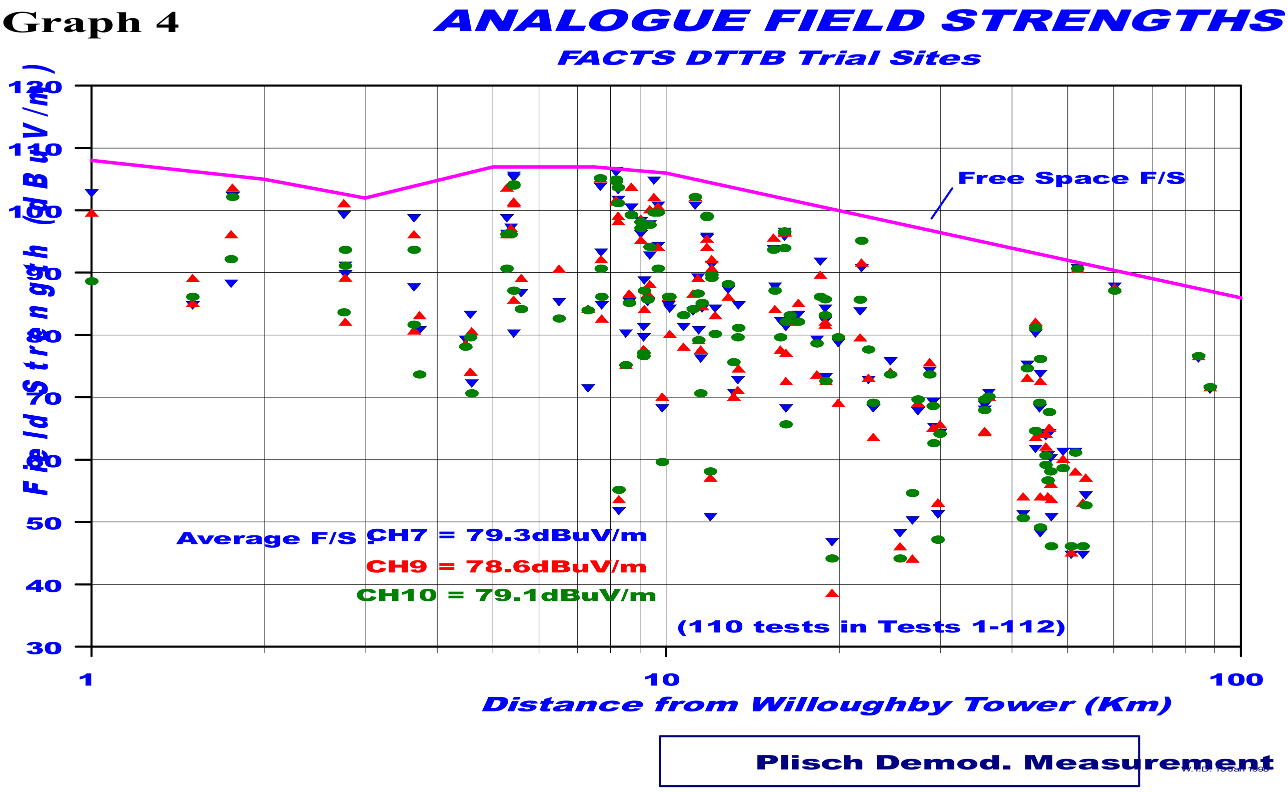
Graph 4



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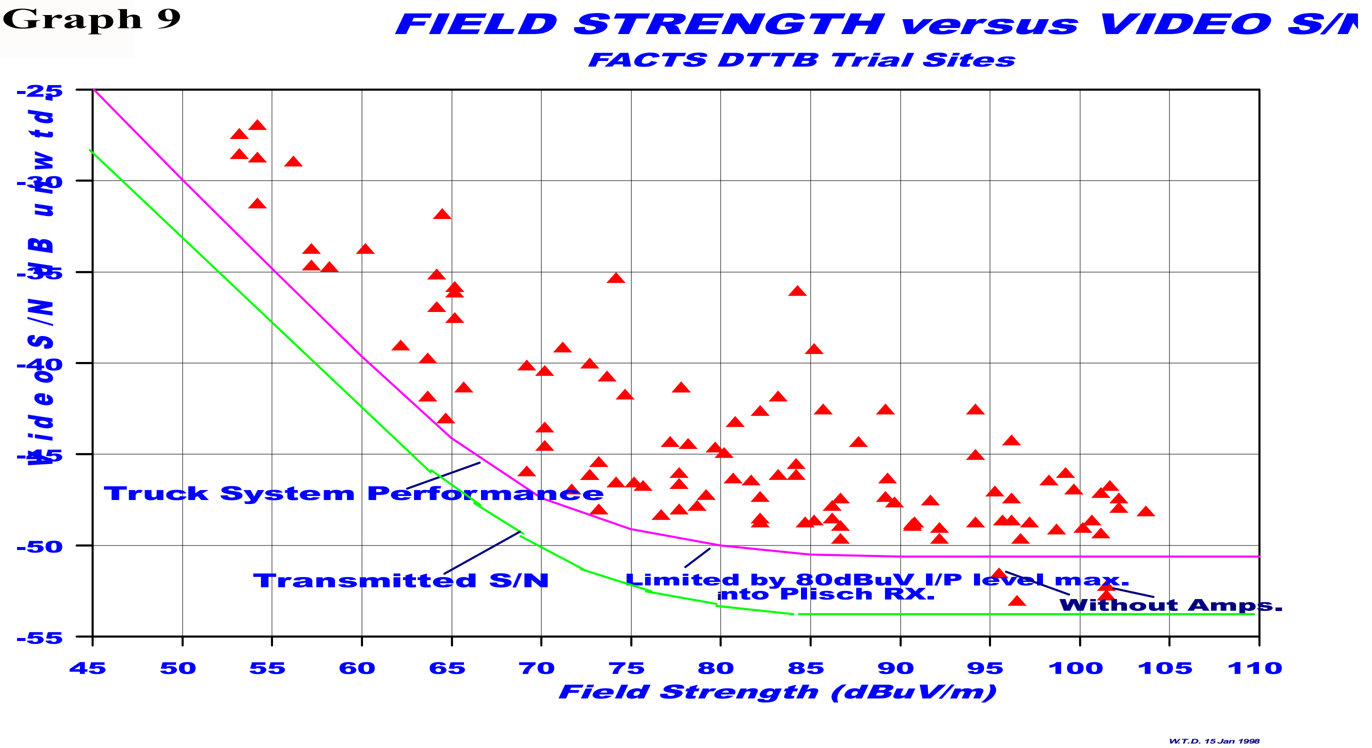
