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Using capture-mark-recapture methods to estimate fire starts in the United Energy distribution area

Prepared for Jeremy Rothfield, United Energy

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Summary

Several estimates of the number of fires in the United Energy distribution area are made using capture-mark-recapture methods.

The methods include the common Lincoln-Petersen estimator, and various applications of a bias-corrected version of this, the Schnabel estimator.

We show that the proportion of fires recorded in the United Energy database varies by season, but that incorporating this heterogeneity into the estimates of fire numbers does not produce large changes in the estimated fire numbers.

There is some evidence in the MFB database that larger fires have a greater probability of being reported, but the data on which this is based are not consistent over time; incorporating this information into predictions of the proportion of fires reported is less effective than incorporating the seasonal information.

Our best estimate of the number of fires per year in the United Energy distribution area is 1453 fires, with 95% confidence limits of 1036 to 1870.

Table of Contents

1 Introduction

Capture-Mark-Recapture (C-M-R) methods have traditionally been used with animal populations to estimate population abundance. A sample of animals is captured; these animals are tagged and then released. A second sample is taken at a later stage and the proportions of tagged and untagged animals can then be used to estimate the number of animals in the population. Often, more than two sampling occasions are used and the animals captured at each stage are tagged. The history of tagged and untagged animals at each sampling occasion allows for refinement in the estimation of population size.

Such methodology can also be applied to situations other than animals. Darroch *et al* (1993) considered census estimation, while Chao *et al* (2001) estimated the number of people infected during a hepatitis outbreak. Fienberg *et al* (1999) used capture-recapture methods to estimate the number of files on the World Wide Web relating to some subject by taking samples using several search engines. One of the authors of this report (RLC) has previously used it to estimate the number of infected grapevines in a vineyard, drawing upon the results from two assessment methods: a DNA assay and a trapping method.

In the current situation we apply it to fire starts. The United Energy (UE) distribution area is covered by two fire authorities: the Country Fire Authority (CFA) and the Metropolitan Fire and Emergency Services Board (MFB). We estimate the number of fires in each area separately and then combine the estimates.

For the UE/CFA area, there are two sources of data on fire starts: the databases held by the CFA and UE. By regarding one sample (UE) as the first sample, and the other sample (CFA) as the second sample, and observing the number of fires which are common to both databases (the 'marked' or 'tagged' fires), C-M-R methods can be used to estimate the total number of fires in the UE/CFA area. Similarly, we can also estimate the number of fires in the UE/MFB area.

2 Data sources

2.1 UE/CFA fires

The UE fire database *UEcomparisonsCFAvMFBTFisher.xls* had an indicator for CFA/MFB fires. UE fires in the CFA area were extracted from this file. There were 316 of them.

The CFA fire database *allfires_ue_extnsn_within_ug.xlsx* had already been filtered to remove those fires not in the UE area. This had been carried out for UE by Grace GIS Services. It was subsequently filtered to retain only fires for the period 2006-2010. Fires not relating to distribution equipment were also removed, using the field *ignition_equipment_description*, retaining only those fires where this field was *electrical distribution equipment not classified* or *electrical distribution equipment; insufficient information to classify.* This left 268 fires.

Fires common to both these reduced databases were identified manually, matching on date, time, address and comment fields as necessary. There were only 17 records in common. These are listed in Appendix 1.

The data is summarised in Table 1.

2.2 UE/MFB fires

The UE fire database *UEcomparisonsCFAvMFBTFisher.xls* had an indicator for CFA/MFB fires. UE fires in the MFB area were extracted from this file. There were 245 of them. However this included 11 fires in the period 1/1/2006 to 31/3/2006, during which time no data was recorded in the MFB fire database because of industrial action[1], and so we exclude these from the calculation. This leaves 234 fires.

