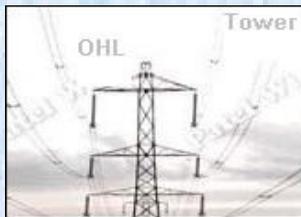# USER'S MANUAL

ELECT

(Release - 7.05)

OVERHEAD LINE ENGINEERING
&
MOST ECONOMICAL
CONDUCTOR SELECTION

UNIQUE SOFTWARE FOR OHL ENERGY AUDIT
SEPTEMBER 2004

I N D E X

I.   INTRODUCTION

i.   OVERHEAD LINES AND MOST ECONOMICAL CONDUCTOR

Overhead transmission lines are used for all types of voltages right from 415V to 400kV. However, the structure of overhead lines and their accessories differ largely from one voltage to other. An overhead line can be dissected mainly into two parts from the energy loss point of view as under:

  1.   Cost of conductor
  2.   Cost of items independent of conductor

It is important to note that there are number of conductors for use with an overhead line. The major types of conductors being ACSR (Aluminium Conductor Steel Reinforced) conductor, AAC (All Aluminium Conductor), AAAC (All Aluminium Alloy Conductor). Each type has a number of sizes starting from about 13 sq. mm. nominal area to 1000 sq. mm. nominal area. Any type and any size of conductor can be used for the overhead line conductor.

According to Kelvin's law, for a given capacity of line, the energy loss can be directly compared with the interest and depreciation part of the cost of conductor to achieve to a most economical conductor for the transmission line. This theory was not perfect because as the cross sectional area of the conductor increases it becomes heavier and heavier. The same infrastructure used previously for a lighter conductor may not withstand when used with a heavier conductor. Also, the sag of the line increases with the weight of the conductor.

To remove the shortcomings of the Kelvin's law for finding the most economical conductor for an overhead line Kelvin-Kapp evolved a revised law for the same.

The **Elect** software has dealt this subject in detail. A summarized description of the **Elect** software is given in the next page.

II.   ELECT SOFTWARE

THE MOST ECONOMICAL CONDUCTOR
&
ALL ABOUT OVERHEAD LINE LOSSES

This **Elect** software, Version 7.xx deals with electrical overhead line networks. The first version of this program was launched in 1993. Initially, it was in a very crude form working under DOS mode. During the period from 1993 till date the program passed through a number of phases and believe it, every latter version came with adding new and innovative ideas of better and more practical utilization of this software. Now this latest Version of the **Elect** software has a number of useful features. It will be proved a great tool for Analysing the un-noticed, hidden and continuous losses being incurred round the year in the overhead transmission lines due to various reasons, like improper selection of overhead line conductor, enhancement of electrical loads, supply to new consumers through the same overhead line, reorganization of electrical loads etc. etc.

i.   UTILITY OF THE ELECT SOFTWARE

The main and ultimate objective of this Software is to save energy by minimizing its losses and removing the wastages. Energy may be wasted in any process e.g. in transmission, distribution or improper planning or use of low efficiency electrical equipment. Energy saving is equivalent to energy generation for a nation. But, for an individual energy saving i.e. optimisation of the energy losses has manyfold affects.

This Elect software has many utilities, a few of which are described hereunder:

1. It suggests Most Economical Conductor for an Overhead Transmission line for transmitting a given quantity of power.
2. It suggests means to reduce the energy bill of the consumer through minimization of losses.
3. It quantifies your line voltage drop and regulation and suggests means to reduce the voltage drop thereby improving the voltage regulation.
4. Once the voltage regulation is improved the performance of dynamic equipment like motors, pumps, conveyors etc. leading to elimination of the increased losses in the system due to it.
5. It helps to reduce, to some extent, the existing power requirement. Though at this stage, it may look funny but it is a fact. 'Drop by drop makes an ocean' proverb is fit to explain it for a country of such large population.
6. Implementations of its results effectively reduce the maximum power demand, which is associated with direct small saving. However, the reduction of maximum demand improves the system performance and allows the consumer to draw more power for a specified contract demand. Exceeding the contract demand becomes a cause of penalty in most of the cases.
7. It suggestions are not only economical but the effect is also to extend stable voltage for industrial as well as domestic purposes so as to avoid malfunctioning of several equipment especially dynamic equipment and poor level of illumination.
8. By minimizing the overhead line losses it helps to avoid the chain reaction in the sense that higher the losses lower the terminal voltage. Lower the terminal voltage higher the required current to drive the same load. Higher the current again amounts to increase the line losses abruptly.

This software is further helpful as mentioned in the following lines hereunder:

1. It will suggest the Most Economical Conductor for an overhead line feeding electrical power to a small/ medium or large industries, coal mines, metal mines, chemical/ fertilizers/ aluminium/ factories, steel plants, electrical power generating, transmitting and distributing agencies

and all other concerns using electrical power of the order of about 100 kVA or above. This does not mean that this software is not useful for consumers having contract demand less than 100 kVA. Everything depends on the type of distribution system and their efficient compatibility for good performance.

2. It will prove helpful in the analysis of overhead lines with any type of given conditions of length, size, spacing, span, sag, temperature, weather conditions etc.

3. It will prove helpful for analysing overhead lines with single conductor or a bundle of conductors of different cross sectional area.

4. It can analyse the equivalent circuit of overhead line considering or neglecting the line capacitances.

5. It will be proved a very good tool also for general students, Engineering students and Research Scholars.

6. It allows you to use either the default data or the calculated data or even allows you to use your own data set for the overhead line conductors.

7. It will tell you the MW-km capacity of your overhead line as the norms led down in Indian Electricity Rules and Bureau of Indian Standards.

8. It will tell you the various data of a given conductor like its copper equivalent area, aluminium equivalent area, resistance per km, weight per km, tensile strength etc. However, it is necessary to supply the basic inputs like the cross sectional area of aluminium and/ or steel single conductor from which the stranded conductor is formed.

9. It has a flexible data system. The universal constants like the resistivity of aluminium, copper and steel, ultimate tensile strength of steel, density of aluminium, steel, coefficient of elasticity, coefficient of linear expansion can be edited to suit the conditions of the user.

10. It takes care of the variation of conductor cost and rate of interest and depreciation. Hence, it is well applicable in the years to come.

11.   It will accept the cost of conductor and cost of unit electricity in any currency like rupees, dollars, pounds, yen etc.

12.   It will give an estimated cost of the suggested line with most economical conductor.

This utility list of the **Elect** software is very long. The above points have been symbolically written to explain its utility and the role it can play to reduce the losses of electrical energy in our present set-up.

III. PROGRAM DESCRIPTION AND EXECUTION METHODS
(Elect version 7.xx)

This manual of Elect version 7.xx has description of the following programs of the Software:

A. BASIC DATA CONSIDERATION
B. DATA SELECTION
C. CONDUCTOR AREA INDEX
D. MOST ECONOMICAL CONDUCTOR SELECTION
E. REGULATION AND VOLTAGE DROP
      i.   OHL with single conductor per phase
      ii.   OHL with multiple conductor per phase
F. MW-km CAPACITY OF OVERHEAD LINES
G. VIEWING TEXTUAL RESULTS
H. VIEWING GRAPHICAL RESULTS
I. README FILES OF THE PROGRAM
J. GENERATION OF ENERGY AUDIT REPORTS

A. BASIC DATA CONSIDERATION

Data sets can be divided as under:
1. CONSTANTS
    a.   Universal constants
    b.   Physical constants
2. WORKING DATA
    a.   Related to internal setup of system
    b.   Related to external setup of system

A.(i) UNIVERSAL CONSTANTS

The following data may be treated in this category:

Pie (π), Permittivity of free space & Young's modulus of elasticity etc. The value of these constants can't be changed. However, you will find these values indicated in the relevant part of the program. For the sake of verification of your results, the following universal constants have been taken for various calculations by this software.