Graph 9



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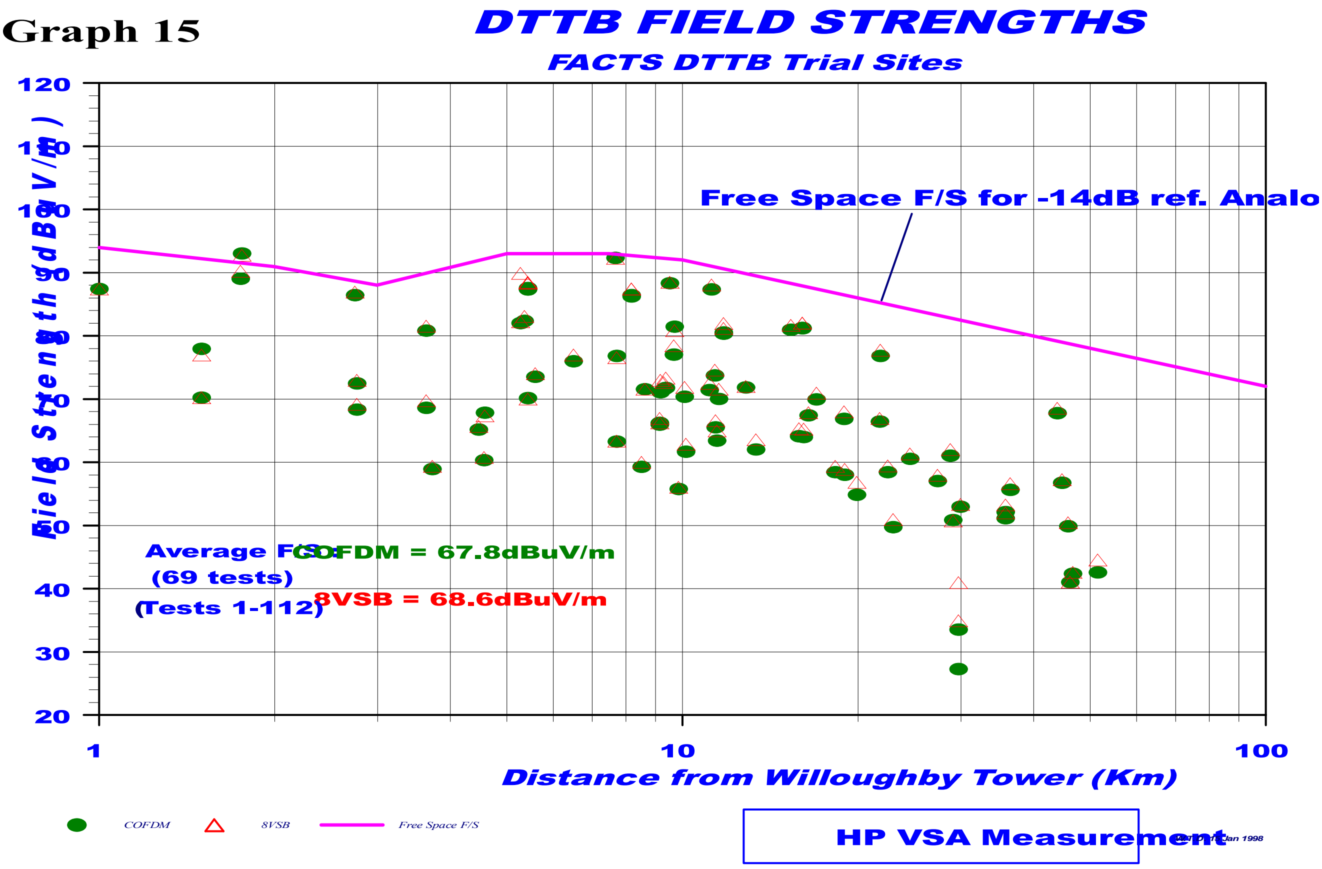
Graph 15