MFB fires were originally identified from the file *DOCCENTRAL-#692962-v1-AER_F-Factor_data_(MFB)_for_release_to_energy_suppliers_gracegis_updated18Nov2011.XLS*. The data file supplied by the AER (see footnote 1) contained suburb, postcode and VicGrid X and Y co-ordinates. The coordinates were converted to approximate street addresses by Grace GIS Services, using reverse geocoding. This file was filtered to remove those fires not in the UE distribution area using a list of postcodes in the UE area supplied by UE. Non-electrical fires had already been removed from this database.

Fires common to both these reduced databases were identified manually, matching on date, time, address and comment fields as necessary. There were 48 records in common. These are listed in Appendix 2.

Subsequently, a second file *MFB_ue_extnsn_within_ug.xlsx* was supplied by UE. This file had been filtered by Grace GIS Services using GIS methods to remove fires not in the UE distribution area; this method was more accurate than the previous postcode filtering. However, regrettably, the time of the fires had been removed from this file, so it was difficult to rematch using this file. Therefore it was used as a check that the previously identified 48 common fires were indeed within the UE distribution area. This file contained information on 500 fires. As stated above, the period covered is 1/04/2006 – 31/12/2010.

A summary of this data is given in Table 1.

[1] Note to Table 1, Figure 1 and Figure 2 in spreadsheet DOCCENTRAL-#692962-v1-AER_F-Factor_data_(MFB)_for_release_to_energy_suppliers.XLS, supplied by Franz Jungerth, AER, to Jeremy Rothfield by email 16/11/2011.

2.3 Data summaries

Table 1 summarises the data in the previous sections.

Table 1: Fires recorded in databases

Area	Years of data	Fires recorded by			Total fires recorded
		UE	Other authority	Both	
UE/CFA	5.0	316	268	17	567
UE/MFB	4.75	234	500	48	686

The data for each authority is further presented in a slightly different form in Table 2 (CFA) and Table 3 (MFB).

Table 2: Numbers of fires in UE and CFA databases

	In CFA d/base	Not in CFA d/base	Total
In UE d/base	17	299	316
Not in UE d/base	251	0	251
Total	268	299	567

Table 3: Numbers of fires in UE and MFB databases

	In MFB d/base	Not in MFB d/base	Total
In UE d/base	48	186	234
Not in UE d/base	452	0	452
Total	500	186	686

The zero values in Table 2 and Table 3 result from the filtering of the databases to remove irrelevant fires.

3 Methodology

Several C-M-R methods have been used to estimate the total number of fires. We define some minimal notation.

The first sample comprises those fires in the UE database which are in the other authority's area. These are the 'marked' fires (= n_1).

The second sample comprises those fires in the other authority's database which are in the UE distribution area (= n_2).

The 'marked' fires in the second sample are then those fires which are common to both samples (= m).

The total number of fires (ie the quantity to be estimated) is N.

3.1 Lincoln-Petersen estimator

This estimator assumes that the proportion of total fires that were marked in the first sample is equal to the proportion of marked fires found in the second sample, ie

$$n_1 / N = m / n_2$$

That is, we can estimate the total fire population N using

$$N = n_1 \, . \, n_2 / m$$

This estimator assumes the population is 'closed', which in terms of the animal model, means that there is no immigration, emigration, births or deaths in the population between sampling occasions. This assumption is satisfied for the fire data.

However the estimator also assumes that any fire which occurs has the same chance of being recorded in the database. It is impossible to test this directly with less than three sampling occasions. We return to this point later in the report.

The estimator was independently developed by Petersen (1896) and Lincoln (1930).

3.2 Schnabel estimator

Chapman (1951) defined an improved estimator with less bias, ie the resulting estimate of the total number of fires is more likely to be closer to the 'true' (but unobservable) number of fires. This estimator is also called the Schnabel estimator (after Schnabel, 1938). It is defined as

$$N = [\ (n_1+1)\ .\ (n_2+1) / (m+1)\ ]\ - 1$$

The estimate is unbiased if $(n_1 + n_2) \geq N$. It also has smaller variance than the Lincoln-Petersen index.

