WHAT AILS THE ENGINEER ?

by

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Mr. Chairman, Fellow Engineers, Ladies and Gentlemen,

I am greatly honoured to have been invited by the Institution of Engineers to deliver this lecture in memory of the late **Professor R.H. Paul**. I accepted the invitation with some trepidation as I realised that I had to attain the high standards set by the distinguished Engineers who had preceded me in this annual tribute.

I was one of about twenty four students who entered the Faculty of Engineering of the University of Ceylon in 1955, then functioning from temporary buildings at Thurstan Road in Colombo. Of this number, seven of us opted for the Electrical Engineering stream and thereby came very much under the influence and guidance of Professor R.H. Paul.

It is in the fitness of things that the first three R.H. Paul Memorial Lectures were delivered by his then colleagues in the Faculty's Electrical Engineering Department viz: Dr. S. Gnanalingam, Prof. W.M.G. Fernando and Prof. W.P. Jayasekera who I salute as my teachers in the various fields of electrical engineering. It is also worthy of record that the fourth memorial lecture was by Prof. K.K.Y.W. Perera who deputised for Prof. Paul for about one term in lecturing to us students on Power System Stability! (I believe he was then a Junior Assistant Electrical Engineer in the DGEU!) A substantial number of the Prof. Paul's students are practising Engineers today, both here and abroad.

My memories of the late Prof. Paul are very vivid, both in the University and later when I had occasion to meet him in my capacity as a (Junior Assistant Electrical) Engineer in the DGEU/CEB. He had a commanding personality and his erudition was obvious, not just in engineering. It is indeed most fitting that he is called "the father of electrical engineering in Ceylon".

Whilst publicly acknowledging our gratitude to the late Prof. R.H. Paul, I wish to highlight another debt which I submit is not sufficiently well recognised. I refer to the free education that almost everyone of us assembled here today received during our student-days. This debt is owed by us to the citizens of Sri Lanka, keeping in mind that most of us get paid a salary for the work done by us. How do we discharge this obligation? I believe that, as we are a group of what may be termed society's "high achievers", it is obligatory on us to do everything in our power to use our knowledge, talents and abilities for the benefit of the present and future generations of our country.

Prof. Paul was never one to mince his words. Please pardon me for emulating this characteristic on this occasion to bring home to ourselves some unpalatable truths. I sincerely hope that my observations and comments are taken in the spirit in which they are offered. Please be assured that not the slightest affront is meant to any person or organisation.

As products of our tertiary education system, are we upto the mark? If we look back on the last three or four decades, can we honestly say that we Engineers have discharged our duty towards our countrymen or even lived upto the ideals and aspirations of our youthful years? We frequently complain about how the foreign 'consultants' have taken over our areas of operations, how the politicians have dictated to us, how the administrators have blocked our every effort, of how the so-called environmentalists are ham-stringing us, etc., etc.

In attempting to search for the reasons which have generally lead to the present status quo, we should retrace our steps to the start of our tertiary education. Persons chosen for entry to the Universities and other bodies of tertiary education have to be successful in the GCE Advanced Level examinations. If we are to grade these successful students in descending order of aggregate marks obtained, we would have a listing such as:

* Engineering
* Medicine
* Accountancy
* Law
* Science, etc.

It is reasonable to conclude, that by and large, the students who successfully complete their respective courses of study will also achieve rewards in roughly the same order of merit displayed at the end of their school career.

In reality this expectation is not fulfilled. On the contrary, society appears to have a different perspective, with higher rewards going to members of the professions of Accountancy, Law and Medicine. The irony of it all is that often students who could not make the grade for selection for engineering studies have ended up taking Law or Accountancy. The engineering profession is apparently slipping, in the collective perception of Sri Lankans.

Members of the professions of Accountancy and Law seem to be the preferred persons when selections for high office are made, both in the public and private sectors. I believe it was Winston Churchill who once said that "Engineers should always be on tap but not on top." Have we unconsciously allowed ourselves to fall into this categorisations? Are we signalling to our fellow citizens that we would rather stay ensconced in our little technological hideouts and prefer not to venture forth?