$\pi = 3.141592654$ (pie,   ratio circumference/diameter)

$\varepsilon = 8.8 \times 10^{-12}$ (Epsilon, permittivity of free space)

$\psi = 0.62 \times 10^{6} \text{ kg/ cm}^2$ (Young's modulus of elasticity)

$\alpha = 23.0 \times 10^{-6} \text{ /°C}$ (Coefficient of Linear Expansion)

A(ii). PHYSICAL CONSTANTS

The following may be considered in this category:

Specific gravity of aluminium, Resistivity of copper, aluminium and steel etc. etc.

For the sake of verifying the results obtained with this software, it may be noted that the program has taken the following values of physical constants for calculations:

Specific gravity of aluminium   = 2.703
Specific gravity of steel   = 7.85
Resistivity of aluminium in ohm mm²/km   = 28.70
Resistivity of copper in ohm mm²/km   = 17.86
Resistivity of steel in ohm mm²/km   = 150.00
Ultimate Tensile Strength of Al in kg/ mm² = 13.0
Ultimate Tensile Strength of steel kg/ mm² = 143.0

A(iii). WORKING DATA FOR INTERNAL CONDITIONS

A specific conductor like the ACSR 'DOG' and its other specifications like the number of steel wires, number of aluminium wires, their diameters, their resistances per km, their ultimate tensile strengths, weights etc. may be considered data under this category.

The program has provided values of a set of twenty AAC and ACSR conductors each in default.

An user may or may not use these data. However, if not changed, the program will use the default data for ACSR conductors.

For the sake of verifying the results obtained from this program, the default values of AAC and ACSR conductors are given hereunder:

A(iv)   AAC DEFAULT DATA

Conductor Name	CuArea mm²	AlArea mm²	CCC Amps	dia in mm	r/km ohms	x/km ohms	UTS kg	Weight kg/km
Conops	13	21	100	6.454	1.3590	0.3537	58	363
Gnat	16	26	116	6.630	1.0900	0.3520	72	444
Weevil	20	31	129	7.874	0.9130	0.3412	86	521
Ladybird	25	42	159	8.370	0.6721	0.3374	117	737
Ant	30	52	182	9.300	0.5441	0.3308	144	892
Fly	40	63	207	10.198	0.4526	0.3250	174	1051
Bluebottle	45	73	225	10.978	0.3906	0.3203	201	1203
Grasshopper	50	83	250	11.728	0.3442	0.3162	230	1356
Cleg	60	95	270	12.508	0.3009	0.3121	261	1523
Wasp	65	105	292	13.168	0.2715	0.3089	290	1673
AAC 11	80	132	335	14.790	0.2152	0.3016	369	2228
Peony	95	149	363	15.676	0.1916	0.2980	414	2484
Caterpillar	110	183	420	17.402	0.1555	0.2914	511	2985
Chafer	130	210	460	18.636	0.1356	0.2871	586	3381
AAC 15	140	234	495	19.670	0.1217	0.2837	652	3736
AAC 16	160	262	530	20.802	0.1088	0.2802	730	4144
AAC 17	185	318	600	22.920	0.0896	0.2741	886	4947
AAC 18	225	367	654	24.650	0.0775	0.2695	1025	5695
AAC 19	300	474	764	27.994	0.0598	0.2615	1343	7289
Scorpion	325	518	805	29.288	0.0548	0.2587	1464	7878

A(v).   ACSR DEFAULT DATA

Conductor Name	CuArea mm²	AlArea mm²	CCC Amps	r/km ohms	x/km ohms	radius in mm	UTS kg	Weight kg/km
SQUIRREL	13	21	75	1.374	0.355	3.16	771	85
GOPHER	16	26	80	1.09	0.349	3.54	952	106
WEASEL	20	31	94	0.9116	0.345	3.89	1136	128
FERRET	25	42	136	0.672	0.339	4.5	1503	171
RABBIT	30	52	156	0.5449	0.335	5.03	1860	214
MINK	40	62	167	0.4565	0.333	5.49	2207	255
BEAVER	45	73	186	0.3906	0.33	5.99	2613	303
RACOON	48	78	204	0.3656	0.329	6.14	2746	318
CAT	55	95	226	0.315	0.327	6.78	3324	385
DOG	65	104	240	0.2745	0.315	7.08	3899	394
TIGER	80	128	295	0.2221	0.282	8.26	5758	604
WOLF	95	154	335	0.1844	0.266	9.07	7350	727
LYNX	110	183	360	0.1554	0.261	9.77	7950	844
PANTHER	130	207	400	0.1375	0.256	10.5	9127	976
LION	140	233	430	0.1223	0.252	11.13	10210	1097
BEAR	160	258	470	0.1102	0.25	11.73	11310	1217
GOAT	185	317	525	0.08988	0.244	12.98	13780	1492
SHEEP	225	366	550	0.07771	0.24	13.97	15910	1726
DEER	260	419	630	0.06786	0.237	14.95	18230	1977
ELK	300	477	670	0.061	0.235	15.75	20240	2196

The results obtained from various the programs of this software use these above data wherever required.

A(vi). WORKING DATA FOR EXTERNAL CONDITIONS

The ambient temperature, temperature rise of conductor, system voltage power factor, load factor, spacing between overhead line conductors, span and sag of OHL etc. etc. may be considered to be under this category of data.

Though these are always supplied externally, the limiting values are of importance and to be noted carefully. In some case data are standardised to some extent. This program has used the following standard data:

3 Phase System Voltages	:	415V, 550V, 1.1kV, 3.3kV, 6.6kV, 11kV and 33kV
Power factor	:	Limits between –1 and +1
Normal temperature	:	20°C, all default values are corresponding to this temperature.

Frequency	: 50 Hz, all default values are corresponding to this frequency.
Spacing between OHL conductors	: 700 mm, triangular.

Working data are always set through the *PROGRAM – USER* interface. One can change/ set any value of these data restricted to those mentioned here above.

For the sake of verifying the results obtained from this program, the limiting values of various input data mentioned here above are given hereunder, program-wise, for ease of calculation:

A(vii). *MOST ECONOMICAL CONDUCTOR SELECTION*

(a) System voltage (Range: as indicated in the program.)
(b) Conductor Index

Note: This is an Index of the cost of conductor. It may be considered as the cost of the one litre volume of conductor material. Its value is given for a reference year. There are numerous methods to find this Index. You will find three methods of finding the Index in this program. If you feel that the value of this Index is no more valid then you can find new value of the Index from other section of the program or as under:

Example:
Let value of Index K in the year 1997 = 1730
It is required to find the value of K in the year 1999 i.e. after 2 yrs. Let the rate of inflation be 5% per annum. Then the inflation in two years will be about 10% (approximately)

Value of K in 1999 = K (1 + inflation)
$$= 1730 (1 + 0.10)$$
$$= 1903$$

So, the conductor Index in 1999 will be 1903.

IMPORTANT: You will find more information inside the program alongwith a number of methods of finding the value of this area Index K.

(c) Percentage rate of interest and depreciation: (Range: 0 to 100) - Normal value may be taken as 21.6% by assuming 16% as annual interest rate and 18 years life for the OHL.

(d) Maximum loading capacity of the OHL (Range: Any positive value)

> *Note:*
> (I) A value beyond limit of the highest conductor size will be rejected afterwards.
> (II) Maximum loading capacity is the designed capacity of the OHL in question.

(e) Ambient temperature in °C (Range: -242.5 to 120)
(f) Power factor of the system (Range: -1 to +1)
(g) Span length of OHL conductors in metre (Range: 30 to 300)
(h) Load factor of the OHL (Range: 0 to 1)
(i) Permissible percentage regulation (Range: Indicated in the program, depends on system voltage)

A(viii). *REGULATION & VOLTAGE DROP IN OVERHEAD LINES SINGLE & BUNDLED CONDUCTORS*

Two options have been considered for this case:

(I) When sending end voltage in known
(II) When receiving end voltage in known

The following input information is required for the calculation of voltage regulation and voltage drop in an OHL in both the above cases:

a) Sending (or receiving) end voltage as the case may be (Range: upto 440 kV).
b) Load in kW (Range: Upto a value as decided by the highest conductor current rating).
c) Load power factor (Range: -1 to +1)

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    d)   Conductor code (Range 1 to 20: to be chosen from the list shown on the screen).
    e)   Length of OHL in km (Range: Upto 2000)
    f)   Separation between conductors in mm (Range: Above 10 but below 12000: Default value is 700).

