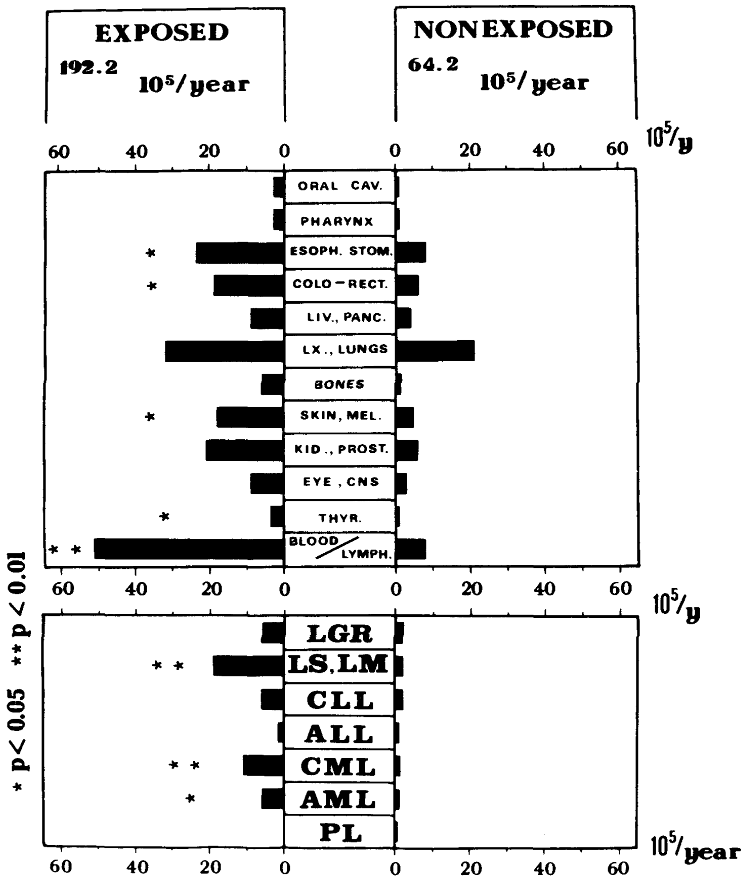

Figure 14: Cumulative yearly morbidity rate of neoplasms during 1971-80 (expressed as the number of new cases per 100,000 person years) for all ages (20-59 years) in MW/RF exposed subjects and non-exposed subjects. Top histogram show organ localization of malignancies for oral cavity; pharynx and larynx; esophagus and stomach; colo-rectal, liver and pancreas; lungs; bones; skin including melanoma; kidneys-urogential tract- prostate; eyes and central nervous system; thyroid gland and other endocrine glands; hematopoietic and lymphatic organs.

The high incidence of cancer of the hemato-lymphatic organs allows the break down given in the lower half of the diagram. LGR: malignant lymphogranulamatosis; LS, LM, lymphosarcomas and lymphomas; CLL, chronic lymphatic leukemia; ALL, acute lymphoblastic leukemia; CML, chronic myelocytic leukemia; AML, acute myeloblastic leukemia and PL, plasmocytoma (plasma cell leukemia).

This data shows that the microwave exposed group, compared to the low exposure group, had increased malignancies in every category of organ, significantly increased in esophagus and stomach, colo-rectum, skin cancer including melanoma and thyroid, and highly significant in blood and lymph organs. Individual leukemia's which were significant were Acute Myeloblastic leukaemia and highly significant were chronic myelocytic leukaemia and lymphosarcomas and lymphomas.

This is the largest of any study carried out to this time shows that RF/MW exposure increased the cancer in every organ of the body, but some organs are more reactive than others, especially the blood and lymph organs. This is consistent with melatonin reduction, a calcium ion efflux mechanism and suppression of the immune system.

10. Szmigielski (1996) "Cancer morbidity in subjects occupationally exposed to high frequency (Radiofrequency and microwave) electromagnetic radiation."

This is a follow-up study from the previous study, adding a further 5 years of morbidity data. The ICNIRP statement is: "In a later study, Szmigielski (1996) found increased rates of leukemia and lymphoma among military personnel exposed to EMF fields, but the assessment of EMF exposure was not well defined."

This is totally misleading and inaccurate. The identification of the high exposure group, clearly separates them from the low exposure group, even though, as in almost every epidemiological study carried out on any disease agent, e.g. particulate air pollution in cities, individual exposures are not known but mean group differences can be reliably identified. The dismissive statement from ICNIRP is not appropriate nor justified for the largest, most carefully identified and classified study of its kind yet carried out.

The data is summarised in three tables, in parallel with the summary diagrams of Szmigielski et al. (1988) above, morbidity of body organs, haemopoietic malignancies and age-grouped relationships.

As in the 1988 analysis, all Risk Ratios are greater than 1. This larger data set shows stronger relationships than the 1988 analysis and Nervous system and brain tumors are now significantly increased from RF/MW exposure.

Table: Incidence of neoplasms (per 100,000 subjects annually) in military personnel exposed and non-exposed (control) to radiofrequency and microwave radiation, Szmigielski (1996).

Localization of malignancies	Incidence (Expected)	Incidence (Exposed)	Risk Ratio	95% CI limits	p-value
Pharynx	1.96	2.12	1.08	0.82-1.24	N.S.
Esophageal and stomach	4.83	15.64	3.24	1.85-5.06	<0.01
Colorectal	3.96	12.65	3.19	1.54-6.18	<0.01
Liver, pancreas	2.43	3.58	1.47	0.76-3.02	N.S.
Laryngeal, lung	21.89	23.26	1.06	0.72-1.56	N.S.
Skin, including melanomas	3.28	5.46	1.67	0.92-4.13	<0.05
Nervous system including brain tumour	2.28	4.36	1.91	1.08-3.47	<0.05
Thyroid	1.38	2.12	1.54	0.82-2.59	N.S.
Haematopoietic system and lymphatic organs	6.83	43.12	6.31	3.12-14.32	<0.001
All malignancies	57.60	119.12	2.07	1.12-3.58	<0.05

In the 1988 data analysis, three sub-categories of leukaemia and lymphoma were significantly increased with RF/MW exposure. In this larger data set all are significantly increased and 4 are very highly significantly increased, Lymphoma, Chronic Myelocytic Leukaemia, Acute Myeloblastic Leukaemia and Total leukaemia/lymphoma.

Table: Incidence of haemopoietic and lymphatic malignancies (per 100,000 subjects annually) in military personnel exposed and non-exposed (control) to radiofrequency and microwave radiation.

Type of malignancy	Incidence Non-exposed	Incidence Exposed	RR	95 % Confid.	Significance
Hodgkin's disease	1.73	5.12	2.96	1.32 - 4.37	<0.05
Lymphoma (non-Hodgkin and lymphosarcoma	1.82	10.65	5.82	2.11 - 9.74	<0.001
Chronic lymphacytic leukaemia	1.37	5.04	3.68	1.45 - 5.18	<0.01
Acute lymphoblastic leukaemia	0.32	1.84	5.75	1.22 - 18.16	<0.05
Chronic myelocytic leukaemia	0.88	12.23	13.90	6.72 - 22.12	<0.001
Acute myeloblastic leukaemia	0.71	6.12	8.62	3.54 - 13.67	<0.001
Total	6.83	43.12	6.31	3.12 - 14.32	<0.001

The age-group relationships also show statistical significance in the large data set except the 50-59 age group. The Haemopoietic/lymphatic cacners are all highly significantly increased in every age group.

Table: Incidence of neoplasms (tumors) (per 100,000 subjects annually) in age groups of military personnel exposed and non-exposed (control) to radiofrequency and microwave radiation, Szmigielski (1996).

Age Group	Incidence Non-exposed	Incidence Exposed	OR	95%Confidence limits	(p-value)
All sites:					
20-29	11.62	21.11	2.33	1.23 - 3.12	<0.05
30-39	18.37	42.28	2.30	1.04 - 3.06	<0.05
40-49	84.29	161.62	1.92	0.98 - 2.84	<0.05
50-59	186.71	274.13	1.47	0.92 - 2.21	N.S.
All Ages	57.6	119.12	2.07	1.12 - 3.58	<0.05
Haemopoietic/lymphatic malignancies					
20-29	2.12	17.30	8.16	3.11 - 22.64	<0.01
30-39	3.08	26.43	8.58	3.46 - 19.58	<0.01
40-49	8.32	73.25	8.80	4.13 - 15.27	<0.01
50-59	24.13	108.62	4.47	2.56 - 6.81	<0.01
All ages	6.83	43.12	6.31	3.12 - 14.13	<0.001

Estimates for Mean Life-time Exposure:

The Polish Military were controlled and required to report and record exposure from 1968 onwards, when compliance was tightened. They worked to the following Occupational Standards. In order to estimate a life-time exposure we need to make assumptions about the daily exposure regime in highly exposed jobs, how long people remain in jobs with potential high exposure and the at work/away ratios. The following table sets out a suggested daily exposure regime for the periods when in a highly exposed regime.