Is there perhaps some shortfall in our education, training, etc.? It is unfortunate that Universities have compartmentalised themselves into Faculties, no doubt for administrative convenience. The result is that graduates, say from the Engineering Faculties, go out to face the world with very little knowledge of other subjects such as history, economics, current affairs, the country's financial environment, etc. These are all subjects of importance for the Engineer if he is to play an effective leadership role in society, viz. "to be on top". It is no coincidence that the curriculum of courses in Law and Accountancy do cover, some if not all, these subjects. The Accountants specially seem to be updating and revising their courses to meet the expanding needs of commerce and industry.

It is essential that we critically examine the syllabuses that the students have to follow when they enter the University Engineering Faculties. We should go even further and analyse the educational and training requirements of the middle level technological staff, to ensure that the professional Engineer can function effectively.

As Engineers, we should subject ourselves and our profession to rigorous analysis if we are not to become a sub-set of 'also-rans' in the country's set of professionals. Often we hear reasons or explanations trotted out blaming various other parties or factors for the poor status of the Engineer. Most of these arguments do not bear close analysis. We rarely point a finger at ourselves. We should not be satisfied with shifting the blame on to others, however plausible that may appear to us.

It is a self-evident truth that we Engineers, as a sub-set of society have to interact and relate to the other members of society. Society in general perceives us, and thereby judges us, by what we do and more importantly by what we had allowed to go by default.

If for example we subject society to planned power-cuts, it is easy for us to list out technical and economic reasons why such disruptions are unavoidable. We can have all sorts of in-house discussions, complete with graphs, charts and equations, to convince ourselves of the inevitability of these events. This may be a balm to our conscience, but we have not exhibited sufficient sympathy with the general public. In the process of our rationalisations, we unwittingly assign derogatory labels to our country, such as "one of the poorest", "third world", etc. In the long run, society judges us by what we deliver and not by the validity of our explanations. Is it any surprise then that both the private and public sectors have installed stand-by generators with capacities conservatively estimated to exceed 200 MVA in total. The tragedy of this is that a very large sum of the country's investment capital is not only unproductively trapped but steadily depreciating.

I am firmly of the opinion that we Engineers have one major failing; we do not inter-face adequately with the rest of society. Most of us are aware of the various situations that have arisen in the recent past where Engineers are perceived to be directly or indirectly responsible. We are not vocal enough in presenting our case to the public. Could this possibly be use to our tertiary education being concerned entirely with inanimate objects? May be it is high time we obtained some professional help in image building! Or, may be it is high time we revamped the engineering course content, with a large dose of lateral thinking!

At this juncture I wish to highlight some examples which should merit careful scrutiny by Engineers, if not as part of their duties at least as a social obligation. These examples are from Low Voltage electrical engineering.

Example 1

Fig. 1 is a sketch showing a concrete pole with a set of channel iron, etc. installed as part of distribution line supporting both LV and 33KV overhead conductors. This is reproduced from the photograph published recently, as part of an advertisement, in an Engineers' Annual Dinner souvenir. Observe the extensions at the top of the pole carrying 33KV lines both in the longitudinal and transverse directions, thereby setting up bending moments substantially greater than if the pole had no extension hardware.

We can assume that the pole shown in the photograph is a "10m HT" which is a standard RC pole commonly used in this sort of application. The CEB drawing relating to this type of pole is C/92/7534 dated 25.05.1992 which gives the following data:

Working load	255 kg, 600mm below pole top
Ratio of Transverse to longitudinal load	4 : 1
Factor of safety	2.5
Total pole height	9,925 mm
Buried length1	675 mm
Deduced longitudinal load	64 kg

It is clear that the pole shown in the photograph is considerably overloaded. However, the fact that it has stood for a long period without collapsing leads us to conclude that the pole is over-designed.

The CEB has stated in a publication in March 1992 that the annual requirements of different sizes of poles is around 300,000. Here is an opportunity for Engineers to show their mettle and design poles which will not be wasteful of materials. Even a 10% reduction in the volume of concrete will lead to savings in excess of 20,000 Tons per annum, as the larger poles weigh around 900 kg. each.

Example 2

From the same sketch we can observe the use of ceramic "LT-insulators" mounted on the pole to support the LV conductors. The usual method of mounting these is to fit the insulator in a so-called "D-bracket". Recently I observed in another country that the insulator is directly mounted on the pole with a through bolt, without any D-bracket (Fig. 2), obviously resulting in a substantial reduction in the cost per mounting. My inquiries reveal that this is standard practice in the UK, provided the line deviation is less than 15 degrees. Assuming an average of three insulators per pole on, say, 100,000 poles per annum, we can achieve significant savings.