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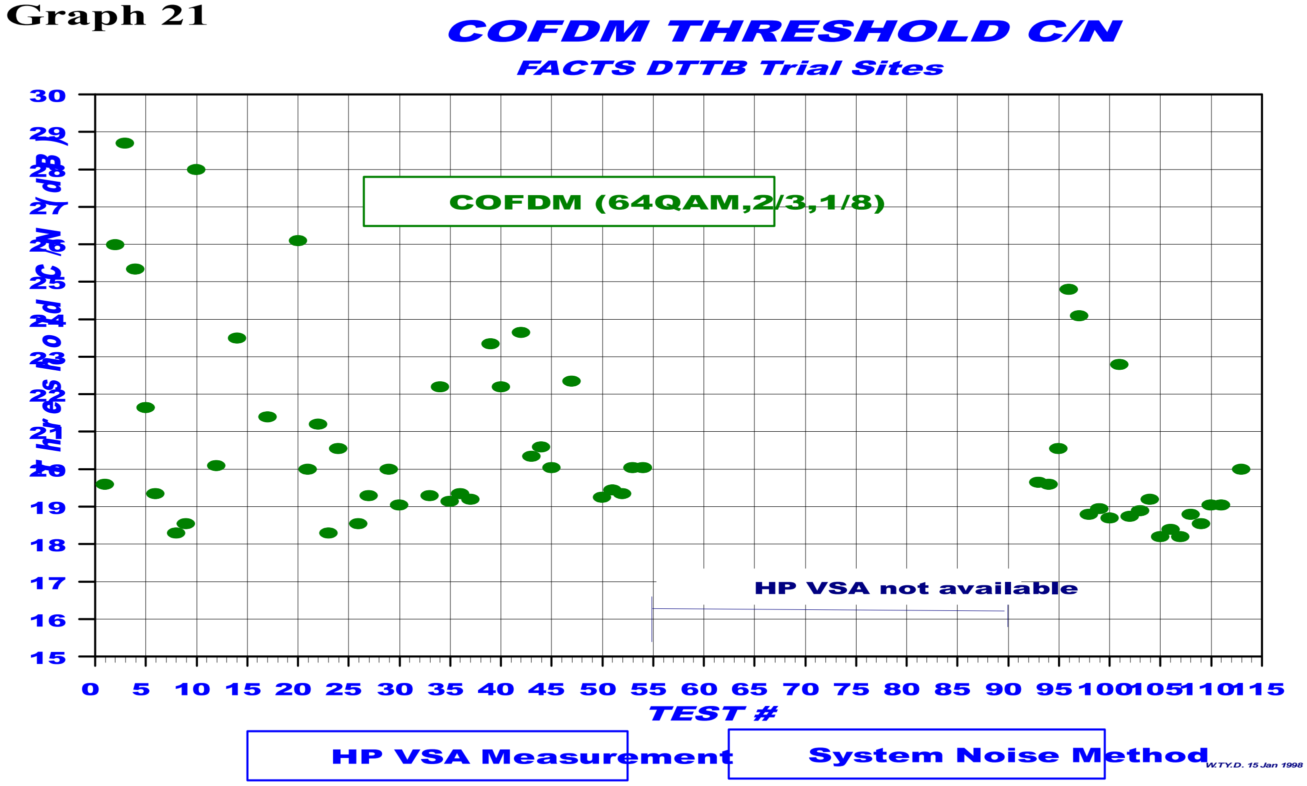
Graph 21



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