Table: Polish <u>Occupational</u> exposure standards (Czerski (1985)) for RF/MW exposure, 300 MHz - 300 GHz. Exposure in mW/cm²

Zone	Stationary Antennae	Rotating antennae
1) Safe, Human occupancy unrestricted	< 10	< 100
2) Intermediate, access limited to authorized personnel, occupational exposure permissible during work shift.	10 - 200	100 - 1000
3) Hazardous, access limited to authorized personnel, duration of exposure (t in hrs) defined by the formula in parentheses. (p in W/m^2: 1 W/m^2 = 100$\mu W/cm^2$)	200 - 10,000 ($t=32/p^2$)	1,000-10,000 ($t=800/p^2$)
4) Danger Zone, human occupancy prohibited.	> 10,000	> 10,000

Szmigielski (1996) notes that from measurements of fields at working places, 80% of the investigated personnel were exposed to peak fields in the 100 - 2000 $\mu W/cm^2$ range, and 15 % to the 2000 to 6000 $\mu W/cm^2$ range.

Szmigielski (1998) provides further insights into the frequency of peak exposures. Szmigielski (1998) is a prospective study on exposed Polish Military personnel between 1986 and 1990. He concludes that the data suggests that cancers “develop faster, with a shorter latency period” in servicemen with occupational RF/MW exposures. He also found a dose-response relationship with cancer rate against maximum microwave exposure. Close exposure monitoring places 92.8% of the exposed men in situations where peak exposures were less than 1000$\mu W/cm^2$, and 83.7 % below 600$\mu W/cm^2$. This data also includes the all cancer risk ratio for these groups of people.

Number of Men	Peak Exposure Range $\mu W/cm^2$	Cancer Rate Ratio
1900 (49.4%)	100-200	1.69
1320 (34.3%)	200-600	1.57
350 (9.1%)	600-1000	4.62
280 (7.2%)	>1000	4.93

Estimating Working Day mean exposures:

Working day mean exposures are based on the Hygiene regime in place since 1968, which limits times of exposure based on level of intensity, i.e. $T = 32/P^2$, where T is the limit time in hours and P is the exposure power density in W/m^2. The following table sets out the estimates and assumptions approximating the average working week for a highly exposed service man, entering the danger zone 5 times per week and the hazard zone 10 times per week (these are very high assumptions).

Table : Estimated mean maximum weekly exposure scenario for a very highly exposed serviceman.

Zone classification and safety limits	Times/wk	Limit Hours	WeeklyTime Hours	Dose
Danger Zone (>10,000µW/cm^2)				
Average 15,000µW/cm^2	5	0.0014	0.007	105
Hazard Zone (200-10,000 µW/cm^2)				
Average 5000 µW/cm^2	10	0.0128	0.128	640
Intermediate Zone (10-200 µW/cm^2)				
Average 100 µW/cm^2			19.6 hours	1960
Safety Zone (<10 µW/cm^2)				
Average 5 µW/cm^2			20.0 hours	100

The total weekly dose during the working day for this highly exposed person is 2805µW/cm^2-hours. Allowing for the person to live on or near the base where the ambient exposure is 1µW/cm^2, gives an overall dose of 2885µW/cm^2-hours, averaging 24.0µW/cm^2 for a working week. Assuming 46 working weeks and 6 away weeks in a year, with the away ambient exposure being 0.1µW/cm^2, gives an annual mean exposure of 21.4µW/cm^2. Assuming that 25 % of a working life is spent in a high exposure job, 25 % in a moderate exposure job (averaging 10µW/cm^2) and 50 % in a low exposure job (5µW/cm^2). This gives a mean life-time exposure of 10.3µW/cm^2. Similar assumptions place the moderate exposure job, mean life-time exposure at 7µW/cm^2 and the low exposure job at 3.5µW/cm^2.

Hence the effects in the Polish Military Study are associated with mean life-time RF/MW exposures in the range 3.5 to 10µW/cm^2. These are associated with all cancer Risk Ratios close to 50% of the mean life-time exposure, i.e. RR=1.7 to RR=4.93 .

Simplified peak and mean exposure regime:

Based on the Polish Military study measurements the following simplified exposure regime has been proposed. The simplified regime could consist of life-time means being half of annual means while working, annual mean is 20% of the weekly working mean, the weekly peak is 10 times the weekly mean and the monthly peak is 10 times the weekly peak. For example:

Exposure	Exposure (µW/cm^2)				
Category	Life-time Mean	Annual Mean	Weekly Mean	Peak Weekly	Peak Monthly
High	10	20	100	1,000	10,000
Medium	5	10	50	500	5,000
Low	2	4	20	200	2,000

Conclusions:

The three published papers in the Polish Military cancer morbidity study shows that RF/MW is associate with cancer in every major organ of the body, with the highest risks occurring for Leukaemia and Lymphoma. A dose response relationship has been found for the latest study which is a prospective study following a large number of exposed servicemen and monitoring their peak exposures associated with their military work.

The significance of these studies cannot be dismissed because of exposure uncertainties. There is very little uncertainty that those chosen as exposed to RF/MW radiation and those chosen to have low exposure to RF/MW have been misclassified. They also contain the largest number of subjects of any study thus far. Hence the ICNIRP criticism of these studies is completely unfounded.

These studies, when taken together with the other studies presented here, show a causal relationship between exposure to RF/MW and sickness and death due to cancer increases and very low mean life-mean exposure levels and non-thermal peak exposures (Szmigielski pers. comm.).

Residential Studies:

We have already seen that the residential study in San Francisco showed dose response related childhood cancer death, brain tumor and leukaemia for residential exposure to low intensity microwaves from a TV/FM tower on Mt Sutra. Szmigielski shows that the highest effect of RF/MW exposure of military personnel is Leukaemia and Lymphoma.

ICNIRP cites two residential studies contain in three papers, Hocking et al. (1996) and Dolk et al. (1997a. and b.). describing them as “have suggested a local increase in leukaemia incidence”, “but the results are inconclusive.”

Taken in isolation any epidemiological study may find statistically significant associations and may still be described as “inconclusive”. However, such a study does show a potential adverse health effects as define by Section 3(f) in the R.M.A.. When a study also shows a dose response relationship, the association significance rises to a probable relationship, but not yet causal. When several studies show statistically significant associations than a causal relationship is sometimes accepted. If one or two show dose response relationships then in almost every case (except in the EMR community) this would be taken as a causal relationship.

The studies cited thus far include several which show statistically significant relationships with cancer and two show dose response relationships. In addition there are many animal and cellular studies giving support to show cancer increases with chronic exposure to low intensity RF/MW radiation. This we already have sufficient to show a causal relationship between RF/MW exposure and cancer at occupational and residential exposure levels. In this context Hocking et al. and Dolk et al. are confirming this causal relationship by adding further statistically significant relationships and dose response relationships.

Hence the ICNIRP comment on these studies is incorrect and misleading.

11. Hocking, Gordon, Grain and Hatfield (1996): “Cancer incidence and mortality and proximity to TV towers.”

This study was carry out to allay public fears about siting cell sites in residential properties in Australia, Hocking (pers. Comm.). when it was commenced Dr Hocking was the Medical Director of the Telstra Research Laboratory. At the time of publication Dr Hocking at become an independent public health consultant and the paper was published with the support of his professional colleagues.

The results of the study did not allay public fears about cell sites, for exposures to similar levels of exposure from these TV towers out to about 4 km gives the same exposure levels out to several hundred metres from cell sites. Within this zone the study found a significant increase in childhood and adult leukaemia incidence and mortality.

The data covered 9 municipalities in the north side of Sydney Harbour for the period 1972 to 1990. The exposed population was chosen to the three municipalities which surrounded three large TV towers, Lane Cove, Willoughby and North Sydney with a population of 135,000. The control group came from six surrounding municipalities, Ryde, Ku-ring-gai, Warringah, Manly, Mosman and Hunters Hill, population 450,000. The cancer incidence and mortality cases were adjusted for sex, age and calendar period and resulted in 3152 (225) cancer incidence and 2300 (148) cancer mortalities for all ages (children 0-14).