Example 3

The large majority of the consumers in Sri Lanka are classified as 'domestic' by the Supply Authorities. The latest publicly available statistics[1] (for 1991) show that the CEB has 751,614 domestic consumers using an annual total of 624 million kWh of electrical energy. The corresponding figures for the years 1983 through 1991 are given in Table 1. Estimates of the average daily demand in Watts and the average connected load are also given in the Table. It will be noted (Fig. 3) that (i) a plot of the **$\log_e$ of the number of consumers** vs **calendar year** yields almost a linear curve and (ii) the average connected load per household is below 9 Amps. The former statistic should interest the planners amongst us.

The second conclusion that the average household needs no more than a 10 Amp single phase supply should alert us to an opportunity to help future consumers. Those familiar with domestic electrical installations will be aware that most house-builders consider it highly desirable to have a three-phase installation in the house. This in fact is frequently stipulated in "house wanted" newspaper advertisements.

Let us now look at what the typical domestic installation has and, more important, is required to have by the Supply Authority. The lowest installation recognised is a 30 Amp single phase supply. This involves an installation with load wires of 6 sq mm Cu PVC/PVC, a Distribution Board (with about 4 fuses or MCB), and final sub-circuit wiring using 1 sq mm Cu PVC/PVC.

If the typical domestic installation is engineered for a demand below 10 Amps, it can be accomplished with a single 10 Amp MCB and a 30mA RCCB and the wires confined to a single size of 1 sq mm Cu PVC/PVC. Based on the current prices, this leads to a saving of at least 30 percent per installation. The number of domestic installations connected to the CEB system in 1991 is 122,873. Assuming that just 50,000 of this are under 10 Amp maximum load, we have then an effective saving of the order of Rs. 20 million per annum.

Savings such as this directly affect the installation cost of the lower-income consumer, in addition to being an indirect national saving.

There are other means by which the cost to the domestic consumer can be reduced. For instance, why do the supply authorities insist on consumers, requiring more than about 7KVA, wiring their premises for three phase supply? Most other countries do not allow, as a matter of safety, voltages in excess of about 250V in domestic environments. It is quite feasible to have metered single-phase supplies up to about 80 Amps using so-called long range kWh meters. This will, if nothing else, save two kWh meters for the supply authority in each such installation.

The examples I have mentioned above are areas where Research and Development should be directed, especially as the outlay for such R & D is not large. The questions I have raised are often met with simplistic "one sentence" answers. Please desist from this temptation and use your obvious talents to critically analyse and find effective improvements to whatever you are required to do. It is

1 Statistical Digest 1991, CEB

usual to look to more glamorous aspects of engineering to involve oneself with, but as professional Engineers we must devote some time to the lower end of the spectrum if we as a group want to stand up and be counted and thereby enhance our public image.

I have restricted myself to some simple examples in Electrical Engineering. There are questions to Engineers in other branches too. For instance, why must a bridge always cross a river or railway line at right-angles? A vivid example of this is the road bridge over the Kelani Valley Railway line near the Panagoda Army Cantonment: the road taking a sweeping S-curve, complete with double-cutting, etc., to preserve the sacred principle of a right-angle crossing!

One final thought: are we still sticking to engineering rules set up during the colonial days? This could explain why some of our current techniques are so archaic.

What then are the answer to the question "What ails the Engineer?" The short answer is: "The Engineer". The more elaborate response has to come from a concerted effort by the Institution and the Universities.

In closing, I wish to quote from a paper[2] in which the results of a small survey of practising graduates from the Massachusetts Institute of Technology in the USA were published. The question posed was "What do you wish you had learned but didn't?". Some of their answers, relevant to us in Sri Lanka, are:

1. Leadership lessons - how to motivate people, manage diverse workforces, integrate business cases, keep bureaucracies at bay, keep arrogance out of an organisation.