Results for both the cases are discussed separately because in case of sending end voltage being known, the capacitance of the line has been neglected, whereas the line capacitance has been taken into account in the other case, when the receiving end voltage is supplied as an input.

A(ix).   MW-km CAPACITY OF AN OVERHEAD LINE

The following input data are required for finding out MW-km capacity of twenty numbers of the selected conductor data set (ACSR/ AAC/ Others):

    a)   Span of the OHL in m (Range: 30 to 300)
    b)   Percentage voltage regulation (Range: 0 to 12.5)
    c)   System line voltage in kV (Range: upto 440)
    d)   System power factor (Range: -1 to +1)
    e)   Ambient temperature in °C (Range: -242.5 to 120)

B. DATA SELECTION

All calculations/ estimations/ results are based on certain Internal or External Data. Broadly speaking the data in this program have been divided in the following four groups as under:

1. Those data which can not be changed for example the constants like the Value of pie (π), value of permittivity of free space (ε) etc. etc.

2. Those data, which are dependent on qualities of materials, like the specific gravity of copper, aluminium etc., Ultimate tensile strength, modulus of elasticity etc.

3. Those data which are based on type of items and their size e.g. Conductors of different size, their resistance, their weight/ km, their tensile strengths, their cross sectional area etc. etc.

4. Those data, which set the Conditions for Calculations. These data are always fed externally according to the type of problem one is dealing with. For example to find the MW-km capacity of a line one have to set conductor's name, span of OHL, percentage regulation, temperature externally.

B(i).   WHAT DATA CAN BE USED FOR CALCULATIONS

Users can select one of the following Data options for using them in any of the programs of this software:

A. Data for ACSR Conductors

1. Default data set for 20 conductors
2. Calculated data set based on no. of steel and al conductors and their diameters.
3. User's own data set for one conductor or even the entire set of 20 conductors' data.

B. Data for AAC/ AAAC Conductors

1. Default data set for 20 AAC/ AAAC conductors
2. Calculated data set based on number of aluminium conductors and their diameters.
3. User's own data set for one conductor or even the entire set of 20 conductors' data.

B(ii).   DATA SELECTION INTERFACE

It is necessary to be aware of the data selection interface, so that you can work safely, quickly and promptly by selecting proper data.

To go to the data selection interface follow these steps:

Main menu → Select option 1 → Data selection interface

You will find a number of data input boxes, command buttons and some pictures of overhead line layout. Most of them are disabled. We will discuss each part one by one.

The first frame at the top portion is marked 'Constants'. By default you cannot edit them. However, to edit the editable data, press 'Open to Edit' command button on the right of this frame. On doing so, you will find that all editable input boxes are enabled for editing. Edit them as per your choice.

It is important to note that editing of the constants is not at all suggested unless it is very necessary and unavoidable. All results will depend on these data. So edit these *carefully*.

On the left part of the screen you will find pictures of overhead line conductor setup. The overhead line of your system must have either of the two options given there. The conductors' placement may be either in triangular section as shown at '1' or in one plane as shown in '2'. Select one of the options. By default it is '1'. After setting the option of placement, it is necessary to supply the distance between conductors marked 'd1', 'd2' and 'd3'. In the second option there will not be any choice for 'd3' because it is the sum of 'd1' and 'd2'.

In the middle of the screen you will find two frames. These frame options are disabled in the 'Open to Edit' mode. To enable these options press 'Lock Data'. The first frame is marked 'Select Conductor Type'. Here, you have only two choices. Your conductor may be either ACSR type or AAC type. You may note that AAAC type conductor may also be placed in AAC type category. Set the conductor type in this section.

The second frame in the middle of this interface is marked 'Data Option'. Here you have three options as under:

Default conductor data
Calculated conductor data and
User's own conductor data

Set your option in any one of them. You will observe that the contents of the interface input boxes below this frame i.e. the name of

conductors, their nominal area, aluminium and steel dia. etc. all changes with the change of 'Data Options' and 'Type of Conductor'. You can edit them while the 'Open to Edit' button is on.

After editing the data according to your requirement, it is advised to 'press the lock command 'Lock Data' for data safety reasons.

B(iii).   HOW TO SELECT DATA

Users can have any one of the options mentioned above. The following data of each conductor is available by default for all the conductors comprising a set of 20:

i.   Name of conductor (Optional)
ii.   Conductor cross sectional area in mm² (copper equivalent)
iii.   Conductor cross sectional area in mm² (Aluminium equivalent)
iv.   Resistance per km in W at 20°C
v.   Inductive reactance per km in W taking equivalent spacing between OHL conductors as 700mm.
vi.   Weight of conductor in kg per km.
vii.   Ultimate Tensile strength of conductor in kg.
viii.   Current carrying capacity in Amps.
ix.   Radius of overall conductor in mm.

B(iv).   USING DEFAULT DATA

It is recommended that one should normally use default values of conductor constants i.e. either A.1 or B.1 (discussed above) depending on whether the conductor is ACSR or AAC.

You can check and confirm the conductor constants in the following way:

Main menu ---> Data selection from default, generated data or User's data ---> Set option for ACSR or AAC ---> Set option default ---> Ready..Go!!

The results, i.e. the default values of each conductor data will be shown in the display section *'Input-Output'*. If you want to continue

with the data obtained, then press *'Load these data to use'* in the display section which will again bring you to the main menu with your required data. If you find any problem with the default values then you may shift to other options i.e. *'Calculated values'*

B(v).   USING CALCULATED DATA

You can change the option from default to *'Calculated values'* in the data selection section. Here by pressing the button *'Ready..Go!!'* again will display the calculated values of conductor data in the display section *'Input-Output'*. If you want to continue with the data obtained, then press *'Load these data to use'* in the display section which will again bring you to the main menu with your required data. If again, you find any problem with the 'Calculated values' then shift to the next option i.e. *'User's own Data'*

B(vi).   INCLUDING USER'S OWN DATA

You will find a new screen for this option, which will allow you to include one or more conductors of your own choice and specifications. It must be noted here, that the user shall have to provide all the following data for each of the conductors to be included.

1.   Name of conductor
2.   Equivalent copper area in sq.mm.
3.   Equivalent aluminium area in sq.mm.
4.   Current carrying capacity in Amps.
5.   Resistance per km in Ohms at 20 deg. cel.
6.   Inductive reactance per km at 50 Hz frequency
7.   Radius of overall conductor in mm.
8.   Tensile strength of conductor in kg.
9.   Weight of conductor in kg/km.

However, the user will be guided by the program about the range of individual data at the time of entry. The second important point to be noted is that the total number of conductors (Existing+Included) must not be more than 20.

You will have to exclude (temporarily) equal number of conductors from the existing list of 20 conductors to accommodate the newer ones so as to keep the number 20 only.

Alternatively, you can make file of your own conductors data and include it in the application at run time. Your data file may contain either of the two options given hereunder:

1. Data set for ONE conductor
2. Data set for 20 conductors in sequentially increasing order of cross sectional area of conductors.

Any abnormal data may lead to termination of the execution of the program or erroneous results.

After the conductor data or data file is supplied and accepted by the program press 'Return'. This will bring you back to the main menu with your own data. You may now work with your own data.

C. CONDUCTOR AREA INDEX

Conductor Area Index may be defined as the 'Cost of 3.15 litres volume of conductor'. This index accounts for the cost of aluminium, steel, cost of drawing wires of Al. & steel, cost of stranding, packing & supply to the actual consumer. This index may vary from conductor to conductor, which is quite evident from the above definition.