We use this method for the data as a whole, and to estimate separately for each month and each season. This is in response to the fact that the proportion of fires in both the CFA and MFB databases recorded in the UE database has seasonal variation. This possibility was assessed with harmonic regression, which we outline in the following section.

3.3 Harmonic regression

A model was fitted to take into account seasonal effects using a simple harmonic. The proportion, p, of fires in the other authority's database recorded by UE at any time through the year was estimated using the model

$$\text{Expected}[\ \ln(p/(1\text{-}p))\ ] = a_1 + a_2 \sin(\theta) + a_3 \cos(\theta)$$

To do this we use data $y = 0$ for fires in the other authority's database but not in UE's database and $=1$ for common fires, and θ = time of year, calculated as 2π (day number)/365.25, and fit the model as a generalised linear model. The distribution of the response variable around the mean (the error distribution: whether a fire observed by another authority was recorded by UE or not) is assumed to follow a binomial distribution; the link function is logistic.

For further details of generalised linear models, see McCullagh and Nelder (1989) or for a simpler description Everitt (2003), section 1.2.

4 Results

4.1 Lincoln-Petersen estimator

This is the simplest of the estimators. Results for this index are given in Table 4; they are calculated separately for each authority (CFA, MFB) for the entire reporting period, then converted to an annual basis so that they can be combined.

Table 4: Results for Lincoln-Petersen index

Area	No years	Reporting period estimates		Annualised estimates	
		fires	stderr	fires/year	stderr
UE/CFA	5	4981.6	1137.4	996.3	227.5
UE/MFB	4.75	2437.5	298.2	513.2	62.8
Total				1509.5	236.0

This gives an estimate of 1510 fires per year, with 95% confidence limits of (1047, 1972).

4.2 Schnabel estimator

4.2.1 Overall

This method uses the same data as the Lincoln-Petersen method in the previous section. Results are given in Table 5.

Table 5: Results for overall Schnabel index

Area	No years	Reporting period estimates		Annualised estimates	
		fires	stderr	fires/year	stderr
UE/CFA	5	4736.4	1019.6	947.3	203.9
UE/MFB	4.75	2401.8	287.1	505.6	60.4
Total				1452.9	212.7

This gives an estimate of 1453 fires per year, with 95% confidence limits of (1036, 1870).

4.2.2 Using monthly data

We expect fire numbers to peak in the summer months and be at a minimum during winter, and it is also possible that the proportion of fires recorded in the databases may change with season. We have tested this possibility using harmonic regression.

Figure 1 shows, for each month, the proportion of fires from the other authorities' databases recorded by United Energy, together with the fitted harmonic regressions. The harmonic regression illustrates the change in recording proportion over the year, and demonstrates graphically the need to take this changing proportion into account.