Hocking et al. shows statistically significantly increased incidence and mortality for total leukaemia, Lymphatic Leukaemia and Other Leukaemia for the whole population, with Risk Ratios in the range 1.09 to 1.67 for leukaemia incidence and 1.01 to 1.57 for leukaemia mortality. The highest relationship is for Lymphatic Leukaemia mortality, RR = 1.39 (95% CI: 1.00-1.92). Results:

Table: Rate Ratios (RR) and 95% confidence intervals (CI) for cancer incidence and mortality in the population of the inner area compared to the outer area, adjusted for age, sex and calendar period.

Cancer Type	RR	(95% CI)	Cases
Incidence			
Brain Tumour	0.89	(0.71-1.11)	740
Total Leukaemia	1.24	(1.09-1.40)	1206
Lymphatic Leukaemia	1.32	(1.09-1.59)	536
Myeloid Leukaemia	1.09	(0.91-1.32)	563
Other Leukaemia	1.67	(1.12-2.49)	107
Mortality			
Brain Tumour	0.82	(0.63-1.07)	606
Total Leukaemia	1.17	(0.96-1.43)	847
Lymphatic Leukaemia	1.39	(1.00-1.92)	267
Myeloid Leukaemia	1.01	(0.82-1.24)	493
Other Leukaemia	1.57	(1.01-2.46)	87

Table: Rate Ratios (RR) and 95% confidence intervals (CI) for cancer incidence and mortality <u>in childhood (0-14 years)</u> in the population of the inner area compared to the outer area, adjusted for age, sex and calendar period.

Cancer Type	RR	(95% CI)	Cases
Incidence			
Brain Tumour	1.01	(0.59-2.06)	64
Total Leukaemia	1.58	(1.07-2.34)	134
Lymphatic Leukaemia	1.55	(1.00-2.41)	107
Myeloid Leukaemia	1.73	(0.62-14.81)	9
Other Leukaemia	1.65	(0.33-8.19)	8
Mortality			
Brain Tumour	0.73	(0.26-2.10)	30
Total Leukaemia	2.32	(1.35-4.01)	59
Lymphatic Leukaemia	2.74	(1.42-5.27)	39
Myeloid Leukaemia	1.77	(0.47-6.69)	11
Other Leukaemia	1.45	(0.30-6.99)	9

For childhood leukaemia the relationships are generally stronger even though the sample size is smaller. Significant relationships exist for Total Leukaemia and Lymphatic leukaemia incidence and mortality. The strongest relationship is for childhood lymphatic leukaemia death, RR=2.74 (95%CI: 1.42-5.27). the study found that 59 children had died from having leukaemia when the expected number was 25.43, an excess of 33.6 deaths. For childhood lymphatic leukaemia 39 children died when 14.2 were expected, an excess of nearly 25 children.

The authors search diligently for confounding factors, including social economic factors, air pollution (benzene), ionizing radiation, migration, hospitals, high voltage power lines and local industries. None affected the relationships found. They investigated the possibility of clustering and found that no significant heterogeneity was found (p=0.10 for incidence and p=0.13 for mortality).

Exposure Regime:

Exposure levels were calculated for the 4 individual TV stations. They were combined and plotted against the geographic centre of the three TV towers. The frequencies involved are in the range 63 - 219 MHz and 626-633 MHz.

Within a radius of about 1 km or so the area is inside the circle of the towers themselves. The high readings between 4 to 8 $\mu W/cm^2$ at about 1 km are the areas immediately adjacent to each of the towers where few people reside. At the geographic centre, between the towers, the calculated exposures are in the range 1 to $2\mu W/cm^2$.

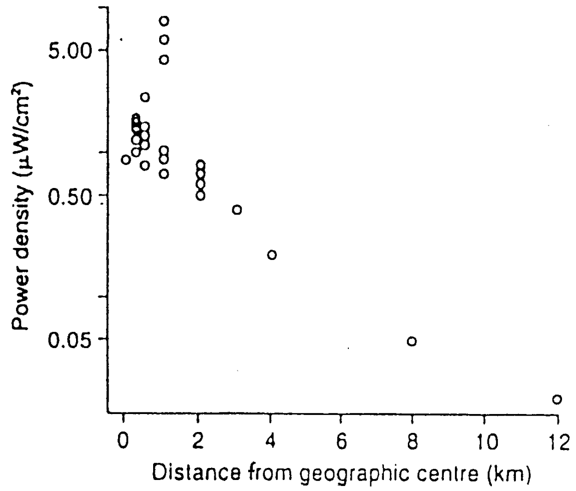

Figure 15: Logarithm of the calculated power densities (in μW/cm^2) for TV signals from the three TV towers against distance from the centre of the towers.

Outside the circle of the towers themselves their combined calculated level of exposure falls from about 1μW/cm^2 at 2 km from the centre, to 0.2μW/cm^2 at 4 km and 0.08μW/cm^2 at 8km. Thus the exposed population resides in calculated outdoor levels between 0.2 and 8μW/cm^2. Measurements found that in the region of Tower 1 the actual levels, among the rolling terrain, trees and buildings, were 5 times lower than those calculated. Indoor exposures would be at least 2 times lower again. Hence the lowest exposure for the exposed population is calculated at 0.2μW/cm^2, and measured at 0.04μW/cm^2. Using the adjustment factor from the San Francisco study of 56% this becomes a probable life-time mean of 0.02μW/cm^2 for the NOEAL level.

12. Dolk, Shaddick, Walls, Grundy, Thakrar, Kleinschmidt and Elliott (1997): "Cancer Incidence near Radio and Television Transmitters in Great Britain: 1. Sutton Coldfield Transmitter".

This is the first of two U.K. studies which show increases in cancer within 10 km of high powered regional TV and FM radio transmission towers. These U.K. studies show in significant increases in adult leukaemia, melanoma of the skin, and bladder cancer and increases a number of other adult cancers as well as childhood leukaemia and brain tumour in association with RF/MW radiation. The incidence is generally low near the towers, rises to a peak between 2 and 6 km, and then declines with distance. In some cases the incidence of particular cancers is high within 1 to 2 km of the towers. This generally occurs only with towers which have both high powered FM and high powered TV transmitters installed. This closely follows the mean RF/MW power density curve and cancer results as shown for the Sutra Tower. which ahs both high powered TV and FM stations. The stations which don't have FM installed have far lower exposures in the immediate vicinity of the towers because of the higher degree of horizontal focussing of the high frequency UHF signals. Such sites consistently show cancer incidence is low near the tower, rising to a broad peak between 2 and 6 km, and then declining with distance. This closely follows the mean RF/MW exposure curves and hence shows highly significant dose response relationships.

Thus these studies are externally and internally consistent, although the authors do not realize this. They appear to assume that at all sites the radiation exposure is highest at the tower and declines with distance from the tower. Since Sutton Coldfield follows this shape for adult leukaemia and the 20 sites study shows adult leukaemia is low near the towers, they call the result "inconsistent". This analysis shows that this is not so.

We must be aware of two primary factors when considering these studies. The first relates to low sample numbers and the second to the markedly different radiation patterns from VHF FM antennae and UHF TV antennae.

Small sample numbers:

When 1 adult leukaemia is identified within 500 m of the Sutton Coldfield transmitter, this produces a Risk Ratio or Observed/Expected (O/E) ratio of 9.09 because the expected incidence in this small population is 0.11. Similarly in the 0.5km to 1 km ring, 5 adult leukaemias occurred when 2.72 were expected (O/E = 1.84). When 1 person with leukaemia lived within 500m of the Crystal Place Tower in London, the O/E ratio was 0.62 because with this far larger population 1.6 adult leukaemias were expected.

A difference of 1 or 2 cases in small samples such as these has a dis-proportional effect.

The chance of one or two cancers happening at random is very high. The chance of 10 to 20 happening in a given small neighbourhood is much lower, and so on...

Differences in VHF and UHF radiation patterns:

The mean radial ground level radiation pattern around high powered transmitter sites is the sum of the patterns of the individual antenna arrays of each radio station or television channel. The resultant power density (exposure) fields are additive at any point. In addition to direct beams coming to a point in line of site from the mast, reflected beams and be added when they are in phase and subtracted when they are out of phase. This large differences can occur over small spatial distances.

When sites contain more than one transmitter then the radiation pattern is smoothed because of the slightly different characteristics of each pattern. When transmitters use completely different frequency bands, then the ground level pattern can be very different for each. Figure 16 shows the different field strengths, with distance from an elevated transmitter for 50 MHz, 100 MHz and 300 MHz carriers.

The lower the frequency the wider are the spatial peaks and the fewer minima occur. The very far field strength is higher for the 300 MHz signal, and then the 100 MHz signal and then the 50 MHz signal, because of the greater horizontal focussing of the higher frequency antennae. The lower frequency, VHF signals, deposit more of their energy at ground level close to the mast while more of the UHF signal propagates into the distance.