2. Management lessons - execute and plan, deal with unions, work through teams, manage scarce resources.

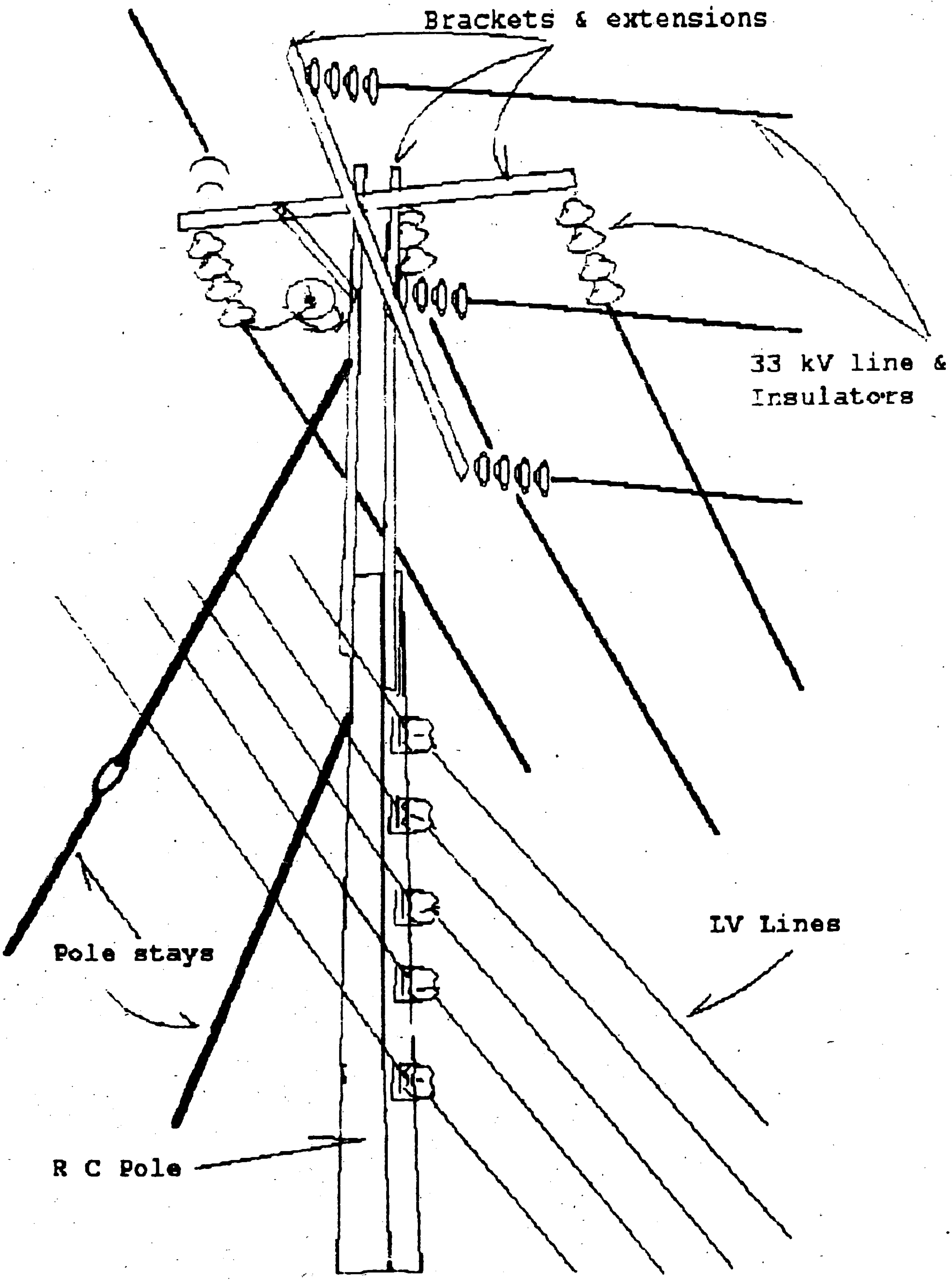
3. Systems Engineering - NOT to view items in isolation.

4. The importance of excellence ..... in whatever we do.

A final poser for all of us to ponder: Since Engineers fade away, their period of effectiveness cannot be quantified. Therefore, we should assign a "half-life" to an Engineer, analogous to radio-activity! If so what is the figure for us Sri Lankan Engineers?