In this Elect software, we will be using a set of twenty conductors as per our choice. The conductors might be ACSR, AAC, AAAC or some other. So, there is every possibility of different conductor area index for each of them.
In view of this difficulty, this program has chosen a mid path of taking average value of index for every set of conductors in use.

In this program, you will find three methods of estimating the value of conductor area index. In the following lines a brief description of methods are given for reference.

C(i).   FIRST METHOD FOR FINDING CONDUCTOR INDEX

This is the simplest lent crude method of finding conductor area index. In this method user is required to give the cost of one kilogram of Aluminium the currency of that country. The value of conductor index is immediately obtained corresponding to this cost of aluminium. This

method of finding of conductor index is based on the following assumptions:

1. The cost of wire drawing from Al. and steel are equal.
2. Stranding cost for steel and Al. are equal.
3. Cost of wire drawing and stranding is 20% of the cost of equivalent aluminium.
4. A factor of 1.60 has been used for conversion from equivalent aluminium area to equivalent copper area.
5. Specific gravity of aluminium has been taken here as 2.703.
6. 5% overhead has been allowed in the overall costing.

Example:
Let the cost of finished material (aluminium) per kg   = Rs. 110
Specific gravity of aluminium   = 2.703

Then conductor index is given by:

k = Volume of conductor as per definition x sp. gr. of al
    x rate of al/kg x wire drawing, stranding, spooling
    x Equiv. Area conversion factor x handling and
               overhead charges.

C(ii).   SECOND METHOD FOR FINDING CONDUCTOR AREA INDEX

This is the most reliable method of finding area index. In this method, user is required to furnish the cost/km of the set of conductors to be used the program. It is important to note that it is not statutory to supply the cost of all the 20 conductors. If you are having one or a few items costs, then that will also do. However, this value thus obtained will be at the cost of accuracy of the value conductor area index. If you have data for only five conductors instead of twenty then you start like this:

In the area index section, go to Method 2. Reset values to zero by pressing the 'Reset' button. Now, irrespective of the name of conductors, fill up values for conductor equivalent copper area and the corresponding cost per km in your currency. Do this for all your available conductor data.

Now, press 'Find k' and you will get the value of the area index 'k' as on date corresponding to cost figures.

Example:

Given hereunder, the cost of conductors per km in Rupees as on 01.01.2002:

C(iii). ACSR Conductors:

CONDUCTOR	mm²	Rs./km	'k'	Average 'k'
Squirrel	13	8500	1962	
Weasel	20	12500	1875	
Ferret	25	17000	2040	
Rabbit	30	21000	2100	
Mink	40	27000	2025	
Racoon	48	32000	2000	
Dog	65	47000	2169	
Wolf	95	65000	2053	
Panther	130	108000	2492	**2080**

C(iv). AAC Conductors:

CONDUCTOR	mm²	Rs./km	'k'	Average 'k'
Gnat	16	13500	2531	
Weevil	20	16500	2475	
Ladybird	25	20500	2460	
Ant	30	25500	2550	
Fly	40	31000	2325	
Grasshopper	50	41000	2460	
Wasp	65	49500	2285	
Chafer	130	98000	2262	
Scorpion	325	244000	2252	**2400**

From here, it can be observed that the conductor area index of ACSR and AAC are different. AAC index is about 15% higher than that of ACSR. So, we can safely assume:

$$k_{aac} = 1.15 \text{ x } k_{acsr}$$

C(v).   THIRD METHOD OF FINDING CONDUCTOR AREA INDEX

In this method a base value on a certain date is given for the conductor area index. The index as on date or any time can be obtained with the following formula:
k (on date)   = k (on base date) x Cumulative inflation in the time span

=> $k = k_{base} (1+\text{Rate of inflation})^{time}$

=> $k = k_b (1+r)^t$

Where, k is the index on date, k_b is base index, r is the rate of inflation and t is the time span. This rate may be taken as 0.31 percent per month for India. This percentage rate has been calculated based on the values of 'k' (2080) as on 01.01.2002 and another value of 'k' (1730) as on 01.01.1997.

Example:

Let the base value of conductor area index be 1730 as on 01.01.1997. To find the area index as on June 2002, we proceed as under:

Time in number of months from 01.01.1997 to 01.06.2002 = 65 months
Rate of inflation per month = 0.31 per cent

Area Index
$$
\begin{aligned}
k &= k_b (1 + r) \, t \\
&= 1730 (1 + 0.31/100)^{65} \\
&= 1730 \text{ x } 1.2229 \\
&= 2116 \qquad \text{(For ACSR)}
\end{aligned}
$$

$$= 2116 \times 1.15 = 2434 \quad \text{(For AAC)}$$

C(vi).   INTERNATIONAL UTILITY

This ELECT software, by default uses Indian Rupees as currency. The values of the following items are dependent on the type of currency in use for finding the most economical conductor:

    i.   Cost of unit volume of aluminium
    ii.   Cost of conductors of the overhead line
    iii.   Cost of other infrastructure like rail poles, iron and steel spares, insulators, earth wires, clamps etc.
    iv.   Cost of complete overhead line/km
    v.   Cost of unit electrical energy
    vi.   Rate of maximum demand charge per kVA, applicable in case of two-part tariff.
    vii.   Value of conductor area index 'k' (Same as item no. i.)

Out of these seven items, item no. i, v, vi and vii are to be supplied by the user, whereas item no. ii, iii and iv are obtained as results from the program.

The selection of most economical conductor depends on these data. So, it is also evident that a conductor found to be most economical for a system in one country may not be economical at all in some other country. It all depends on the relative values of item no. v, vi and vii. For example, consider the values of unit electricity and conductor area index of the following country for comparison:

DETAILS	COUNTRY A	COUNTRY B
Conductor area index	2400	60
Cost of unit electrical energy	3.00	0.25
Currency ratio	50	1

With the given currency conversion ratio, the value of conductor area index should have been 48 instead of 60 corresponding to 2400 and also the cost of unit electricity should have been 0.06 instead of 0.25 corresponding to 3.00. so the conversions may not be taken in direct proportion of the currency to currency ratio. This is the reason, why for

a given system, two different countries have different 'most economical conductor'. In this case, what we observe that the electrical energy is much costlier than that of the relative value of conductor cost ('k'). So, it is quite evident that the comparative size of conductor in country A must be higher for being the 'most economical conductor'.

To further clarify this case, consider the following tabular results obtained for a similar system in two different countries:

ITEM DESCRIPTION	COUNTRY A	COUNTRY B
Voltage in kV	11	11
Power in kW	2000	2000
Power factor	0.90	0.90
Load factor (annual)	0.65	0.65
Temperature in °C	55	55
Max. Demand charge	200	4.00*
Conductor Area Index	2400	60
Cost of unit electricity	3.00	0.25
SELECTED MOST ECONOMICAL CONDUCTOR	**2 x 65 mm² Two circuits of ACSR 'DOG' conductor**	**2 x 110 mm² Two circuits of ACSR 'LYNX' conductor**

So, it is important and statutory to set the 'currency' to be used by the program, prior to finding out 'most economical conductor' for a system.

To change the currency of use, follow the following sequence in the program:

Main menu -> Conductor Area Index Option -> International Utility

Here, you will supply the Rupee equivalent of your currency. After you give this data press 'Change currency and find k'. You will get value of area index 'k' corresponding to a given index of 2300. Update the value of this index by using 'Inflation Method' described as Second Method here above.

Now, you have changed the currency to be used by the program and corresponding value of area index 'k'.

You will observe that the corresponding default values in the 'most economical conductor selection' section have changed in proportion. However, the figures are to be supplied as per actual prevailing rates.