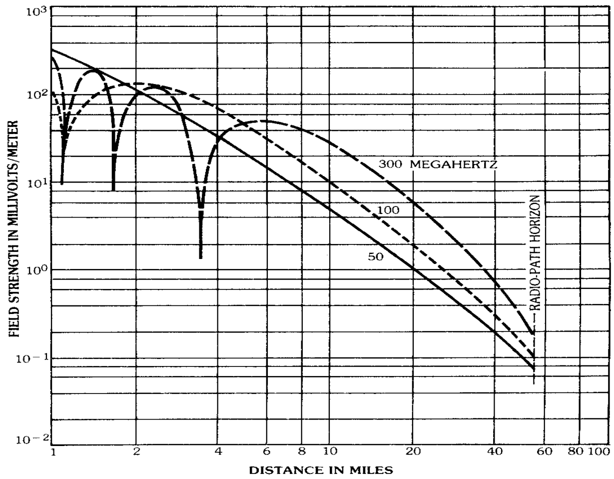

Figure 16: An example of the far-field variation of resultant field strength with distance and frequency. Antenna height 304 m (1000'), power 1 kW, Jordon (1985).

Also, inside about 6.4 km (4 miles), the broad ground level field strength peak is much more spatially variable. It has low points at 3.0°, 6.2° and 8.9°, corresponding to distances from a 240m tower of 4.6 km 2.2 km and 1.5 km. Dolk et al.'s description of the exposure regime captures many of these characteristics but fail to become aware of the difference between the FM and TV signal patterns:

> **"Field strength measurements have been made in the vicinity of the transmitter (British Broadcasting Corporation, BBC). In general both measured and predicted field strength values tended to show a decline in average field strength or power with distance from the transmitter, although there are undulations in the predicted field strength up to distances of about 6 km from the transmitter resulting form the vertical radiation pattern. The maximum total power density equivalent summed across frequencies at any one measurement point (at 2.5m above ground) was 0.013 W/m^2 (1.3mW/cm^2) for TV, and 0.057 W/m^2 (5.7mW/cm^2) for FM. However, there was considerable variability between different measurement points at any one distance from the transmitter, as one would expect from the impact of reflections from ground and buildings, and this variability was as great as that related to distance. Power density on average declines by a factor of 5 to 10 over 10 km."**

There is no comment by Dolk et al about measurements or predictions of power densities within the nearest 2 km, except in the second paper they comment that at Crystal Palace there are no high powered FM transmitters, and the TV signal strength with 2 km is similar to that at Sutton Coldfield.

The Sutton Coldfield transmitter has 4 TV and 3 FM stations, giving 4 MW erp of UHF and 0.75 MW erp of VHF, and yet the VHF has This shows that much broader relative field pattern of the VHF antennae gives higher intensity exposures close into the towers.

The Physics of the situation where a lower powered FM signal has a higher ground level power density, 5.7µW/cm^2, shows, following the inverse square law, that this peak must occur far closer to the base of the tower, inside 1 km. On the other hand 4 MW of UHF produces 1.3µW/cm^2 where the relative field factor is at a peak between 1.5 and 3 km.

The presence of FM helps to explain the high exposure readings within 800m and round the base of the Sutra Tower, whereas towers with only UHF transmitters will have relatively lower near tower exposures. They have more of their antenna induced local variations in a broad and variable peak in the middle distance because of the “crisper” relative field patterns of UHF antenna, see the figure above.

Hence antennae with UHF alone have a ground level peak somewhere outside 1.5 km, while those with VHF (FM) signals, peak within 100s of metres of the base of the tower, falling to a minimum around 800m to 1.5 km radius, and then rising into a broad, variable peak, then falling at approximately an inverse square law beyond about 6 km.

The Sutton Coldfield Study:

Background to the U.K. studies:

The U.K. studies were initiated because a Birmingham G.P., Dr Mark Payne had collected data on cancer cases from a north Birmingham general practitioner with 2600 patients. He reported that seven existing cases of leukaemia and lymphoma, five men and two women aged 18-66 years, were identified living with 400 to 1500m from the Sutton Coldfield Transmitter.

All but one had lived in the region for 14-25 years except one who had lived there for only 2 years. Dr Payne explained that the age range new diagnosed rates of leukaemia were 2.5 per 100,000 p-years. The population living within 2 km of the transmitter was16,250. Hence over a 20 year period the expected leukaemia incidence is expected to be 8.1 cases. A search of the cancer registry a total of 23 (12.59) leukaemias and 8 (12.17) Non-Hodgkins Lymphomas, and at total 703 (647.36) people with cancer living with 2 km of this site, with expected numbers in brackets.

This data and a full data set out to 10 km from the transmitter was obtained by the Small Area Health Statistics Unit of the Department of Epidemiology and Public Health of the Imperial College of Medicine, London. They obtained adult (>=15 years) cancer data for a wide range of cancers, but childhood (0-14) data was limited to all cancer and all leukaemia. The period was 1974-1986. The population living with 10 km of the Sutton Coldfield transmitter was 408,000 from the 1981 census. For the complete data set there was a statistically significant 3 % increase in all cancer with 10 km radius of the transmitter compared to regional expected rates (O/E = 1.03, 95%CI: 1.02-1.05).

The Sutton Coldfield Tower has been operating since 1949 but the first high power TV (UHF) transmitter (1 MW ERP) was installed in 1964. In 1969 two more were added and a further channel was added in 1982 taking the total power to 4 MW ERP. Three FM (VHF) stations were added in 1957. Hence from 1957 the ERP was 750 kW, in 1964 it rose to 1.75 MW, in 1969 to 3.75 MW and to 4.75 MW in 1982. The cancer registry data was for cancers diagnosed in the period 1974-1986. Adult cancers emerging in this period would have been initiated up to at least three decades earlier, i.e. some would have been initiated prior to the establishment of the tower. A good number of cancers have mean latencies in the 8 to 20 year range, and would have been initiated and promoted during the period of the tower's operation. Cancers initiated prior to the towers erection would be being promoted during exposure to the tower's changing RF/MW output.

Cancer results:

This study involves a far smaller sample than the San Francisco study, less than half a million compared to several million total population, but this study considers a wide range of cancer types for adults as well as for children. However, the population of children involved is very small, especially in the "exposed" group, and therefore reaching statistical significance is unlikely. For example, at Sutton Coldfield there are 97 children with cancer with 10 km of the tower. Within 2 km of the tower there were two childhood leukaemia cases when 1.1 was expected. This gives RR = 1.82 but is far from significant. Hence the Sutton Coldfield study cannot reliably address the childhood cancer issue. This problem, of small numbers, also limits the reliability of relationships with individual cancer types, especially close to the towers where population numbers are necessarily small.

For adult cancers the results are presented in the following two tables.

Distance from :ransmitter (km)	All cancers*				All leukemias				Non-Hodgkin's lymphomas			
	Observed	Expected	O/E ratio	Cumulative O/E ratio	Observed	Expected	O/E ratio	Cumulative O/E ratio	Observed	Expected	O/E ratio	Cumulative O/E ratio
0–0.5	2	5.61	0.36	0.36	1	0.11	9.09	9.09	0	0.11	0.00	0.00
0.5–1.0	96	137.19	0.70	0.69	5	2.72	1.84	2.12	3	2.60	1.15	1.11
1.0–2.0	605	504.59	1.20	1.09	17	9.76	1.74	1.83	5	9.46	0.53	0.66
2.0–3.0	282	279.01	1.01	1.06	9	5.56	1.62	1.76	9	5.76	1.56	0.95
3.0–4.9	1,002	1,050.86	0.95	1.00	25	20.22	1.24	1.49	20	20.25	0.99	0.97
4.9–6.3	2,414	2,301.25	1.05	1.03	54	41.96	1.29	1.38	45	40.60	1.11	1.04
6.3–7.4	2,734	2,650.62	1.03	1.03	48	46.54	1.03	1.25	57	43.95	1.30	1.13
7.4–8.3	2,827	2,798.65	1.01	1.02	51	49.22	1.04	1.19	52	47.19	1.10	1.12
8.3–9.2	3,363	3,213.75	1.05	1.03	40	57.35	0.70	1.07	80	54.56	1.47	1.21
9.2–10	4,084	3,919.59	1.04	1.03	54	68.90	0.78	1.01	86	66.02	1.30	1.23

* All cancers excluding non-melanoma skin cancer.

Non-Hodgkin's Lymphoma, Skin Melanoma and Bladder cancer all follow the same pattern of being lower than average near the tower, rising to a peak 2-3 km from the tower and then generally declining with distance. They is a secondary peak between 4.9 and 7.3 km. Leukaemia also has two peak, but the first is inside 2 km and the second is between 4.9 and 6.6 km as for the other cancers. Because All Cancer includes leukaemia it doesn't have the low rates inside 1 km which the other cancers show.