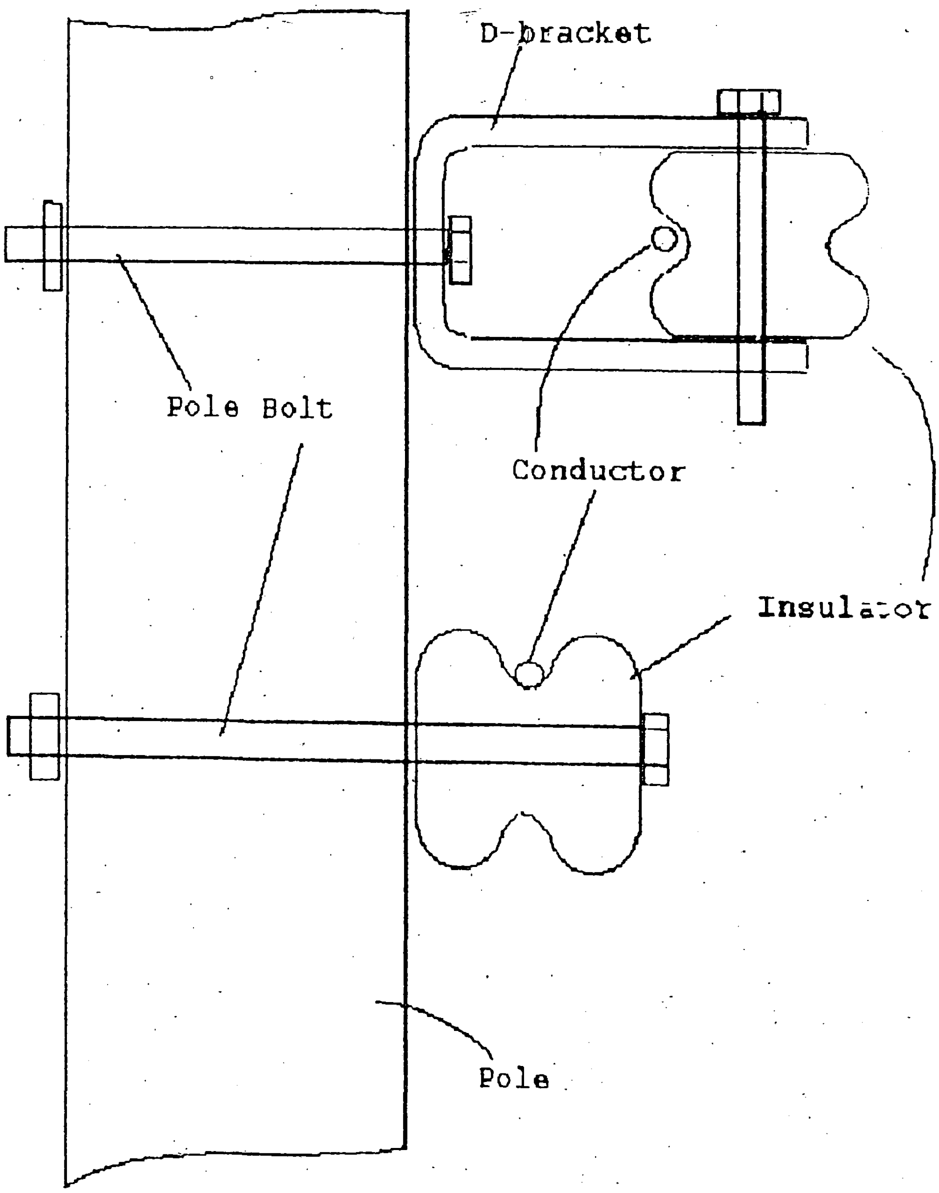
Thank you again for your courtesy. Our annual tribute to the late **Professor Robert H Paul** will be all the more meaningful if we re-dedicate ourselves to provide quality service to our fellow countrypersons.