D. MOST ECONOMICAL CONDUCTOR SELECTION

D(i).   *PREPARATION*

Before attempting to execute this option of the program, users are advised to perform the following:

1. Select proper data for overhead line conductors – For this purpose, *option 1 of the main menu* should be executed. It may be noted that any one of the following data can be selected for use in other programs.

   a. Default data of ACSR conductors
   b. Default data of AAC conductors
   c. Calculated data of ACSR conductors
   d. Calculated data of AAC conductors
   e. User's own data (for one specific conductor)
   f. User's own data (for set of 20 conductors)

2. Set the conductor layout of the overhead line and spacing between conductors – To do this, follow the following path:

   Main menu --> Data Selection (Option 1)

   Select the conductor setup option on the left part of this interface. Set 1 for triangular overhead conductor layout or 2 for horizontal or vertical conductor setup. Enter the spacing between conductors in the input boxes d1, d2 and d3. Check your data choice as discussed in section 1 above. Now press the button 'Ready…Go!'. You will find the equivalent conductor spacing in the 'Most Economical Conductor Selection' program.

3. Set the 'currency' to be used by the program. To do this follow the following path:

    Main menu --> Finding conductor area index (Option 2)

    Go to international utility and check for the currency. If it is other than Rupees then you will have to give a rupee equivalent of your currency. After supplying this data press 'Convert currency and k'. The program will now use your selected currency. It is important to note here that with the conversion of this currency, you are also getting the changed equivalent value of the conductor area index 'k' as on 1st April 2001.

4. Update/ Find the value of conductor area index. To do this follow the following path:

    Main menu --> Finding conductor area index (Option 2)

    Use any of the three methods given here for finding or updating the value of conductor area index 'k'. Return to main menu by pressing 'Home' in this section.

After executing necessary part of the program as mentioned in the above four sections, you are in a position to find out 'Most Economical Conductor' of any overhead line.

D(ii).   *DATA ENTRY & EXECUTION*

Once the preparation is done, user may go to Data Entry section of the 'Most Economical Conductor Selection' by selecting option 3 in the main menu. In the Data Entry section you will find a number of data input boxes, command buttons and some menu items etc.

Info button 'i' and 'about' menu item will give information about the program, whereas '?' command button and 'help' menu item will open the help file. 'Cond codes' button will display the current values of conductors, their local codes and cross sectional area in mm². The button 'k=2300' will take you to the 'Conductor Area Index' section where you can once again view the values set for calculations.

You will find the description about the type of data, to be filled, on the left of each input box. Read each description and fill up carefully, the data required for finding the 'Most Economical Conductor'. Each data is bounded by certain limitations which have already been described elsewhere. However, for the sake of convenience, the limits are given hereunder again:

1. Limiting conductor size for the OH line   (Range: 1...20)
2. Overhead line system voltage in kV   (upto 36.3 kV)
3. Loading capacity of OHL in kW   (Range: +ve value)
4. Power factor of the load on OHL   (Range: -1 to +1)
5. Annual Load factor of the system   (Range: 0 to 1)
6. Length of the overhead line in km   (Range: upto 2000km)
7. Avg. span of the overhead line in m   (Range: 30 to 300)
8. OHL Conductor temperature in °C   (Range: -242.5 to 120)
9. Permissible voltage regulation in %   (Range: Indicated in the program, depends on system voltage)
10. Inflated value of cond. area constant   (Range: 20…20000)
11. Annual interest+depr. of cond. cost in %   (Range: upto 100)
12. Cost of unit electricity in currency specified   (Range: 0…100)

After you fill up the required data for finding the 'Most Economical Conductor' you have to press the command button 'Execute', written in red, over it. But, before you press this button, it is helpful to know the functions of other command buttons in its surrounding. I give hereunder, a brief note on function of each command button:

Clear cells -   This will set all the data values of input boxes to zero for fresh data entry.

Test Values -   This will supply a set of test data for testing the functioning of the program.

More- info -   Opens help file of the software.

Show intersection: This will take you to a graphical display section, where you can view an existing graph created by this program (you can also view any other image in this viewer).

Execute -   This command will first check your input data supplied here and will pass on to the next part only if these are found to be ok as per the limitations set for the program.

After Execution the program will pass on to the result display section 'Input – Output'.

In this 'Input–Output' section you will find your input data in the upper half portion of the display and the results of execution in the lower part of the screen display. Check whether your input data are reflected correctly or not in the 'input' part. You will find no discrepancy in this display.

If you want to change any of your input data then from the menu item press 'Back' and you will go back to the data entry section. Here you can change your input value and press 'Execute' again. You will get the revised input displayed in the result display section.

After you are satisfied with the input data, check the results obtained against these input data. You will find a series of information obtained for finding the most economical conductor.

Now, at this stage, suppose you want to see/ check the impact of change in any input data. To see this change, you can again go back to data entry section, change input data and press 'Execute' to view the revised result. You will find revised results in the display section.

The following results will be displayed on execution of this 'most economical conductor selection' part of the program:

1. Most economical number of OHL feeder(s)
2. Most economical Conductor selected for the OHL
3. Receiving end voltage of the OHL
4. Sending end power factor of the OHL
5. Percentage voltage regulation of OHL
6. Voltage drop in the overhead line/phase
7. Total overhead line losses (rms)
8. Line efficiency of the OHL system
9. Current through the overhead line
10. Disruptive critical voltage/phase
11. Total corona loss in the OH Line
12. Annual energy loss in the OH Line

13.   Total resistance/ phase of the OH Line
14.   Total inductive reactance/ phase of OHL
15.   Total capacitance of the line/ phase of OHL
16.   Maximum sag of the overhead line
17.   Recommended spacing between conductors
18.   Standard capacity of the selected OHL/feeder
19.   Cost of selected OHL & conductor /km in Rs.
20.   Most economical conductor's equiv. Cu cs area
21.   Least no. of circuits for the given regulation
22.   Cond. selected on the basis of max. load current

Once, the results are found satisfactory (may not be in all case), you may like to save this result. The results can be saved in two types as given in the menu item.

1.   Elect file format
2.   Text file format

The files saved in 'Elect file format' can be redisplayed in the editor of this software. On the other hand files saved in 'Text file format' can be displayed on any text editor like the 'notepad', ' word pad' or even in 'ms word' or so. It is advised to save the results in 'Text format'.

From the menu items of this section, you will find a number of operations can be performed here. The important among them are:

You can copy any or entire part of 'input' and paste in text pad or 'ms word' or 'excel' or 'lotus' wherever you like to paste. Similar actions can also be performed on the 'output' part.

You can graphically view the point of 'most economical condition' by pressing the 'Show Curves' in the menu item.

D(iii).   GRAPHICAL VIEW OF A SERIES OF CONDUCTORS AROUND THE MOST ECONOMICAL CONDUCTOR

On pressing the 'Show Curves' item in the results display section 'input-output' you will come to this part of the program where you can view the position of your 'most economical conductor' compared with its surrounding available conductors. For example if

the program has found 'DOG' as the 'most economical conductor' then you will see two or three conductors above and below 'DOG' size in the graph. This gives a better option of selecting a more suitable conductor depending on availability and economy.

On arriving to this section, you will find a blank space in place of graph display. However, you will find a number of command buttons and menu items in the screen.

In the upper part of the screen above the graph display window you will find two command buttons. The left button marked 'Elect' will tell you about the program while the button on the right side will call Help file of this software. In between these buttons are two labels "CS Area in sq.mm." and "Amount in '000". You will find no values against these labels. This is because you have not opened any file and there is no any display of active graph. The values of X-axis and Y-axis will be displayed in these places and will change according to your mouse movement. This facility will help you in locating a point on the graph.

Above these labels are as usual menu items of the program. If you compare these menu items with the command buttons given in the lower part of the display window, you will find a few menu items are common. This is just to ease the viewing of the graph.

Now, to view the graph generated by the currently executed results, press 'Show Current' at either on the upper or lower part of the menu. A graph will be displayed in the graph display window. There are some 'details' written in text form on the display window. These details can be either removed or re-write by pressing the button 'Details (-)' or 'Details (+)' as the case may be.

Size of the displayed graph can be increased or decreased in width or in height by pressing the '+' or '-' buttons on left and right side of 'Width' and 'Height' labels indicated below the graph. To normalize the size of the graph, press 'Normalize'.