Distance from transmitter (km)	Skin melanoma				Bladder cancer			
	Observed	Expected	O/E ratio	Cumulative O/E ratio	Observed	Expected	O/E ratio	Cumulative O/E ratio
0–0.5	0	0.09	0.00	0.00	0	0.24	0.00	0.00
0.5–1.0	2	2.02	0.99	0.95	4	5.96	0.67	0.65
1.0–2.0	11	6.99	1.57	1.43	39	22.17	1.76	1.52
2.0–3.0	12	5.03	2.39	1.77	11	11.94	0.92	1.34
3.0–4.9	16	16.16	0.99	1.35	43	45.27	0.95	1.13
4.9–6.3	26	28.77	0.90	1.13	119	100.31	1.19	1.16
6.3–7.4	28	27.93	1.00	1.09	131	114.85	1.14	1.15
7.4–8.3	32	30.90	1.04	1.08	117	120.64	0.97	1.10
8.3–9.2	28	35.66	0.79	1.01	169	140.13	1.21	1.13
9.2–10	34	43.08	0.79	0.96	155	167.45	0.93	1.08

The significant role of 3 people who as a group are statistically insignificant:

The close-in peak in leukaemia rates is strongly influenced by 2 or 3 people living very near the tower. This is a statistically insignificant number of people in the overall context of the data. The effect of removing three people from the inner 1 km the 0-0.5 km rate O/E=0 and the 0.5-1 km O/E = 1.10 . This would result in leukaemia having a broad peak between 1 and 3 km.

The UHF signal is relatively low inside about 1.5 km because it is strongly directed outwards in the main beam and this is inside the three primary side lobes, but, because of the very high power of the transmitters, when added to the VHF signal, creates a high mixed signal inside 2 km from the tower. The VHF signal strength in this ring likely to be high.

These people could have occurred at random, or there is a chance that a high incidence of chronic lymphatic leukaemia is associated with high combined VHF/UHF exposures. The highest incidence in Hocking et al.(1996) was for lymphatic leukaemia. In the 20 sites study (Dolk et al) it was chronic lymphatic leukaemia. This cancer had a Risk Ratio of 3.68 (95%CI: 1.45-5.18) in Szmigielski (1996). High UHF exposure is often associated with high Risk Ratios for Chronic Myeloblastic Leukaemia, Szmigielski (1996), RR = 13.90 (95%CI: 6.72-22.12). Milham (1988) found the highest cancer rate for Acute Myeloid Leukaemia among ham radio operators, SMR = 176 (95%CI:103-285).

In this present study Chronic and Acute Lymphatic Leukaemia peaks inside 2 km while Chronic Myeloid Leukaemia peaks between 4.9 and 7.4 km, reinforcing the concept that UHF radiation gives a higher rate of Myeloid Leukaemia and VHF with Lymphatic Leukaemia, and the risk of Lymphatic Leukaemia close to the tower is caused by the combination of higher power and the present of high intensity FM (VHF).

Summary of conclusions:

There are three sets of results in paper which are of importance.

Firstly certain cancers appear to relate more to the VHF signal which is high near the tower and declines quickly with distance from the tower, i.e. Lymphatic Leukaemia. The high rate of this cancer within 2 km of the tower is also related to the very high output power of the tower.

Secondly, a number of increases in cancer relate more to the UHF component, which is low to moderate near the tower, falls before rising to form a wide undulating peak between 2 and 6 km, and thence declining with distance from the tower. Melanoma of the skin, bladder cancer and Myeloid Leukaemia follow this pattern.

Thirdly, a wide range of cancers are elevated, but small sample numbers restrict them from reaching statistical significance. They include: both malignant and malignant + benign brain tumour (O/E= 1.31 and 1.29 respl'y.), male breast cancer (O/E = 1.64), female breast cancer (O/E = 1.08), colo-rectal cancer (O/E = 1.13) and prostate cancer (O/E = 1.13). Female breast cancer and Colorectal cancer are approaching significance.

These results are with the elevated incidence of cancer found by Szmigielski (1996) and the data in Robinette et al. (1980), and many other papers.

At Sutton Coldfield there are two distinct types of exposed populations. There is a high FM exposed population inside 2 km and a high UHF exposed population outside 2 km, with a broad exposure peak between 2 and 6 km.

13. Dolk, Elliott, Shaddick, Walls, and Thakrar (1997): "Cancer Incidence near Radio and Television Transmitters in Great Britain: 2. All High Power Transmitters."

Twenty Site Survey:

Following the analysis of the Sutton Coldfield data, Dolk et al. decided to obtain data for all of the other high powered regional TV/FM towers in Great Britain.

Childhood Leukaemia and Brain Tumours:

The larger sample added 8 children (to the 2 already identified near Sutton Coldfield) with leukaemia who lived within 2 km of towers, when 8.94 were expected. This gives O/E = 1.12 (95%CI: 0.61-2.06). There was a slight increase in childhood brain tumour from living within 10 km of a tower, O/E = 1.06 (95%CI: 0.93-1.20) for malignant + benign and O/E = 1.03 (95%CI:0.90 - 1.18) for malignant brain tumours.

Hence the childhood cancer results, when recognizing that in the U.K. case everyone is exposed out to 10 km, is consistent with the Sutra Tower study and reinforces the causal relationship between RF/MW exposure and childhood cancer, particularly leukaemia and brain tumor.

Adult Cancer:

The following table summarizes the analysis for a range of cancer types.

TABLE 4. Cancer incidence near 20 high power radio and TV transmitters in Great Britain (excluding Sutton Coldfield)—leukemia subtypes, skin melanoma, and bladder cancer: observed numbers of cases and observed/expected (O/E) ratios, for all transmitters combined, by distance of residence from transmitter, in persons aged ≥15 years, 1974–1986

Type of cancer	Distance from transmitter (km)							
	0–2		2–4.9		4.9–7.4		7.4–10	
	Observed	O/E ratio	Observed	O/E ratio	Observed	O/E ratio	Observed	O/E ratio
Leukemia								
Acute	34	0.94	302	1.12	494	1.06	585	1.03
Acute myeloid	20	0.77	227	1.17	347	1.04	424	1.04
Acute lymphatic	5	0.90	42	1.04	66	0.95	89	1.04
Chronic myeloid	7	0.63	82	0.96	177	1.16	179	0.92
Chronic lymphatic	27	1.20	208	1.13	323	0.99	401	0.97
Skin melanoma	51	1.11	297	0.86	508	0.86	673	0.94
Bladder cancer	204	1.08	1,620	1.08	2,815	1.06	3,603	1.10

All leukaemia (from Table 2) is near average (O/E = 0.97) within 2 km, Peaks between 2 and 4.9 km (O/E = 1.103), declines with distance (O/E = 1.06 4.9-7.4 km, and O/E = 0.99, 7.4 -10 km). Chronic Lymphatic Leukaemia, Melanoma and Bladder Cancer are elevated within 2 km. They decline with distance, except bladder cancer, which remains elevated out to and including the 7.4 - 10 km ring. Most of the individual leukaemia types peak in the 2 - 4.9 km ring. Acute Myeloid Leukaemia peaks in the 2-4.9 km band and is still elevated at 10 km. These results are total consistent with the Sutton Coldfield observations

Thus the 20 site study also finds elevations of leukaemia, melanoma and bladder cancer in the vicinity of high powered TV/FM towers, and after reaching a peak, a decline with distance, except for bladder cancer. In both cases, bladder cancer remains elevated at 10 km radius.

The greatest incidence and interest comes from leukaemia, the summary results being presented below. This shows the highly significant result for all 20 transmitters that the average incidence of leukaemia is lower than average near the towers, rises to a peak in the 2 - 3 km band, and declines, with undulations, with distance, in a significant dose-response fashion. This is dominated by the Crystal Palace data which has a very large population and no FM stations.

Group 1, which contains all of the high powered towers similar to Sutton Coldfield, has a peak close to the tower, a reduction followed by a stronger peak in the 2-3 km band, and then generally declines with distance from the towers.

Hence Crystal Palace and either Emley Moor or Sandy Heath (the other High Power Group 1 sites) also have 1 person with leukaemia living within 500 m of a high powered TV/FM transmitter. Thus is requires a large population and/or a combination of high powered FM and TV transmissions to increase the incidence of adult leukaemia in the closest 500m from the towers. This is completely consistent with the Sutton Coldfield results.