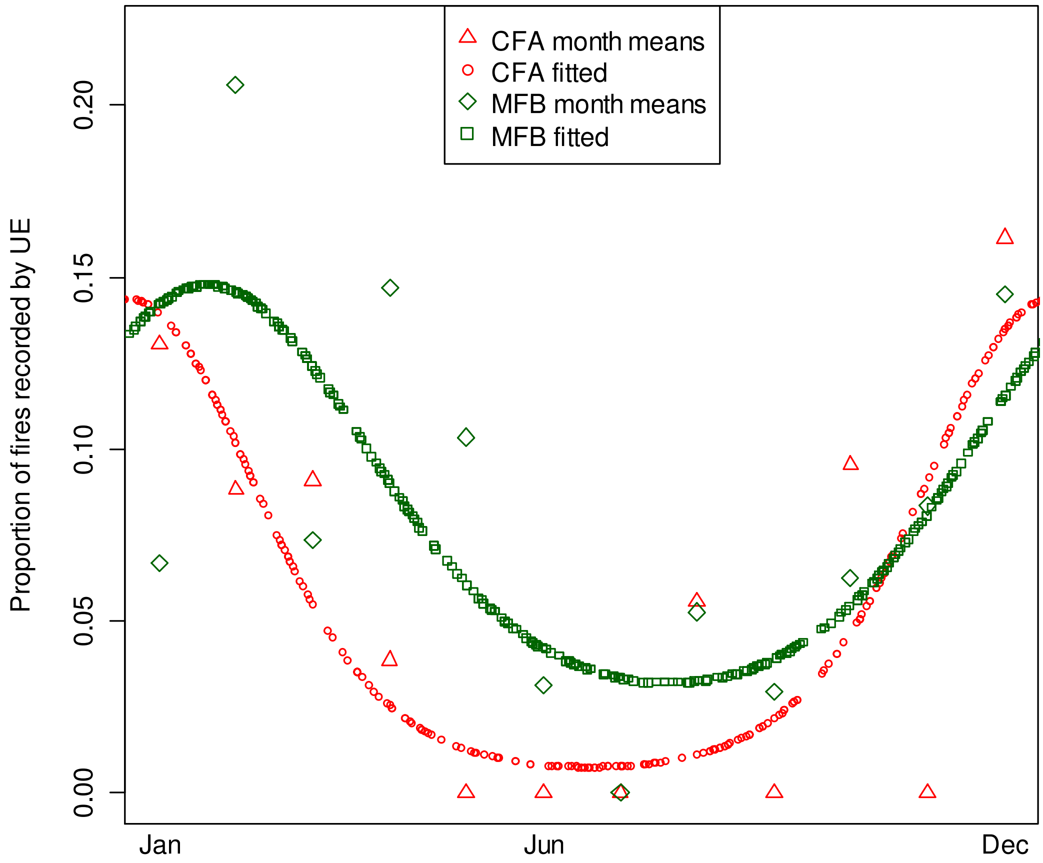

Figure 1: Harmonic regressions

There is a reasonable consistency for the two data sets, with both showing low recording proportions in winter.

To cope with this variation in recording probability we initially tried fitting the Schnabel index on a month-by-month basis (summed over years) and then combining the monthly estimates.

Monthly data is shown for the UE/CFA fires in Table 6 and UE/MFB fires in Table 7.

Table 6: Fires in CFA area by month

Month	Fires in databases			Total estimate
	CFA	UE	Both	
Jan	23	46	3	281.0
Feb	34	71	3	629.0
Mar	22	45	2	351.7
Apr	26	18	1	255.5
May	12	16	0	220.0
Jun	15	9	0	159.0
Jul	26	13	0	377.0
Aug	18	13	1	132.0
Sep	21	13	0	307.0
Oct	21	21	2	160.3
Nov	19	20	0	419.0
Dec	31	31	5	169.7
Total	268	316	17	3461.2

Table 7: Fires in MFB area by month

Month (yrs of data)	Fires in databases			Total estimate
	MFB	UE	Both	
Jan (4)	60	28	4	352.8
Feb (4)	68	54	14	252.0
Mar (4)	68	33	5	390.0
Apr (5)	34	13	5	80.7
May (5)	29	9	3	74.0
Jun (5)	32	7	1	131.0
Jul (5)	26	8	0	242.0
Aug (5)	19	7	1	79.0
Sep (5)	34	9	1	174.0
Oct (5)	32	15	2	175.0
Nov (5)	36	18	3	174.8
Dec (5)	62	33	9	213.2
Total	500	234	48	2252.1

The sum of the total fires for the MFB area is weighted by the number of years of data available for each month.

This gives total estimates as shown in Table 8.

Table 8: Estimates using Schnabel estimator by month

Area	No years	Reporting period estimates		Annualised estimates	
		fires	stderr	fires/year	stderr
UE/CFA	5	3461.2	593.2	692.2	118.6
UE/MFB	4.75	2252.1	294.3	474.1	62.0
Total				1166.3	113.8

This gives an estimate of 1166 fires per year, with 95% confidence limits of (943, 1389). However there are several months with no common fires, and so we discount this estimate and the estimated confidence limits. Note that the Lincoln-Petersen estimate cannot be used for the monthly data because it is undefined when there are zero common fires.