Now, view the graph carefully and try to analyse the situation. You will see two curves one in blue colour and the other in deep brown colour.

The first curve indicated in blue is for the annual energy losses in thousand units of currency versus the cross sectional area of the conductors in sq.mm. You will find that as the cross sectional area (plotted in x-axis) increases the annual energy loss decreases.

The second curve indicated in deep brown is for the annual interest and depreciation of the conductors part only in thousand units of currency versus the cross sectional area of the conductors in sq.mm. You will find that as the cross sectional area (plotted in x-axis) increases the annual interest and depreciation of the conductors cost part also increases. This is because the interest and depreciation of different conductors will only increase when the cost increases with the increase of cross sectional area.

Both these curve/ line intersect at a point. This point of intersection is the point of our interest. The x-axis value of this point is the point of most economical conductor cross sectional area and is given in mm². The y-axis value of this point is the point of minimum annual energy losses corresponding to given interest and depreciation of conductor cost.

Now, go to the left of this 'Most Economical' point. You will find that the conductor cost is less but the corresponding annual energy loss is higher. The difference of these two figures is such that the saving due to change of conductor from higher size to lower size causes more loss of energy and the net impact is more loss.

Further, on the right of the 'Most Economical' point, you will find that the conductor cost is more than the corresponding annual energy loss. However, the difference of these two figures is such that the saving due to change of conductor from lower size to higher size causes more loss in interest and depreciation than the saving in energy and the net impact is more loss.

Thus you will find that both the conditions i.e. lower conductor size than the Most Economical Size and higher conductor size than the Most Economical Size are uneconomical.

Hence, the point of intersection of these curves gives the most economical conductor size for the overhead line with the given conditions and specifications.

All details of the most economical conductor have been provided in this graphical display section. For example, you must check the number of circuits/ parallel paths per phase / bundled conductor per phase. This information is very much necessary. The result obtained here has no meaning unless you also check this value. If the number of OHL circuit(s) is one then there is no problem. But if the number of OHL circuit(s) is more than 1 then the information that the 'most economical conductor' is conductor A or Conductor B has no meaning, because the truth is else.
The Name of conductors and the annual energy losses have been indicated for each of the conductors used for the purpose of comparison with the most economical conductor. Moreover, the annual cost towards the interest and depreciation of each such conductors have also been indicated against each conductor used for the purpose of comparison. These figures will facilitate the user to quantify the losses and saving for each and every point of conductor cross sectional area irrespective of the fact that whether that conductor exist or not.

In the 'Details' part you will find some other information like the value of each unit mark on x-axis and y-axis.

The 'SaveGraph' command button will open a dialog box asking a name for the graph. Give a suitable name and press 'ok'. The graph will be saved. You will see that the background color of the displayed changes from light yellow to white indicating that the graph has been saved once.

One can directly go to the main menu or exit the program by pressing 'Home' or 'Exit' in the menu item.

E. REGULATION AND VOLTAGE DROP

E(I). OHL WITH SINGLE CONDUCTOR PER PHASE

This is most important section of the program. This type of calculation is very common in the Electrical Engineering applications. This program deals two methods with two different conditions as under:

i.   Analysing circuit performance when the sending end voltage of the system is known.

ii.   Analysing circuit performance when the receiving end voltage of the system is known.

In the first method, the capacitance of the overhead line is assumed to be negligible and is neglected in calculations, while *in the second method* the capacitance of the equivalent circuit of the overhead line system is considered (however small it may be) in calculations.

While considering the capacitance of overhead line, the method adopted for calculation is that given by Dr. Steinmetz, i.e. the three-condenser method. In this method, the capacitance per phase is divided in six parts. The entire overhead line is divided in two equivalent parts per phase1/6th of capacitance is assumed concentrated at the sending end, 2/3rd in middle of the line and finally 1/6th at the receiving end.

Per phase equivalent circuit diagrams can be viewed in the 'Data Entry' section of this program. You can arrive to this section from the main menu by selecting any of the option-4 or option-5.

In the data entry interface of this section of the program you will find one frame on the left top part, some descriptive text on the right top part, a number of input boxes with descriptive labels on their left, a few animated command buttons for different functions

and two picture boxes (one with the equivalent circuit diagram of the option chosen and the other with its vector diagram) on right half of screen.

First of all, user will select one of the two options of the left top frame which is about the given system voltage. Thereafter, user may observe that the input box with the label 'Number of conductors per phase' is disabled. It is because you have chosen single conductor option-4 in the main menu. Another input box with label 'Spacing between conductors in mm' is also disabled with some value of spacing in the input box. This is to show the user that the inductance and capacitance will be calculated with this value of spacing. However, if the user is interested to change this value then he should go to the 1st option in the main menu i.e. Data Selection part and set the data for the overhead line conductor layout setting and then return back to this section. The value of spacing will be changed automatically to the desired one.

User will have to supply the following input data to execute this program:

1. Sending end voltage in kV (Range: upto 99)
2. Receiving end Load in kW   (Range: Any +ve value)
3. Power factor of the load   (Range: -1 to +1)
4. Load factor of the system (Range: upto 1)
5. Overhead line Conductor code (Range: 1...20)
6. Length of the overhead line in km (Range: upto 2000)
7. Eq. spacing between cond.in mm (Range: 100...12000)
8. OHL Conductor temp. in °C (Range: -241.5 to 120)

You will find a command button marked 'Cond. codes' on the left of input box. Press this to know the names of conductors and their codes.

Each data to be supplied has a certain range. The program will not accept data beyond these limits.

After the data entry is over, you are now ready to execute the program. Before execution it is better to know the other functions of the command buttons of this section.

The 'Reset' button clears all the input cells for fresh data entry.

The 'Default data' button supplies all the data in the input boxes for testing purpose.

The 'Home' button will take you back to the main menu.

The 🔮 button will give information about this program.

In addition, you will find a few menu items, which are self-explanatory.

E(II). EXECUTING THE PROGRAM:

After supplying all the required data in the input boxes, press 'Execute' button to execute the program. After execution, the program will pass on to the result display section, displaying the input and the corresponding resulting output.
The following output will be displayed in the result display section:

1 Receiving end load shared by conductor path
2 Receiving end voltage of the OHL
3 Sending end power factor
4 Percentage voltage regulation
5 Voltage drop in the overhead line/ phase
6 Annual energy losses in the overhead line
7 Total line losses (Maximum)
8 Total line losses (rms value)
9 Resistance/ conductor of the OHL at the given temp.
10 Inductive React./ conductor of the OHL.
11 Capacitive React./ conductor of the OHL.
12 Capacitance/ conductor of the OHL.
13 Form factor of the system.
14 Line efficiency of the OHL system.

15 Surge impedance of the OHL.
16 Current through conductor of the OHL
17 Disruptive critical voltage/ phase
18 Equivalent impedance/ phase of OHL
19 Equivalent Cu cs area of conductor
20 Equivalent Al cs area of conductor
21 Current carrying capacity of conductor

As usual, you can select, copy, cut and paste the input display or output display to '**Excel**' or '**Lotus**' and further edit them according to your necessity.

You can save the results alongwith the corresponding input in two formats. To do this, press 'Save As' item in the menu and save the results either in the text format or as an Elect file. You can re-open this Elect file in the editor which is an integral part of this Software.

In case, you want to change any of the input and see the resulting impact, then press 'Back'. You will again go to the data entry section. Here you can change your data and execute again to see the impact of this change.

You can exit the program from here or return to the main menu by pressing 'Back' and then 'Home' in the menu items.

E(III). OHL WITH MULTIPLE/ BUNDLED CONDUCTOR PER PHASE

In this arrangement, the number of conductors per phase is more than one. The conductors are placed with spacers in between them. The average distance between conductors is kept between 20 cm and 60 cm. The number of conductors may be two, three, four or even higher. This program has kept the maximum number of conductors at 10.