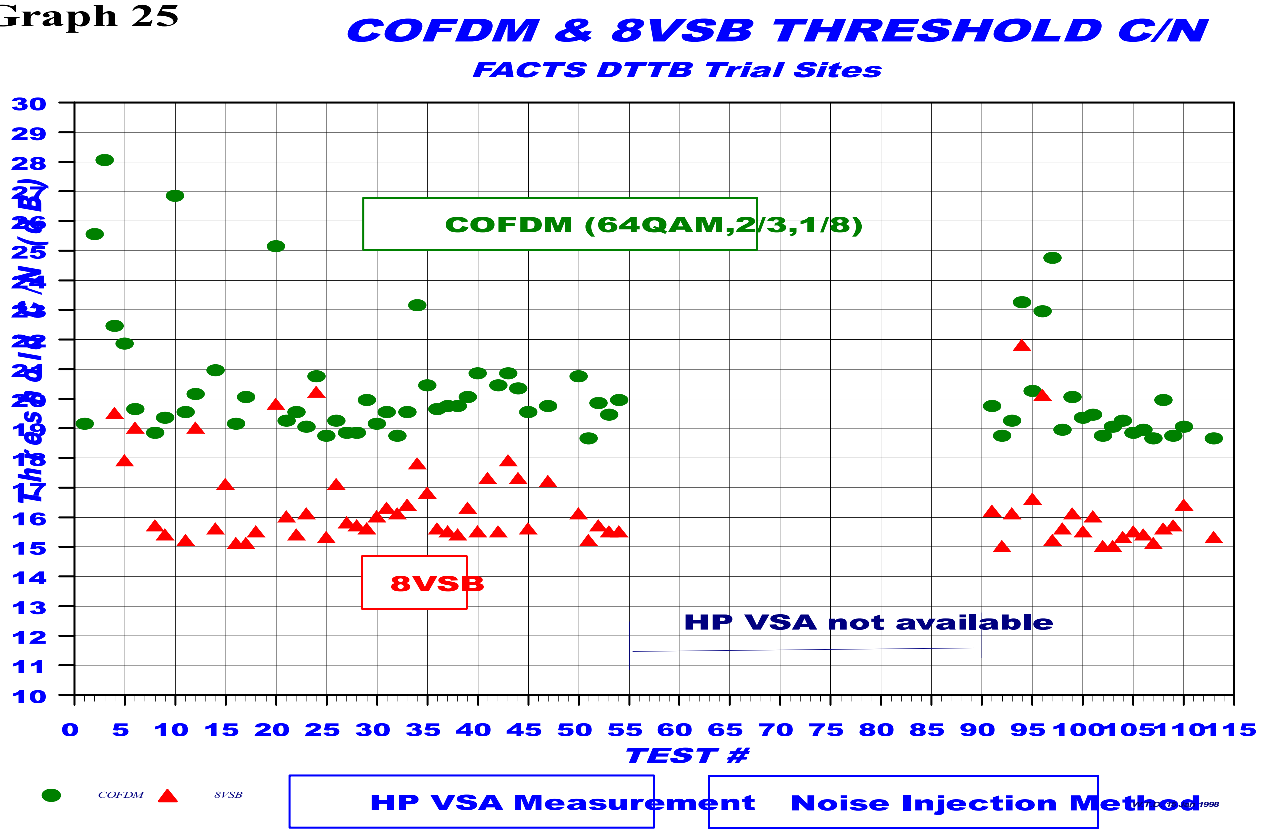
Graph 25



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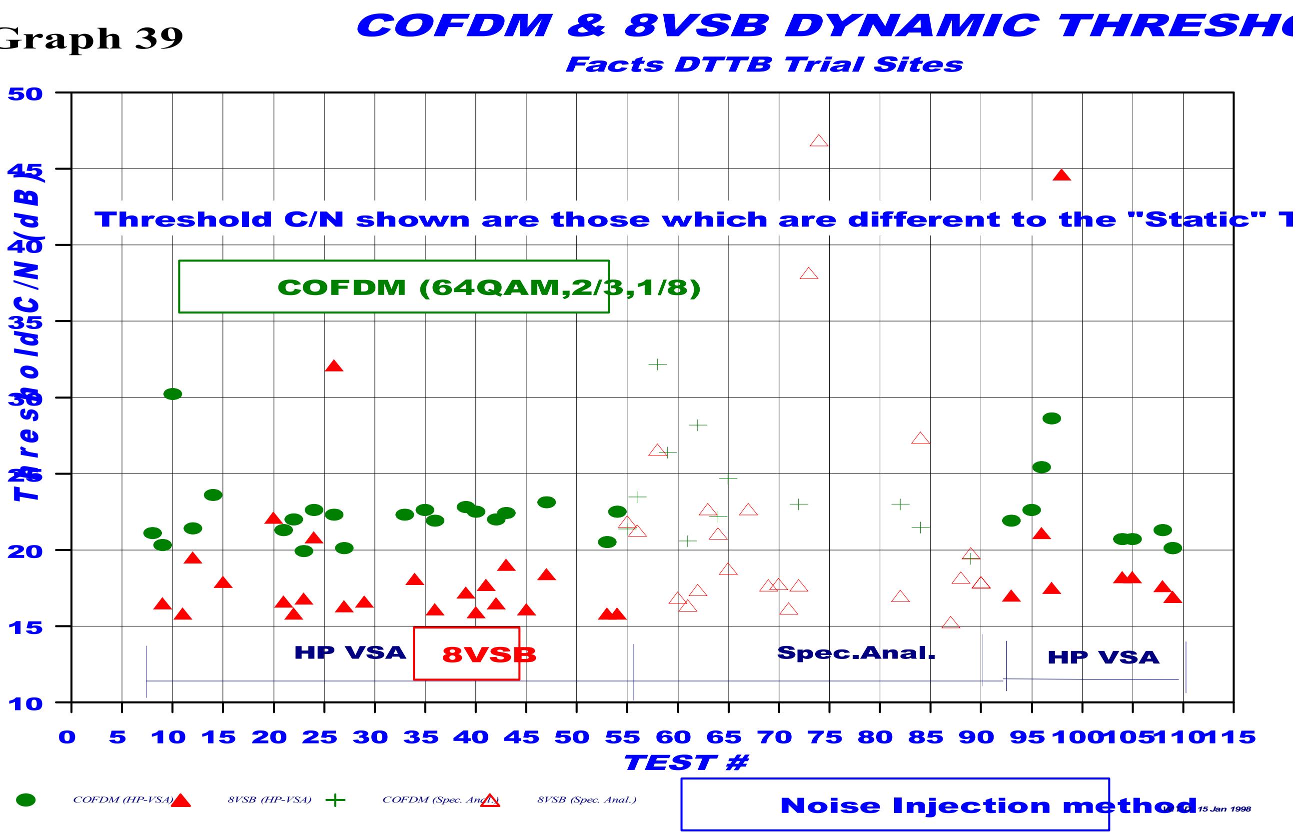