Most other sites have very few people in total, and an extremely small number living with 2 km of the tower. In Group 3, Wenvoe, Rowridge and Group 4 number of expected leukaemias indicates extremely small populations inside 1 km of the towers. This makes it makes it impossible to meaningfully use them for estimating the effects of RF exposure near transmitters. The overall result is dominated by Crystal Palace because of the very large population involved. This is high powered with no FM and shows low leukaemia rates near the tower, and hence the mean result reflects this. The absence of FM is a significant physical difference between Sutton Coldfield and Crystal Palace as it significantly reduces the EMR exposures of the population living near the tower compared to those at Sutton Coldfield, and hence their leukaemia rates are understandably low with the evidence that it is causally related to RF/MW exposure. Given the low RF/MW exposure near the base of the Crystal Palace tower, the site data follows a dose response relationship, as does Sutton Coldfield, following a different exposure pattern.

Dolk et al. claim lack of replication with the Sutton Coldfield result because "the pattern and magnitude of risk associated with residence near the Sutton Coldfield transmitter do not appear to be replicated around other transmitters". It was this key finding of a high leukaemia rate near the Sutton Coldfield tower was the primary purpose of the follow up study.

Dolk et al. acknowledge that the antenna combination that Sutton Coldfield is unique and not repeated at any other site. They also acknowledge in their conclusions that "if there were a true association with radio transmission, the lack of replication of the pattern and magnitude of the excesses near Sutton Coldfield may indicate that a simple radial decline exposure model is not sufficient."

In this comment they are entirely correct because with both VHF and UHF transmissions there is a complex radial pattern in the near and middle fields, with a rather wavy and variable pattern, before it starts to decline with and inverse square law beyond about 6 km. The difference in radial patterns with VHF FM compared with UHF TV completely explains the difference in results between Crystal Palace and Sutton Coldfield. These papers both show strong but different dose response relationships, confirming the causal relationship between extremely low mean RF/MW exposure and cancer.

Both in radiation exposure difference and in difference of increases in specific types of cancer and how they vary with exposure, the results are remarkably consistent. When compared with other research, these two papers are internally and externally consistent with finding increases in a wide range of cancers when exposed to RF/MW radiation at very low mean levels.

Exposure Assessment:

Slight excesses in cancer are still seen at 10 km, where the direct exposure is 5 to 10 times less than the UHF peak of 1.3μW/cm^2, i.e. between 0.13 and 0.26μW/cm^2. Applying the lifetime mean factor of 0.6 for residential exposure reduces the exposure associated with these adverse health effects to the range 0.08 to 0.16 μW/cm^2.

This is consistent with the widely identified no observable adverse effect level of 0.06mW/cm^2.

Additional studies not cited by ICNIRP:

There is a large body of epidemiologic scientific literature which is relevant to the assessment of RF/MW exposures risk of cancer. Almost all of these studies have not been referenced in the WHO/UNEP/IRPA review which is assumed by the ICNIRP to be "more detailed reviews". In fact the ICNIRP review covers more published studies than does the WHO/UNEP/IRPA review, but both ignore most of the published epidemiological studies.

This again raises the question about the motives and criteria for choosing and ignoring published epidemiological studies.

It is not widely recognized that ELF epidemiological studies have relevance to RF/MW assessments of effects. There are two primary reasons for this. High voltage power lines are sources of RF radiation, especially in the 3 to 30 MHz range, which is why you hear a buzz on your radio as you drive under a powerline.

Secondly, the induced electric field changes in tissues are 100,000 to 1 million times higher for ELF modulated RF/MW than for ELF signals alone, Adey (1976). Thus since biological effects, such as calcium ion efflux or influx, and adverse health effects such as childhood cancer, breast cancer, sleep and mood problems, clinical depression and suicide, all of which have been statistically significantly associated with ELF exposure, then they are more likely to be found in populations exposed to very low levels of RF/MW radiation. This has been confirmed many time, as shown in some cases above, to be true when the RF/MW epidemiological research was carried out.

These ELF studies will only be noted here. The following review covers the RF/MW based studies of epidemiological studies of adverse health effects on people. These are in addition to the 13 studies cited above and the reproduction studies already discussed.

- More neurasthenic symptoms (chronic mental and physical weakness and fatigue) in group exposed to radar (Djordevic et al., 1979).

- Higher frequency of increase in red blood cells (polycythemaemia) with microwave exposure (Friedman, 1981).

- Cancer incidence in the vicinity of Wichita, Kansas was found to be higher on ridges which were exposed to radar transmissions than those residents who lived in the valleys, Lester and Moore (1982 a). Residents were potentially exposed to two radars, one radar and no radars with relative cancer incidences of 470, 429 and 303 per 100,000 (1.55: 1.42 : 1.00). The association persisted through age, sex, race and socio-economic adjustments.

- Lester and Moore (1982b) found significantly higher cancer rates in U.S. counties with Air Force bases compared to those without Air Force bases, which they related to prolonged environmental exposure to RF/MW from radar.

- Association between heart disease and work with shortwave therapies, increasing with the number of treatments/week (Physiotherapists using 27 MHz diathermy) (Hamburger et al., 1983).

- Polson and Merritt (1985) criticized the analysis of Lester and Moore (1982b), pointing out weaknesses in their use of the data, such as a city could be in a country with no Air Force Base but be closer to a base in another country than a city in that county. Having made corrections for this, Lester and Moore (1985) found strengthened associations between cities and air force bases, with higher incidences of cancer related to radar transmissions.

- Lin et al. (1985) studied 951 cases of brain tumors among white male residents of Maryland during the period 1969-1982. Fifty cases of glioma and astrocytoma were observed among electrical workers exposed to EMR compared to an expected number of 18, i.e. an risk ratio of 2.8. While their exposure was mainly to ELF fields it shows the common link over a wide range of frequencies.

- Increased risk of leukaemia amongst amateur radio operators (Milham, 1985).

- In 1985 an unusual number of children with leukaemia were identified living in the vicinity of broadcasting facilities (OR = 3.4: CI=0.70 -16.41), Maskarinec et al. (1993).

- Upper limb paraesthesia and eye irritation among 30 exposed workers using 27 MHz plastic sealers (Bini et al., 1986);

- De Guire et al. (1987) report increased malignant melanoma of the skin in workers in a telecommunication industry, affecting only men, SIR = 2.7 CI : 1.31-5.02).

- Thomas et al. (1987) report a 10-fold increase in astrocytic brain tumor among electronics and repair workers employed for 20 years or more. Some risk was due to solvents, put at a factor of 2, placing RF/MW contribution at a factor of 5.

- Increased rates of paraesthesia in hands, neurasthenia and eye complaints, using 27 MHz plastic welders and sewing machines (Kolmodin-Hedman et al., 1988).

- Milham (1988) studied 67,829 amateur radio operators in Washington State and California. He concludes "The all-cause standardized mortality ratio (SMR) was 71 but a statistically significant increased mortality was seen for cancers of the other lymphatic tissues (SMR = 162), a rubric which includes multiple myeloma and non-Hodgkin's lymphomas. The all leukemia SMR was slightly but not significantly elevated (SMR = 124). However, mortality due to acute myeloid leukemia was significantly elevated (SMR = 176).

- A doubling of miscarriage rates has been reported in women working at computer terminals for more than 20 hours/week in the first three months of pregnancy (Goldhaber et al. 1988). Note that VDU's emit a wide range of RF radiation.

- Duration and severity of tonsillitis increased with combined air pollution and RF exposure (Shandala and Zvinjatskovsky, 1988);

- Electrical workers in Los Angeles county have a 4.3-fold increased risk of certain brain tumors (Preston-Martin et al. 1989).

- An increased incidence of malignant brain tumors has been reported in children of fathers exposed to electromagnetic fields and electronic solvents (Johnson and Spitz, 1989).

- Increased protein band in CSF in exposed group or radar mechanics (Nilsson et al., 1989).

- Hayes et al.(1990) report an Odds ratio for all testicular cancer of 3.1 (CI: 1.4-6.9) for a small sample of workers who were occupationally exposed to RF/MW radiation.

- Navy electrician's mates have an excess risk of leukaemia, RR=2.4 (1.0-5.0), Garland et al. (1990)

- W Shao-Guang, et al. (1990) reports a Chinese study which found a significant increase in neurasthenic syndrome backed up by blood biochemical changes.

- Savitz and Chen (1990) show significant increased risk of childhood cancer (Neuroblastoma (OR=11.8*), Brain Tumour (OR=2.7*) and CNS tumors (OR=1.7)) associated with parents who work in electrical and electronic industries.

- Increased risk for all brain tumours (RR=2.9 (1.2-5.9)) and glioblastomas (RR=3.4 (1.1-8.0)) for assemblers, and repairmen in the radio and TV industry, Tornqvist et al. (1991)

- Microwave heating reduces immune system factors in human breast milk, compared to conventional heating. Microwave heating significantly reduces the IgA for E coli bacteria, producing five times more E coli for 25 °C heating and 18 times more after 3 hours for 98°C heating, Quan et al. (1992).