4.2.3 Using seasonal data

Using four seasons instead of 12 months may improve the stability of the estimates, and so we use seasonal data instead, with summer = Dec – Feb, autumn = Mar – May, winter = Jun – Aug, and spring = Sep – Nov. Details by season are shown in the tables below.

Table 9: Fires in CFA area by season

Season	Fires in databases			Total estimate
	CFA	UE	Both	
Summer	88	148	11	1104.1
Autumn	60	79	3	1219.0
Winter	59	35	1	1079.0
Spring	61	54	2	1135.7
Total	268	316	17	4537.8

Table 10: Fires in MFB area by season

Season	Fires in databases			Total estimate
	MFB	UE	Both	
Summer	190	115	27	790.3
Autumn	131	55	13	527.0
Winter	77	22	2	597.0
Spring	102	42	6	631.7
Total	500	234	48	2546.0

The final results are shown in Table 11.

Table 11: Estimates using Schnabel estimator by season

Area	No years	Reporting period estimates		Annualised estimates	
		fires	stderr	fires/year	stderr
UE/CFA	5	4537.8	992.2	907.6	198.4
UE/MFB	4.75	2546.0	374.5	536.0	78.8
Total				1443.6	213.5

So this method gives an estimate of 1444 fires per year with 95% confidence limits (1025, 1862).

4.3 Summary

The results of the various methods are summarized in Table 12.

Table 12: Fires per year with 95% confidence limits

Estimation method	Estimated fires per year	95% confidence limits
Lincoln-Petersen	1510	1047 – 1972
Schnabel, all data	1453	1036 – 1870
Schnabel, monthly data	1166	943 – 1389
Schnabel, seasonal data	1444	1025 – 1862

Given that we have discounted the estimates from the Schnabel index using monthly data because of several months with zero common fires, the remaining estimates are remarkably similar, ranging from 1444 to 1510 fires per year.

5 Comments

Heterogeneity: With only two sampling occasions (ie two fire databases) it is impossible to use the data on fires to make any adjustments for possible heterogeneity of sampling probabilities. With three or more databases, methods exist to do this (eg, Darroch *et al*, 1993)

However the MFB database has a dollar amount recorded against each fire, which is a rough estimate of the damage made at the scene by an MFB officer. This data potentially allows us to examine the hypothesis that more severe fires have a greater probability of being recorded than smaller ones.

Categorising the damage into four classes we get the data in Table 13 below.

Table 13: Recorded damage for MFB fires

Damage	In both MFB & UE databases	In MFB database only	Total fires in MFB database
$0	23 (8%)	255	278 (100%)
$1 – $1,000	10 (7%)	137	147 (100%)
$1,001 – $10,000	10 (15%)	56	66 (100%)
$10,001 – $200,000	5 (56%)	4	9 (100%)
Total	48	452	500

We see that for the smallest damage classes of fires, only 7% or 8% find their way into both databases. This figure doubles for 'medium' damage fires, and increases to over half of the 'large' damage fires. Formally a Fisher's exact test for counts shows that the proportions recorded in both databases increases as the fire severity increases ($P<0.001$).

Thus there is evidence that the probability of a fire being recorded increases as the severity of the fire increases.

However we do have concerns about this data. Table 14 shows that increasingly, fires are recorded with zero damage. This presumably is not a real trend, and we are unaware of the reasons for this. However it does throw some doubt on the non-zero values which are recorded, particularly since 2009.

Despite these misgivings, we tried to incorporate damage into our models but found that although damage was a significant factor, season was a better predictor of the proportion of fires that were reported. The reason for this may be the change in the manner in which damage has been recorded.

The consistency of the estimated numbers of fires from the overall and seasonal Schnabel estimators gives credibility to the estimators, and means that the effects of heterogeneity do not appear so great as to make the estimates unusable.