Graph 39



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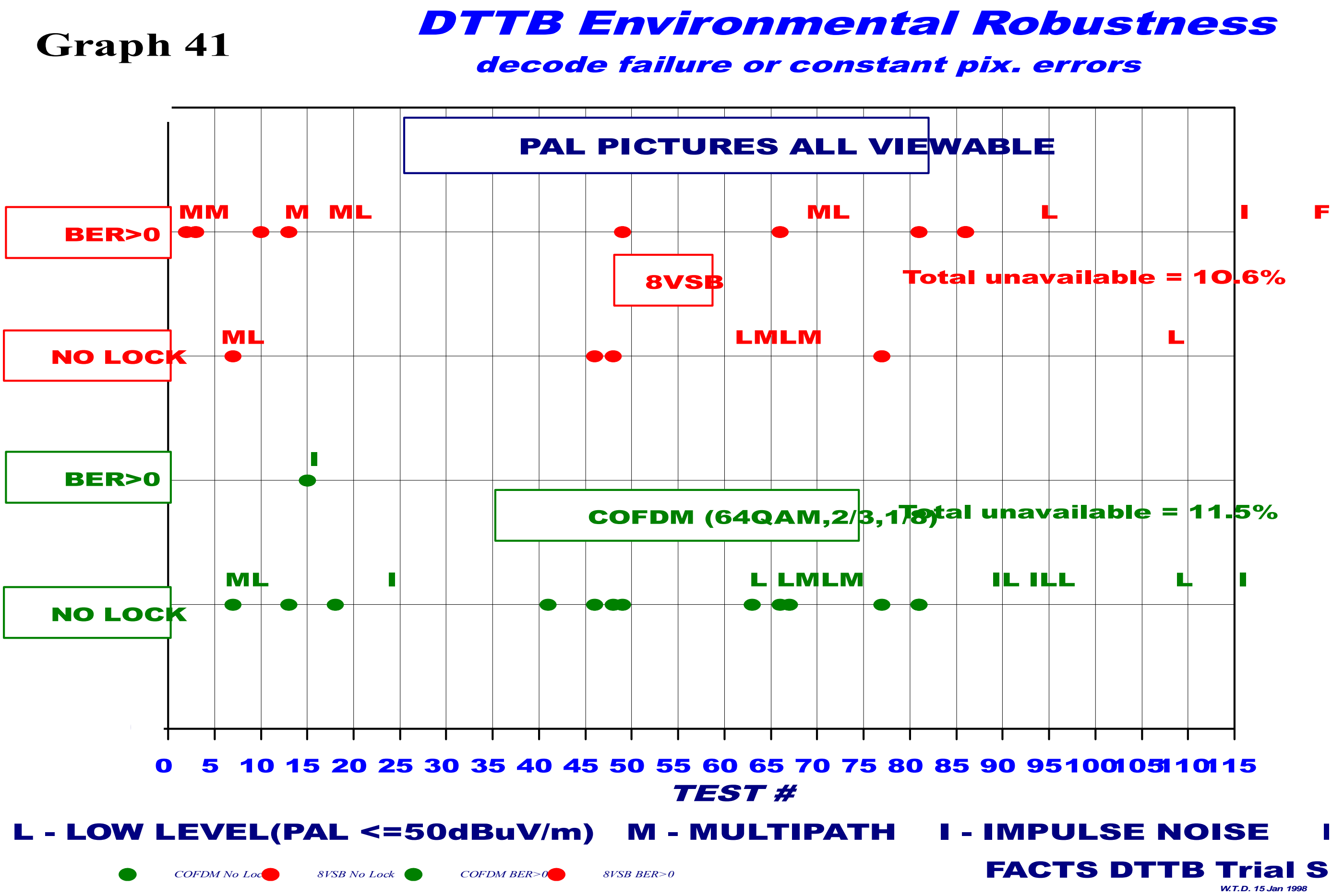
Graph 41