- Increased risk of female breast cancer with exposure to radiofrequency EMF, RR=1.15 (1.1-1.2), Cantor et al. (1995).

- Altpeter et al (1995) studied populations living near and further away from a shortwave transmitter in Schwarzenburg, Switzerland. The statistically elevated symptoms in the high and medium exposure groups, compared to the low exposure group, include Nervosity and restlessness, Disturbances in falling asleep and difficulty in maintaining sleep, Joint pains, Psychovegetative Index changes, Disturbances of Concentration, General Weakness and Tiredness, Constipation, Diarrhea and Lower back pain, all significant at p<0.02 except the first for which p=0.034 which is less than the usual significance level of p<0.05. Children's advancement from primary school to secondary school was significantly slower in the exposed group. They conclude that even though the association is weakened by a small sample size, an adverse effect from the transmitter "cannot be excluded".

  Following further experiments including moving the beams of the radiation and find the effects changing with the exposure changed, and studying a fourth group which resides in mean exposures between groups B and C, and finding the rate of effects between the rates found for Group B and Group C, Professor Theodor Abelin, the research leader of this study, concluded that there was a causal relationship between the SW radio exposure and sleep disturbance and associated effects (pers. comm - email).

An increased exposure from 1 mA/m to 10 mA/m (0.038μW/cm^2 to 3.8μW/cm^2) had on Odds Ratio for insomnia of 1.13 (CI: 1.04-1.23) and from 0.1 mA/m to 1 mA/m (0.00038μW/cm^2 to 0.038μW/cm^2), OR=2.1 (CI: 0.95-4.57). Table 9 presents the adjusted Odds Ratios for the primary effects found, which show significant dose response relationships and a highly statistically significant increase with mean exposure increase.

Table: Odds Ratios for an increase in 24-hour average exposure from 1 mA/m (0.04 mW/cm^2) to 10 mA/m (3.8 mW/cm^2) adjusted for age, sex, attribution, and duration of time lived at the same place.

Symptoms	OR	95% Conf. Interval
Nervosity	2.77	1.62-4.74
Diff. in falling asleep	3.35	1.86-6.03
Diff. in maintaining sleep	3.19	1.84-5.52
Joint Pain	2.46	1.37-4.43
Limb Pain	2.51	1.15-5.50
Cough and Sputum	2.80	1.18-6.64

- The Skrunda Radar provides a living laboratory for the chronic low level effects of exposure to RF/MW radiation. To date investigations have revealed a number of statistically significant changes associated with exposure to the radar signal. These include:

  Impaired physical and scholastic performance of children in the open field exposure range of 0.0008-0.41 μW/cm^2, mean measured level in the range 0.0028-0.039μW/cm^2.

  A 6-fold increase in broken chromosomes in the peripheral erythrocytes of the exposed cows (p<0.01). for a measured exposure would be in the range 0.042 to 6.6μW/cm^2, mean exposures in the range 0.157 to 0.63μW/cm^2.

  A statistically significant (P<0.01) negative correlation between the relative additional increment in tree growth and the intensity of the electric field. The Pine trees at 4 km were exposed to a range of 0.011 to 0.41μW/cm^2, a mean open field exposure of 0.039μW/cm^2 and measured distance exposure of 0.0027μW/cm^2 (for the radar signal). A probable biological mechanism was identified through observed changes in physiological conditions.

  Chromosome and reproductive damage in plants exposed RF/MW in the range 0.042 to 6.6μW/cm^2.

  Chronic exposure to pulsed RF radar signals is associated with chromosome damage in plants and animals, with associated reproductive aberration in plants, and growth reduction in pine trees linked to observed physiological changes, and scholastic impairment of school children occurs in relation to exposure levels which fall well below 2μW/cm^2, below 0.1μW/cm^2. and even below 0.01μW/cm^2.

The latest research, in press, shows a small but statistically significant reduction of human immune system competence.

Summary:

Dozens of papers strengthen and confirm the causal relationship between RF/MW exposure and a wide range of cancers.

The set of studies by Lester and Moore are a good example, and probably the first residential study to find a statistically significant relationship between cancer and radar exposure, Lester and Moore (1982a). This study, ranking the cancer rates in the population living in Wichita, Kansas, who were exposed to no radar, one radar or two radars shows a significant dose response relationship. Based on this result they studied countries which had air force bases and hence radar systems exposing nearby populations. They found a significantly higher cancer rate in counties which have air force bases, Lester and Moore (1982b). This was criticized for methodological weaknesses by Polson and Merritt (1985). Lester and Moore corrected the weaknesses and related cities near air force bases to cities well away from air force bases and found an even stronger relationship. This conclusion is mis-represented by the WHO/UNEP/IRPA (1993) review by claiming it as a no effect conclusion by failing to quote this final result. Mean RF/MW exposures were not measured but even in the highly exposed group they were extremely low.

Milham (1985, 1988) found significant increased of leukaemia in amateurs radio operators in the western states.

There are several other studies finding leukaemia, and brain tumours particularly, but also melanoma and breast cancer.

The Schwarzenberg is a very significant study showing a causal relationship between short wave radio exposure at extremely low intensities and sleep disturbance, chronic fatigue, children's learning ability and many other symptoms, with statistically significant associations and dose response relationships ($p<0.001$). This was confirmed by experimentation by deliberately changing the orientation of the beams without notifying the people and finding that the effects changed appropriately for a causal effect. Even the lowest exposure group showed a significant improvement in sleep quality when the transmitter was turned off secretly. Their group measured mean and median direct exposure to SW radiation associated with this effect was 0.4 nW/cm^2.

The Skrunda Radar series of papers and studies shows statistically significant effects on people, plants and animals from extremely low mean measured RF/MW exposures. Probably the most significant human effect, apart from the recently reported immune system suppression effects, was the measured impairment of children's learning and physical performance associated with a measured direct outdoor exposure in the range 0.0028 to 0.039μW/cm^2. The upper limit is close to the NOAEL for cancer and the lower limit of the range is 7 times higher than sleep difficulties were identified in Schwarzenburg. At this lower level pine trees showed significant growth retardation.

The relevance of sleep disturbance and learning difficulties to cancer is a common biological mechanism, melatonin reduction. Melatonin reduction because of RF/MW exposure is a plausible mechanism for cancer, sleep disruption, chronic fatigue syndrome, learning difficulties, depression and immune system suppression. All of these effects have been identified in low level exposure to RF/MW.

It also means we must revise the NOEAL level downwards to 0.0004μW/cm^2.

Cancer Conclusions:

One of the primary scientific reviews behind the ICNIRP assessment is the WHO/UNEP/IRPA review of 1993. Dr Michael Repacholi was the chairperson of the WHO/UNEP/IRPA review team and the technical editor of the report. Dr Repacholi was also the chairman of ICNIRP until recently and the author of several ICNIRP assessments and statements, e.g. Repacholi (1996) - The ICNIRP Statement on “Health Issues related to the use of Hand-Held Radiotelephones and Base Station Transmitters A number of the statements in the current 1998 ICNIRP assessment are word for word what Dr Repacholi wrote in the 1996 ICNIRP statement.

For example, in the assessment of Szmigielski (1988):

ICNIRP (Repacholi) 1996 : “Szmigielski (1988) reported an increased risk of cancer in military personnel. However, the results of this study are difficult to interpret because neither the size of the population nor the exposure levels are clearly stated.”

ICNIRP (1998): “There has been a report of increased cancer risk among military personnel (Szmigielski, 1988), but the results the results of the study are difficult to interpret because neither the size of the population nor the exposure levels are clearly stated.”

In other respects the present ICNIRP statement is in conflict with the 1996 statement:

ICNIRP (1996): “Many epidemiological studies have addressed possible links between exposure to RF radiation and excess risk of cancer.”

ICNIRP (1998) “Studies on cancer risk and microwave exposure are few and generally lacking in quantitative assessment.”

Dr Repacholi has appeared for industry in hearings and court cases, ads and videos, and industry sponsored press conferences. He is on the public record in all of these situations as saying that the consensus of science is that there are no adverse effects from RW/MW apart from tissue heating at very high exposure levels. Such statements were made in sworn testimony on court in New Zealand, MacIntyre (1995). Dr Repacholi repeated this claim as recently as late October 1998 at the Vienna Workshop on Biological effects of RF radiation, despite the wealth of research, including his own, which found a doubling of cancer in mice with a mean exposure level in the range 0.005 to

0.058 W/kg. Dr Repacholi's statements, and ICNIRP's assessments are based on the conviction that only thermal effects can and do occur, despite compelling scientific evidence to the contrary.