Table 14: MFB fires with zero damage

Year	Total fires	No. with \$0 damage	Percentage with \$0 damage
2006	76	14	18%
2007	96	20	21%
2008	85	29	34%
2009	160	140	88%
2010	83	75	90%
Total	500	278	56%

Bias: When $n_1 + n_2$ is not greater than N (as is the case in this study), the Schnabel estimator is not completely unbiased. Our simulations indicate that it can be used with smaller numbers (e.g. n_1=21, n_2 = 21, m= 2) and still return credible results. For larger values (n_1 = 268, n_2= 316, m = 17; ie the UE/CFA data) any bias was found to be less than 1%. By contrast, the Lincoln-Peterson cannot be estimated for the case when m = 0, and for the larger sample size it showed a substantial bias.

Overall, the results are reasonably consistent if we exclude the Schnabel estimate based on monthly data, which we know to be unstable because of the inclusion of months with no common fires. We therefore recommend the use of the Schnabel index based on all data.

Conclusion: The best estimate obtained in this study is based on the Schnabel index, with an estimate of 1453 fires per year with 95% confidence limits of 1036 – 1870.

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Appendix 1: Fires common to CFA and UE databases

Date	CFA incident no.	UE fire start no.	UE record no.
20/01/06	199829	007	216575
18/10/06	216966	055	283198
27/10/06	217599	067	285879
08/12/06	220814	082	294996
14/12/06	221515	094	296601
16/12/06	221731	104	297346
03/02/07	225483	137	309338
06/03/07	227977	176	318205
02/04/08	263165	270	408743
15/12/08	289201	317	TOWA
01/01/09	291005	322	446548
30/01/09	295314	345	452577
01/02/09	295600	348	453209
13/02/09	298844	381	456143
10/03/09	302985	427	460051
31/08/10	355176	536	538623
31/12/10	366869	561	TOWA

Appendix 2: Fires common to MFB and UE databases

Date	MFB incident no.	UE fire start no.	UE record no.
05/04/06	5	29	234848
12/04/06	9	32	236748
16/05/06	36	35	243973
25/10/06	144	59	285124
13/11/06	162	74	289034
03/12/06	177	79	293937
14/12/06	190	87	296562
14/12/06	198	90	296621
14/12/06	212	92	296640
14/12/06	238	95	296686
14/12/06	239	96	296703
22/12/06	263	113	298793
19/02/07	405	169	314411
08/03/07	427	177	318800
16/03/07	433	180	320257
16/04/07	452	192	326615
27/05/07	484	197	335603
29/10/07	590	215	368389
17/11/07	616	222	374425
10/01/08	655	228	TOWA
19/02/08	724	244	401423
20/02/08	732	245	401704
20/02/08	736	247	401728
20/02/08	745	249	401762
30/05/08	822	276	415734
22/11/08	955	312	441462
24/01/09	1000	333	449614
24/01/09	1001	332	449612
28/01/09	1025	340	450792
06/02/09	1061	355	454395
06/02/09	1064	360	454486
08/02/09	1080	374	455199
08/02/09	1081	376	455230

08/02/09	1082	369	455246
03/03/09	1153	393	458739
03/03/09	1180	408	458947
05/03/09	1201	423	459438
08/06/09	1304	448	473027
26/08/09	1349	458	484616
27/09/09	1376	465	488790
16/12/09	1435	474	500688
06/02/10	1498	490	507586
08/02/10	1501	492	507830
08/02/10	1502	493	507888
14/02/10	1507	496	509026
15/04/10	1550	514	516943
24/04/10	1559	515	518276
27/12/10	1724	556	557680

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Dr Ray Correll
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Dear Dr Correll,

Expert report in relation to the historical data on fire starts

The Australian Energy Regulator is responsible for the administration and operation of the f-factor scheme, and has recently released a draft determination, which is to apply over the period from 2012 to 2015[1]. The scheme aims to provide incentives for Distribution Network Service Providers (DNSPs) to reduce the risk of fire starts, and to reduce the risk of loss or damage caused by fire starts[2]. The scheme was developed by the Victorian Government.