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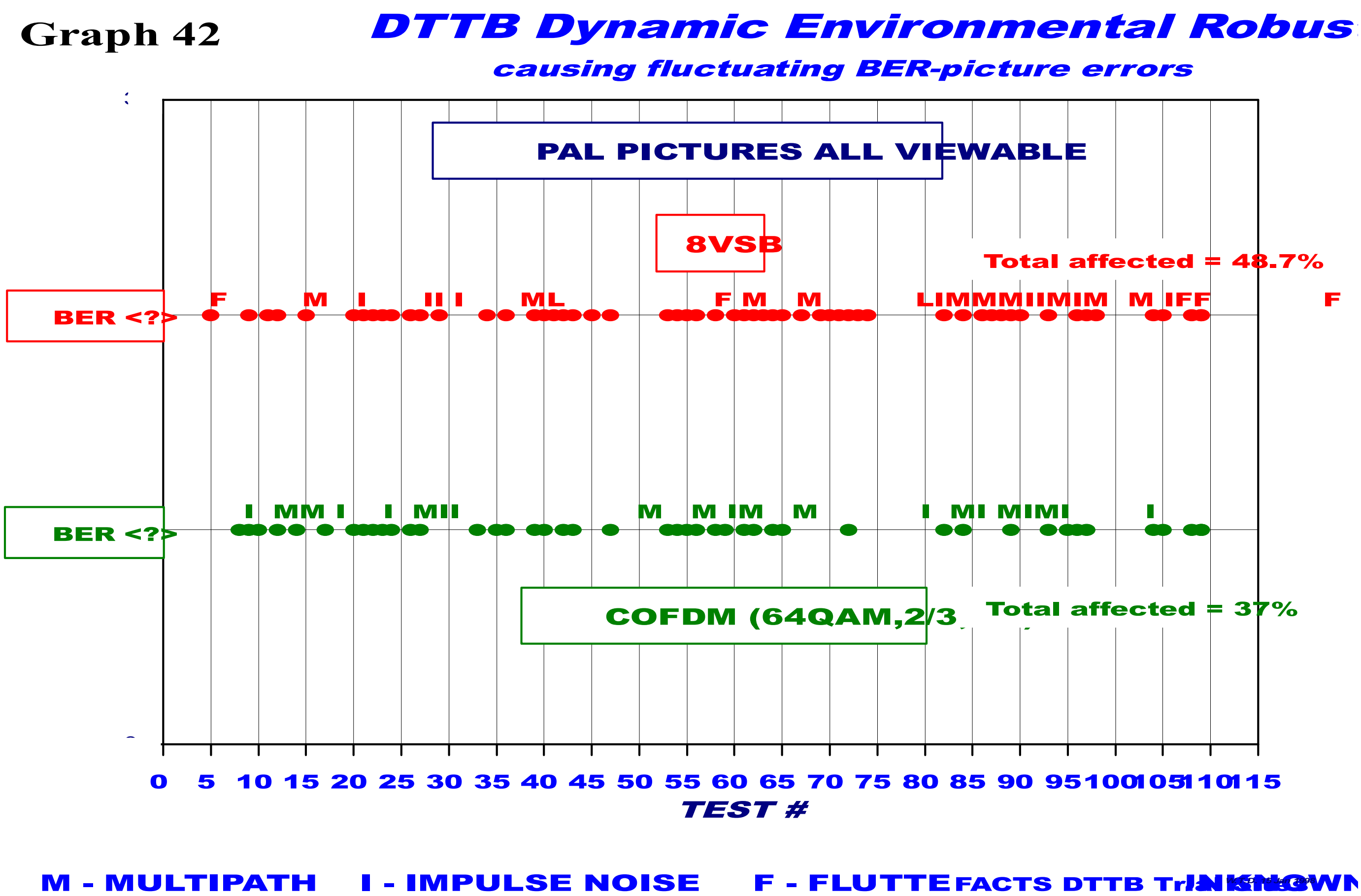
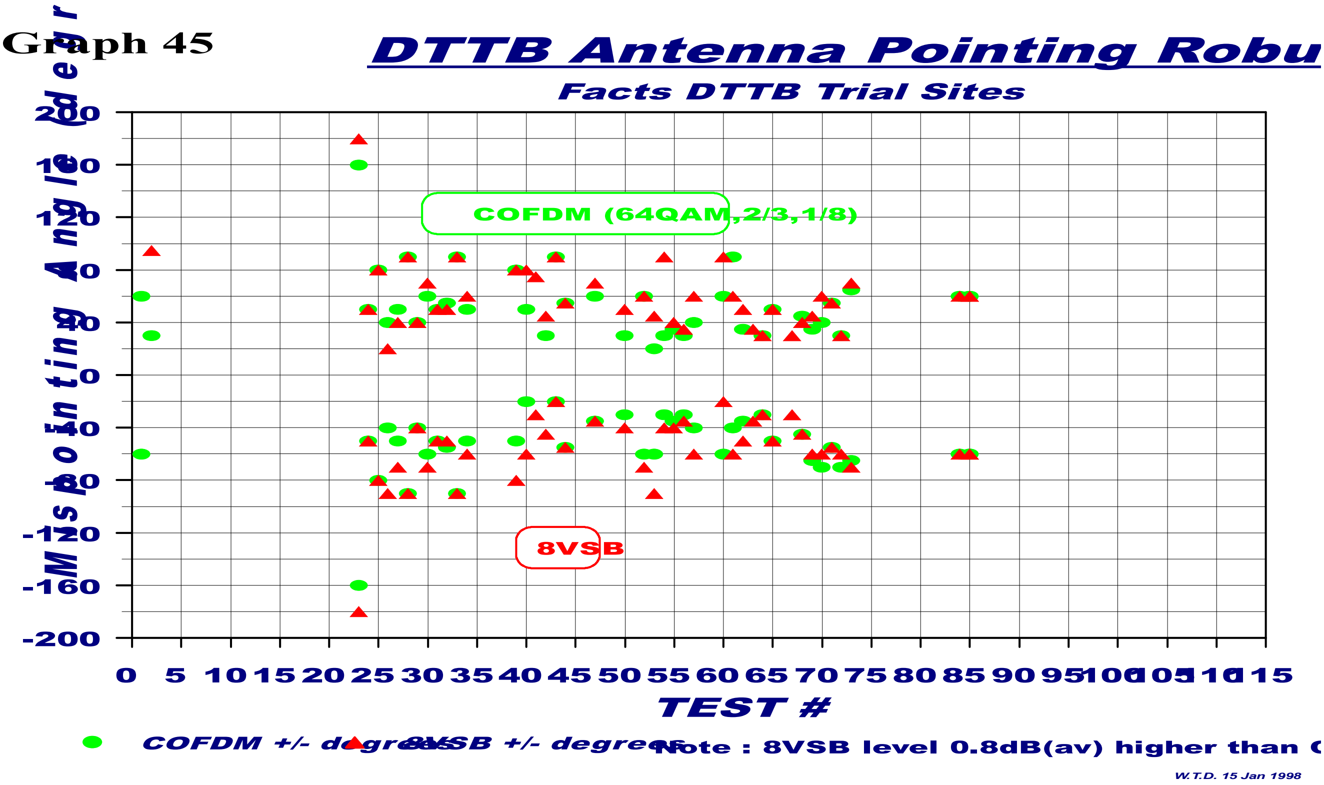
Graph 42