2 Sloan Management Review/Fall 1991, MIT (USA)



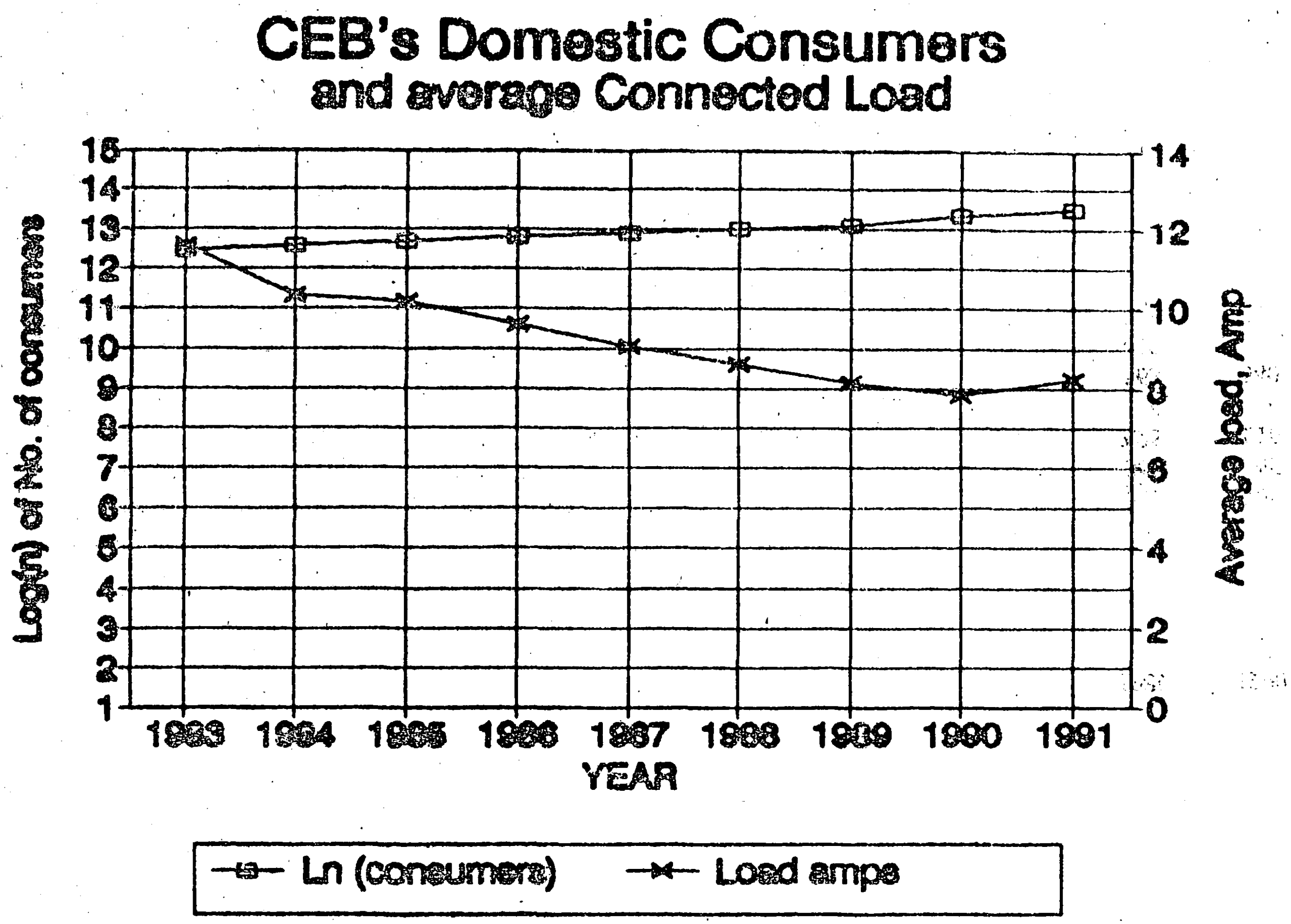
Example of a heavily loaded R C Pole

FIG. 1



Alternative method of a LV Insulator mounting

FIG. 2



CEB's Domestic Consumers
and average Connected Load
Log(n) of No. of consumers
Average load, Amp
YEAR
1983 1984 1985 1986 1987 1988 1989 1990 1991
Ln (consumers)
Load amps

FIG. 3.

Domestic consumers connected to CEB system: 1983 to 1991

	Unit	1983	1984	1985	1986	1987	1988	1989	1990	1991
Domestic consumers	no.	255,225	295,854	329,165	370,048	404,962	450,431	495,932	628,741	751,614
Energy used	GWh	298	309	337	358	370	392	408	496	624
Log(e) of No of consumers		12.4	12.6	12.7	12.8	12.9	13.0	13.1	13.4	13.5
Annual Units per residence	kWh	1,168	1,044	1,024	967	914	870	823	789	830
Days per year	day	365	366	365	365	365	366	365	365	365
Average units per day	kWh	3.20	2.85	2.80	2.65	2.50	2.38	2.25	2.16	2.27
Assumed hours per day	hr	4	4	4	4	4	4	4	4	4
Average power demand	Watt	800	713	701	663	626	594	563	540	569
Assumed diversity	p.u.	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Connected load per residence	Watt	2,666	2,378	2,337	2,209	2,086	1,982	1,878	1,801	1,895
Connected load @ 230 V	Amp.	11.6	10.3	10.2	9.6	9.1	8.6	8.2	7.8	8.2