There are many advantages of using bundled conductor in overhead lines. The effective inductances per phase decreases that improves the voltage-drop and in turn the regulation. It also increases the loading capacity of the overhead line. The capacitance of the bundled conductor also increases which is

advantageous because it improves the power factor as well as the voltage regulation of the overhead line. There are other advantages also for this arrangement.

The data entry part of this section is similar to that of the previous part i.e. OHL with single conductor per phase. The only difference being the number of conductors per phase.

You will observe that once the number of conductors is supplied in the related data input box, the number of input boxes for the 'OHL conductor codes' also increases or decreases accordingly. You can input same or different conductors in each input box against this item. For example, you can use 'DOG', 'TIGER' and 'WOLF' (i.e. 10, 11 and 12).

E(iv). EXECUTING THE PROGRAM:

After supplying all the required data in the input boxes, press 'Execute' button to execute the program. After execution, the program will pass on to the result display section, displaying the input and the corresponding resulting output.

The following output will be displayed in the result display section. *It may be noted that the results are displayed for individual conductors as well as with their combined effect*:

1	Receiving end load shared by conductor path
2	Receiving end voltage of the OHL
3	Sending end power factor
4	Percentage voltage regulation
5	Voltage drop in the overhead line/ phase
6	Annual energy losses in the overhead line
7	Total line losses (Maximum)
8	Total line losses (rms value)
9	Resistance/ conductor of the OHL at the given temp.
10	Inductive React./ conductor of the OHL.
11	Capacitive React./ conductor of the OHL.

12	Capacitance/ conductor of the OHL.
13	Form factor of the system.
14	Line efficiency of the OHL system.
15	Surge impedance of the OHL.
16	Current through conductor of the OHL
17	Disruptive critical voltage/ phase
18	Equivalent impedance/ phase of OHL
19	Equivalent Cu cs area of conductor
20	Equivalent Al cs area of conductor
21	Current carrying capacity of conductor

As usual, you can select, copy, cut and paste the input display or output display to '**Excel**' or '**Lotus**' and further edit them according to your necessity.

For more details, users may refer the OHL with single conductor per phase program.

F. MW-km CAPACITY OF OVERHEAD LINES

MW-km (MegaWatt-kilometre) is a measure to express the capacity of the overhead lines. The basic requirements are resistance, reactance of the conductor of the overhead line. These data are normally supplied by default as per the data you have selected for the programs.

To arrive at the data entry section of this section the following is advised:

Main menu --> Option 7 (MW-km) --> Data entry interface of MW-km program

In addition to internally supplied data, user is requested to supply the data through the interface of this section. In this interface, you will find an animated Text-Box with some instruction/ information about this program, two diagrams on the right of the interface. The upper one is equivalent circuit of the 'Analysis Module' while the lower diagram is its 'Vector diagram'.

Before discussing about the data entry, it is better to know the various functions of the command buttons of this section.

You will find four command buttons on the left lower part of the interface and one command button on the mid right of the interface.

'Home' button will take you back to the 'Main menu'.

'Reset' button will clear the contents of the input boxes.

'Default Values' will write the default values of inputs in the 'input boxes' for testing purpose.

'Execute' button executes the program based on the values supplied in the input boxes.

The command button on the mid right half of the interface will display information about the programs.

In the central part of the interface there are five input boxes each with a label on left of it indicating the type of data to be supplied. These boxes are to be filled up by the user externally as per his requirement. The ranges of required data are given hereunder for reference:

Transmission voltage of the system in kV (Range: 0.415 to 400)
Percentage regulation as specified (Range: -6 to +15)
Power factor of the system (Range -1 to +1)
Span of the overhead line in m (Range: 10 to 1000)
Temperature of the OHL conductor in °C (Range: -241.5 to 120)

On pressing the 'Execution' command, the program filters your data and reports for its correction, if any. It executes and calculates MW-km for the entire set of 20 conductors at temperatures from 10°C to 80°C at an interval of 10°C. The MW-km at the desired temperature is also calculated. The control then passes on to the

result display section. In this section the following results are displayed:

Conductor' Name	MW-km at 70°C
MW-km at 55°C	MW-km at 80°C
MW-km at 10°C	Weight in kg/ km.
MW-km at 20°C	Effective Wt. in kg/ km
MW-km at 30°C	MW-km (maximum limit)
MW-km at 40°C	MVAr-km (maximum limit)
MW-km at 50°C	pf at limiting conditions
MW-km at 60°C	Recommended Spacing in mm

As usual, you can select, copy, cut and paste the input display or output display to '**Excel**' or '**Lotus**' and further edit them according to your necessity.

You can save the results alongwith the corresponding input in two formats. To do this, press 'Save As' item in the menu and save the results either in the text format or as an Elect file. You can re-open this Elect file in the editor which is an integral part of this Software.

In case, you want to change any of the input and see the resulting impact, then press 'Back'. You will again go to the data entry section. Here you can change your data and execute again to see the impact of this change.

You can exit the program from here or return to the main menu by pressing 'Back' and then 'Home' in the menu items.

G. VIEWING TEXTUAL RESULTS (Eliminated in Version 7.xx)

You can reach this part of the program through the following path:

Main menu --> Option-X (Editor)

The Elect Editor is a small program included in this Software. It has been used just as an Editor for displaying and a few editing options of the results obtained and saved in 'Elect Format'. The Default extension of the resulting Elect files is '.grd'.

At the first appearance, it looks like 'Lotus' or 'Excel' environment. But it is not so. The two sections with grids are meant for displaying 'Input Data' and 'Output Results'. The upper section is for input and lower for output. It may be seen that to the left of each grid, line numbers are written and are of fixed type.

A few menu items are to be discussed here in reference to the concerned program. The menu items are as under:

1. *Exit*   2.   *Back*
3. *File*   4.   *Save As*
5. *Edit Input*   6.   *Edit Output*

'Exit' will terminate the program and control will return to system.

'Back' will take you back to the 'Main menu'.

'File' will open a sub-menu for 'Opening a new File' or 'Opening an Existing File'. It must be noted that this editor has a special format with special data of both 'Input' and 'Output' at the same time. Only those files can be re-opened in this Editor which have been saved from this program with '.grd' extension only.

'Save As' menu will also open a sub menu with two options:

Saving a current file in Elect Editor's format
Saving a current file in Text format

User may choose one of the options or else can save the contents of the file in both the formats.
'Edit Input' has a sub-menu with the following items:

Copy Input Selection

Cut Input Selection
Paste Input
Select All Input
Clear Clipboard Input Contents

All these sub-menu items are self-explanatory. The only thing to be kept in mind is that these menu items are for the *Input display section only* and should be applied accordingly. However, it is to be noted that, one can copy or cut any part of the input section and paste it either in Input section or Output section wherever he desires.

'Edit Output' has a sub-menu with the following items:

Copy Output Selection
Cut Output Selection
Paste Output
Select All Output
Clear Clipboard Output Contents

All these sub-menu items are self-explanatory. The only thing to be kept in mind is that these menu items are for the *Output display section only* and should be applied accordingly. However, it is to be noted that, one can copy or cut any part of the Output section and paste it either in Input section or Output section wherever he desires.

G(i).   POP-UP MENU

Pop-up menu has been provided for both the 'Input' and 'Output' part of display section. This menu has been given for ease of working on this editor. Right click your mouse over either 'Input' or 'Output' part of the display and you will find the sub-menu according to the place of click.

H. VIEWING GRAPHICAL RESULTS

You can arrive at this part of the program through the following routes:

Main menu --> View Existing MEC Graphs

This is a unique part of this program where one can visualize and feel the actual state of facts regarding the selection of Most Economical Conductor of an Overhead line. The graphical representation gives an overall view of the ground facts and figures. In short the visualization can be encapsulate as under:

To open an existing saved bitmap file, go to the menu item 'Open Existing'. You will asked to browse for your file. Load your existing file from here.