Graph 45



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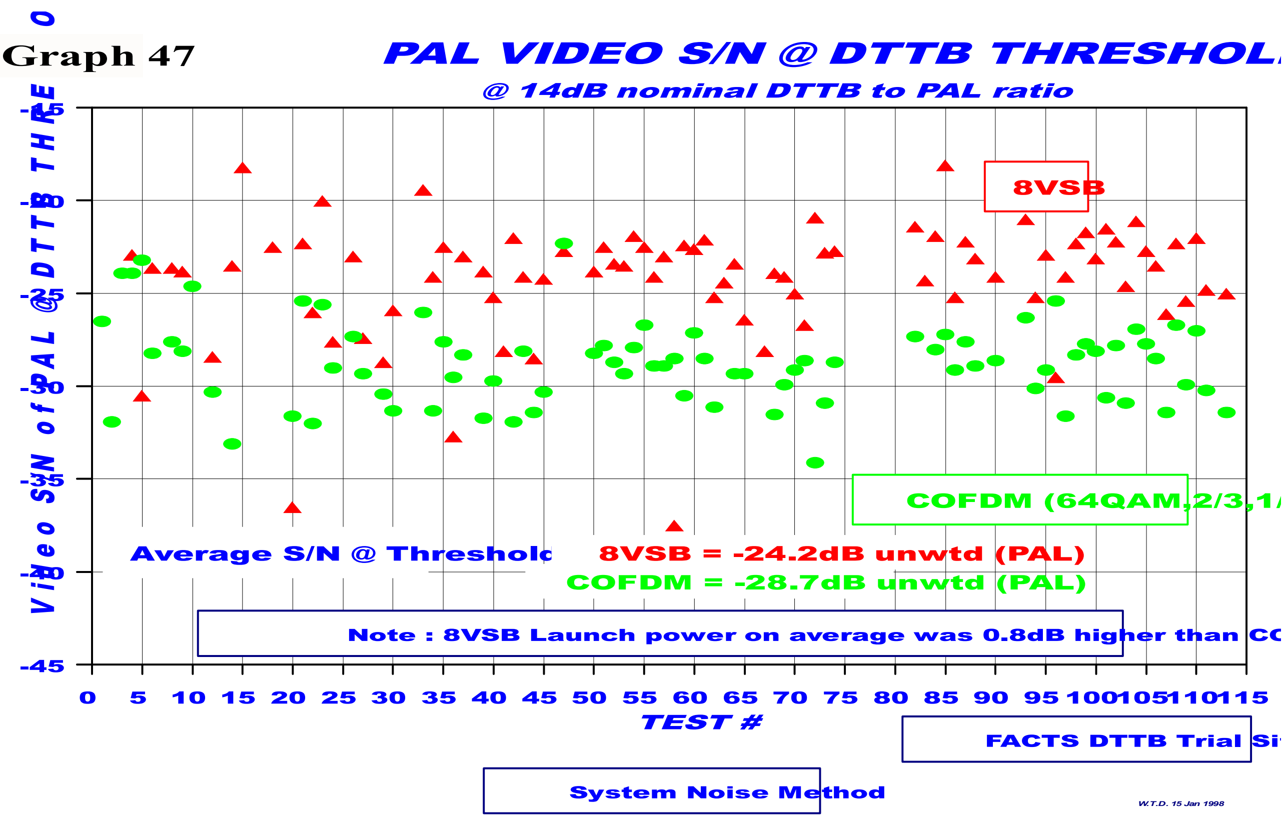
Graph 47



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14 Equipment Diagram for Field Test Vehicle (From Annex 3)

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