The cancer assessment of WHO/UNEP/IRPA, for which Dr Repacholi was responsible, cites only five studies in relation to cancer to justify their conclusion:

> **"In summary, the epidemiological and comparative clinical studies do not provide clear evidence of detrimental effects in humans from exposure to RF fields. Some occupational groups, such as exposed physiotherapists and industrial workers, should be studied further. The question of whether RF might act as a carcinogen should be further evaluated in epidemiological studies."**

For this to be claimed and accepted as a high quality, prestigious, leading and reliable health risk assessment is seriously challengable. Many of the approaches, attitudes, conclusions and recommendations of ICNIRP in 1996 and 1998 are derived from and based on this review.

It is clearly deficient to base a claimed comprehensive international cancer and other health risk assessment on a small faction of the available research, deliberately and knowingly ignoring a large number of studies which show elevated Risks and statistically significant increases in cancer and reproductive effects in RF exposed groups of people.

The assessment is based on five chosen studies. Four are assessed as "No Effect" studies, (1) Robinette et al. (1980), (2) Lilienfeld et al. (1978), (3) Lester and Moore (1982b). Two studies which found effects are cited: viz. (4) Szmigielski at al. (1988) and (5) Milham (1985). You will see more than a dozen ignored papers in the epidemiological list above.

They also refer to a case study, Archimbaud et al. (1989) which discusses a radar mechanic who developed acute myelogenous leukaemia, but take this no further and don't treat it as a study showing that there are effects.

Milham (1985) is quoted and criticized, but Milham (1988), which has a larger data set and stronger conclusions, is ignored.

These five are chosen so that it can be claimed that there are 3 big and reliable no effects studies while there are only 2 small and weak studies which can be dismissed. On the balance of probabilities approach taken here you reach the conclusion that the evidence is weak and inconclusive, providing "no clear evidence of effects". (3 : 2)

All three claimed no effects studies do in fact show statistically significant increases in cancer and a host of other adverse health effects, as I have shown above and others have shown, Goldsmith (1995). Hence in reality the balance of evidence among the chosen studies is (0:5), zero no effects studies and five showing significant increases in cancer with RF/MW exposure.

<u>Thus the WHO/UNEP/IRPA Review conclusion is wrong.</u>

There was compelling evidence of a probable relationship in the studies they cite, which would be assessed as causal if the available studies which were ignored were objectively taken into account.

The ICNIRP 1998 assessment

The ICNIRP assessment suffers from the same systematic errors, misrepresentations, selections and wrong interpretations and conclusions as the WHO/UNEP/IRPA 1993 Review and the 1996 ICNIRP statement (Repacholi , 1996).

It is so flawed as to be scientifically incredible and worthless, misleading and dangerous for public health protection.

It follows the balance of probabilities approach and cites only selected studies, citing 13 papers, assessing 8 as no effects studies and 5 as showing effects but being so flawed that they cannot be taken as showing serious effects. Even so, on the balance of probabilities (8:5) and hence:

> **"Overall, the results from a small number of epidemiological studies published provide only limited information on cancer risk."**

Apart from cancer study (1) and studies (7) and (8), all of which don't claim to be cancer risk assessments, The other 5 "no effects" studies all show statistically significant increases in cancer, even containing dose response relationships in a couple of cases. The 5 which are accepted as showing effects but are criticized as being weak and inconclusive, are in fact strong, consistent, reinforcing and conclusive. Hence, of the dozens of studies which do show effects and could be chosen, the "classic" set has been extended with some clearly wrong claims. This gives a cancer assessment set of studies totaling 10, 5 claimed to show no effects and 5 claimed to show effects but not useful nor reliable. This is designed to tip the balance of probabilities towards no effects and hence to justify the conclusions already decided on.

In reality the ratio of (no effect: effect) cancer studies the ratio is (0:10) . Hence the assessment is wrong. The extent of the deceit, error and subjectivity is clear in the overall conclusion:

And, page 507,

> **"Data on human responses to high-frequency EMF that produce detectable heating have obtained from controlled exposure of volunteers and from epidemiological studies on workers exposed to sources such as radar, medical diathermy equipment and heat sealers. They are supportive of the conclusions drawn from laboratory work, that adverse biological effects can be caused by temperature rises in tissue that exceed 1℃. epidemiological studies on exposed workers and the general public have shown no major health effects associated with typical exposure environments. Although there are deficiencies in epidemiological work, such as poor exposure assessment, the studies have yielded no convincing evidence that typical**

> **exposure levels lead to adverse reproductive outcomes or an increased cancer risk in exposed individuals. This is consistent with the results of laboratory research on cellular and animal models which have demonstrated neither teratogenic nor carcinogenic effects of exposure to athermal levels of high frequency EMF."**

Apart from the statement about there being adverse effects of tissue warming, every other statement made is scientifically challengable, wrong and misleading. It is conclusions such as these which continue to put thousands of lives at risk in New Zealand alone.

Conclusion and Recommendations:

The ICNIRP assessment grossly and consistently misrepresents the results, significant of result, the implications of the results of cellular experiments, animal experiments and human studies, all of which form a consistent and coherent set of evidence that RF/MW is causally associated with reproductive and cancer effects, as well as altering and impairing brain function, reaction times, sleep and learning, and impairment of the immune system. There is compelling and consistent evidence of cancer, especially leukaemia.

The table above summarizes results of studies on RF/MW exposure and adult leukaemia incidence and mortality. It shows the repeated finding of Leukaemia, and various forms of Leukaemia, with a distinct, significant and appropriate gradient of Risk Ratio with the level of group exposure. Thus a causal relationship is supported by dose response relationships within studies, consistency between studies and an ecological dose response relationship with all studies taken together.

Note that childhood leukaemia has also been found to be elevated, Dolk et al. (1997a. and b.) , Maskarinec and Cooper (1993) and significantly elevated, Selvin et al. (1992) and Hocking et al. (1996).

The evidence shows effects relating to genetic cellular alteration, including chromosome aberrations and DNA breakage, which leads to neoplastically transformed cells, which leads to reproductive and cancer effects in animals and people. Together this indicates a causal adverse effect with a level of no observed adverse effects level for cancer and reproductive adverse effects near 0.06μW/cm^2.

Table: A summary of epidemiological studies involving adult leukaemia mortality or incidence, ranked by probable RF/MW exposure category.

Study	Reference	Exposure Category	Leukaemia Type	Risk Ratio	95% Confidence Interval
Polish Military	Szmigielski et al., 1996	High	ALL	5.75	1.22-18.16

(Mortality)			CML 13.90	6.72-22.12
			CLL 3.68	1.45-5.18
			AML 8.62	3.54-13.67
			All Leuk.6.31	3.12-14.32
Korean War (Mortality)	Robinette et a. (1980)	High	All Leuk.2.22	1.02-4.81
Amateur Radio (Mortality)	Milham (1988)	Moderate	AML 1.79	1.03-2.85
UK TV/FM (Incidence)	Dolk et al. (1997a)	Mod/Low	Adult Leuk.1.83	1.22-1.74
			CML 1.02	0.28-2.60
			AML 1.86	0.89-3.42
			ALL 3.57	0.74-10.43
			CLL 2.56	1.11-5.05
North Sydney TV/FM towers (Mortality)	Hocking et al. (1996)	Low	All Leuk.1.17	0.96-1.43
			ALL+CLL1.39	1.00-1.92
			AML+CML1.01	0.82-1.24
			Other Leuk1.57	1.01-2.46
UK TV/FM (Incidence)	Dolk et al. (1997b)	Low	Adult Leuk.1.03	1.00-1.07
			CML 1.16	
			AML 1.17	
			ALL 1.04	
			CLL 1.20	

Note: ALL : Acute Lymphatic Leukemia; CLL: Chronic Lymphatic Leukaemia; AML Acute Myeloid Leukaemia; CML: Chronic Myeloid Leukaemia; and All Leuk.: All Adult Leukaemias.

However brain function alteration, associated with melatonin reduction and induced calcium ion alteration has been observed down to 0.0004µW/cm^2 or 0.4 nW/cm^2. Human biometeorology has identified significant brain altering effects at even lower levels of exposure to particular combinations of modulated RF fields, the modulation frequencies of which appear to relate to EEG frequency bands in the ELF region, but the ELF signal is carried into tissue by RF carriers.

Since background RF/MW levels in New Zealand cities are already in the range 1nW/cm^2 - 3nW/cm^2, the only practical option to avoid these demonstrated effects is to set the initial public exposure limit at

50 nW/cm^2 (0.05mW/cm^2)

Aiming, over 10 years, to reduce it to

10 nW/cm^2 (0.01mW/cm^2).

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