An f-factor target has been set, which has been based, in part, on the historical occurrence of fire starts in each distribution network (including the United Energy distribution network) over the period from 2006 to 2010. United Energy has examined its data and has become aware that there was systematic under-reporting of fire starts over the five years from 2006 to 2010. The distribution management system used by the business was aimed at gathering information on faults, with a lesser degree of effort directed towards the gathering of data on fire starts.

An examination of the records in the distribution management system shows that evidence of fires and fire starts was reported in an *ad hoc* fashion. Inconsistent terminology has been used, spelling is inaccurate, and the descriptions in the text field are sometimes incomplete. The questions posed by SKM in relation to specific records in the UE Distribution Management System (DMS) are indicative of some of the problems with the historic recording of information pertaining to fire starts[3].

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[1] AER, Draft determinations and Explanatory statement for the draft determinations, F-factor scheme determinations 2012-15 for Victorian electricity distribution network service providers, Australian Energy Regulator, 5th October 2011.

[2] Energy and Resources Legislation Amendment Bill 2010, Explanatory Memorandum, page 10.

[3] See AER – Guide to Questions – F-Factor Data Verification, questions posed by Terry Krieg, Sinclair Knight Merz, 2nd September 2011.

We are aware that linesmen were not fully briefed on the methods for reporting fire starts, although this situation began to change in 2010. Considering the 2006 to 2010 period as a whole, field personnel appear to have recorded the evidence for fire starts somewhat sporadically. Linesmen were not obliged to note down fire-related symptoms.

Previously, United Energy had formed the view that the reporting of pole and cross-arm fires from 2006 to 2010 was reasonably rigorous and well-founded. However, from a detailed examination of the records, and from discussions with field staff, we are confident that there were a number of pole fires that occurred which have not been documented.

In future, we expect more rigorous reporting of fire starts, because additional effort has been expended on re-training linesmen, and a new and enhanced reporting template has been created. The new template provides for answers to be chosen from among a menu of responses. Hence, there will be less reliance on the direct comments provided by linesmen.

In this context, we would like you to undertake and report on the following task:

- Review and assess the methods which have been applied by the AER in its draft determination to allow, and compensate for past under-recording of fire starts.
- Analyse a number of approaches which might assist in correcting for the past under-reporting of data on fire starts.
- Apply the methods making use of the various databases provided by United Energy.
- Determine a result which can be used as an appropriate benchmark to be adopted by United Energy as its "target" under the f-factor scheme.

Guidelines in preparing your report

Attached are Expert Witness Guidelines issued by the Federal Court of Australia. Although this brief is not in the context of litigation, the Victorian electricity distribution businesses are seeking a rigorously prepared independent view for use in the context of regulatory decision making and you are requested to follow the Guidelines to the extent reasonably possible in the context.

In particular, please:

Identify your relevant area of expertise and provide a curriculum vitae setting out the details of that expertise:

1.1.1. only address matters that are within your expertise;

1.1.2. where you have used factual or data inputs please identify those inputs and the sources;

1.1.3. if you make assumptions, please identify them as such and confirm that they are in your opinion reasonable assumptions to make;

1.1.4. if you undertake empirical work, please identify and explain the methods used by you in a manner that is accessible to a person not expert in your field;

1.1.5. confirm that you have made all the inquiries that you believe are desirable and appropriate and that no matters of significance that you regard as relevant have, to your knowledge, been withheld from your report; and

1.1.6. please do not provide legal advocacy or argument and please do not use an argumentative tone.

Yours sincerely,

Jeremy Rothfield
Network Regulation and Compliance Manager

FEDERAL COURT OF AUSTRALIA

Practice Note CM 7

EXPERT WITNESSES IN PROCEEDINGS IN THE FEDERAL COURT OF AUSTRALIA

1. Practitioners should give a copy of the following guidelines to any witness they propose to retain for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based on the specialised knowledge of the witness (see **Part 3.3 - Opinion** of the *Evidence Act 1995* (Cth)).

2. The guidelines are not intended to address all aspects of an expert witness's duties, but are intended to facilitate the admission of opinion evidence[1], and to assist experts to understand in general terms what the Court expects of them. Additionally, it is hoped that the guidelines will assist individual expert witnesses to avoid the criticism that is sometimes made (whether rightly or wrongly) that expert witnesses lack objectivity, or have coloured their evidence in favour of the party calling them.

<u>**Guidelines**</u>

1. General Duty to the Court[2]

1.1 An expert witness has an overriding duty to assist the Court on matters relevant to the expert's area of expertise.

1.2 An expert witness is not an advocate for a party even when giving testimony that is necessarily evaluative rather than inferential[3].

1.3 An expert witness's paramount duty is to the Court and not to the person retaining the expert.

2. The Form of the Expert Evidence[4]

2.1 An expert's written report must give details of the expert's qualifications and of the literature or other material used in making the report.

2.2 All assumptions of fact made by the expert should be clearly and fully stated.

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[1] As to the distinction between expert opinion evidence and expert assistance see *Evans Deakin Pty Ltd v Sebel Furniture Ltd* [2003] FCA 171 per Allsop J at [676].

[2] See rule 35.3 Civil Procedure Rules (UK); see also Lord Woolf "Medics, Lawyers and the Courts" [1997] 16 CJQ 302 at 313.

[3] See *Sampi v State of Western Australia* [2005] FCA 777 at [792]-[793], and *ACCC v Liquorland and Woolworths* [2006] FCA 826 at [836]-[842]

[4] See rule 35.10 Civil Procedure Rules (UK) and Practice Direction 35 – Experts and Assessors (UK); *HG v the Queen* (1999) 197 CLR 414 per Gleeson CJ at [39]-[43]; *Ocean Marine Mutual Insurance Association (Europe) OV v Jetopay Pty Ltd* [2000] FCA 1463 (FC) at [17]-[23]

2.3 The report should identify and state the qualifications of each person who carried out any tests or experiments upon which the expert relied in compiling the report.

2.4 Where several opinions are provided in the report, the expert should summarise them.

2.5 The expert should give the reasons for each opinion.

2.6 At the end of the report the expert should declare that "[the expert] has *made all the inquiries that* [the expert] *believes are desirable and appropriate and that no matters of significance that* [the expert] *regards as relevant have, to* [the expert's] *knowledge, been withheld from the Court*."

2.7 There should be included in or attached to the report: (i) a statement of the questions or issues that the expert was asked to address; (ii) the factual premises upon which the report proceeds; and (iii) the documents and other materials that the expert has been instructed to consider.

2.8 If, after exchange of reports or at any other stage, an expert witness changes a material opinion, having read another expert's report or for any other reason, the change should be communicated in a timely manner (through legal representatives) to each party to whom the expert witness's report has been provided and, when appropriate, to the Court[5].

2.9 If an expert's opinion is not fully researched because the expert considers that insufficient data are available, or for any other reason, this must be stated with an indication that the opinion is no more than a provisional one. Where an expert witness who has prepared a report believes that it may be incomplete or inaccurate without some qualification, that qualification must be stated in the report (see footnote 5).

2.10 The expert should make it clear when a particular question or issue falls outside the relevant field of expertise.

2.11 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the opposite party at the same time as the exchange of reports[6].

3. Experts' Conference

3.1 If experts retained by the parties meet at the direction of the Court, it would be improper for an expert to be given, or to accept, instructions not to reach agreement. If, at a meeting directed by the Court, the experts cannot reach agreement about matters of expert opinion, they should specify their reasons for being unable to do so.

M E J BLACK
Chief Justice
25 September 2009

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[5] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565

[6] The *"Ikarian Reefer"* [1993] 20 FSR 563 at 565-566. See also Ormrod *"Scientific Evidence in Court"* [1968] Crim LR 240