You will see two curves:
First one for the annual energy losses incurred with different types of conductors, for and around, the possible conductors of selection. This curve is represented in blue color. The annual/ monthly Energy losses with different conductors and their Names are written at the nodal points. You will see cross sectional areas of conductors in sq. mm. also written along the x-axis of the curves below respective nodes.

Second curve for the annual interest and depreciation of the respective conductors costs is represented in maroon color.

Mark the Intersection point of the above two curves. This point of intersection gives the Cross sectional Area in sq. mm. of the Most Economical Conductor for the Overhead line for carrying power as specified in the Input section of the program. It is also important to note that the number of parallel circuits is also to be seen written above the curves. The selected conductor will be that standard size which will be nearer to the point of intersection.

Now, given hereunder, the functions and purpose of various command keys of this section:
1. 'Elect' key and 'About' Menu item at the upper part will open the program information section.

---

2. 'Help' key and 'Help' Menu item at the upper right part opens this Help file for a systematic help on various topics.

3. 'Exit' key and 'Exit' Menu item terminates the entire program and exits to windows.

4. 'OpenExisting' menu item opens an existing file saved as a bitmap image. You will observe that the editing commands disables on opening an existing graph indicating that you can not edit this display.

5. 'ShowCurrent' key & menu item both opens the currently existing data file and creates the graph. It should be noted that if you have directly arrived to this Graphical Display Section from the 'Data Input Section' i.e. you have not executed the current data of the 'Input Section' the file created in the last session of the program takes the position of the 'Existing Data File' and display is created accordingly.

6. 'ShowGrids' Menu item displays the grids on both vertical and horizontal directions. This is useful in estimating the x-axis and y-axis values. In this context this is also to be noted that the x-axis per unit measures and y-axis per unit measures are written above the curves. You can count accordingly.

7. 'Details(-)' key as well as the Menu item are used to erase the text details written above the curves. However, these can be restored by pressing the 'ShowCurrent' key or Menu item. Further, it is to be noted that the display of the text above curves vanishes after a certain reduction of size in width or height. You may restore it by pressing the 'Normalize' key.

8. 'Height keys with '+' and '-' may be used to increase and reduce the height of the graphical display in steps. you can increase and reduce it to any extent. However, after a certain reduction, the displayed text above the curves will disappear. Press 'Normalize' to restore.

9. 'Width' keys with '+' and '-' may be used to increase and reduce the graphical display in steps. you can increase and decrease it to any extent. However, after a certain reduction, the displayed text above the curves will disappear. Press 'Normalize' to restore.

10. 'Normalize' key may be pressed at any time during the process of increment or reduction of height or width. This key normalizes the graphical display.

11. 'SaveGraph' key and Menu item saves the graphical display in bitmap format, no matter whatever be the current size. The saved graph is as seen on the screen at the time of saving.

I. README FILES OF THE PROGRAM

A number of Readme files have been supplied for users. These files can be accessed from the 'Main menu' of the program through the following path:

Main menu → Option-11Readme Files)

This will take you to the section where Readme files are displayed. All the Raedme files are html files and you can also access them directly at the following address (Under normal situations):

Application path (C:\Program Files\MostEconom Conductors)
\html\Readme files with extension .htm

You will find the following Readme files below 'CONTENTS'. Any of the files can be accessed through the menu item options displayed on the left part of the display screen This display screen is actually Internet Explorer.

1. Introduction
2. Most Economical Conductor Selection
3. Conductor Constants
4. Data Selection

5. Voltage Regulation & Drop in Overhead Lines
6. View Existing Graph of MECond. Selection
7. MW-km of Overhead Lines

If you are having multi-media system, you will find a light tune (midi sequence) background sound in this section.

All Readme files are hyper-linked. You go through them one by one in the same screen just by clicking the hyper-linked topics.

I(i).   VIEWING THE INTERFACES OF THE SOFTWARE

One can view all the interfaces at one place. You can come to view them from this explorer screen by clicking your mouse over the animated image at the lower part of the 'CONTENTS' marked 'Next-Click'. You will find the following interfaces listed on the left part of the screen. All these listed items are hyper-linked and one can access just by clicking over the required interface item.

Main Program Menu
Data Selection screen
User data input screen
MEConductor Input screen
Reg. & voltage drop screen
MW-km input screen
Conductor area constant screen
Results display screen
MEC graphical display screen
Readme display screen
Registered version menu
Registry input screen
Conductor display screen
Program Info screen

There are a few menu items at the top of the screen for stopping and refreshing the explorer screen.

One can shift from one part of the screen to the next part as usual just by clicking the hyper-linked items.

J. GENERATION OF ENERGY AUDIT REPORTS

J(i). PREPARATION

Before creating a report for Analysis of Overhead line and Most Economical Conductor, the following pre requisite results are required to be obtained from this software:

1. *Regulation and Voltage drop of overhead line under study (Option-4 in the Main menu)*
2. *Most Economical Conductor Selection of the Overhead line (Option-3 in the Main menu)*

It is statutory to perform both the operations 1 and 2 with the same values of the following elements:

i.   System Voltage (kV)
ii.   Power to be transmitted through the line (kW)
iii. Power factor
iv.   Length of overhead line (km)
v.   Annual Load Factor
vi.   Conductor temperature in °C

In case of 'Regulation and Voltage drop of overhead line under study' you will find two options, one when the sending end voltage is known and the other when the receiving end voltage is known. Here, it should also be noted that the results of the second requisition 'Most Economical Conductor Selection of the Overhead line' is obtained, assuming the case that 'Sending end Voltage' is known. The equivalent circuit of the overhead line under study is the same, which has been taken in the case of 'Most Economical Conductor Selection'. So, you will find more accurate resulting report if you perform the 'Regulation and Voltage Drop Calculations' with the 'Sending end voltage' known. However, the difference between the reports obtained with 'Sending' and 'Receiving' conditions is comparable.

Once you perform these pre requisites of the 'Create Energy Audit Report of Overhead Line', you can move to this section through the following path:

Main menu --> Option-6 (Create Energy Audit Report of Overhead Line)

The control will search for the pre requisite information. On getting these information, it will verify for the Statutory conditions. On getting through, it will prompt asking you to confirm the basis of report file information. If the user's reply is in affirmative, the control will pass on to the 'Report' section.

On the upper part of this interface, you will find the specification of your overhead line. The figures against some items will be similar. The left side figures in these cases are for the 'Most Economical Conductor' system while the right side figures are for 'Regulation and Voltage Drop' case. In rest of the boxes, the figures are either for 'Most Economical Conductor' except the one "Existing conductor's name". On the Left upper part, you will find an Input box with the label 'Name this project'. If you like, you may give here, a name for this Report.

Below this Input box, you will find two command buttons with the captions 'Save Report' and 'Show Report'. You will also see a large space for the report display. Here, it is important to note that the report display has three pages i.e. two pages below the one you are seeing on the top. You can have access to these pages by double clicking your mouse over the top of the screen displaying the report.

Below the report display screen, you will find and important note about the statutory conditions to get the report out for any project. Bring your mouse icon over this instruction and see the effect.

Now, everything is set for displaying the report on the screen. Press 'Show Report' command button and you will immediately

see the report displayed on the screen. Check all the pages of the report by double clicking over the report.

You can 'select', 'cut' and 'copy' the contents of the report to anywhere in the text format with the help of pop-up menu. Pop-up menu can be displayed by right clicking the mouse over the report. You will also find a few menu items at the top of the screen.

To save all the pages of the report, press 'Save Report'. Select a suitable name of the report file and your report file will be saved in text format.

You can re-open this report either in any text editor or even in MS Word. It is better to open this report in ms word and reformat it according to your choice for presentation or inclusion in any other report.

A replica of the report generated by this program is given hereunder for ready reference.

J(ii, iii, iv, v, vi).   CASE STUDY

ENERGY AUDIT REPORT OF OVERHEAD LINE
AND ITS MOST ECONOMICAL CONDUCTOR

WORKS/ PROJECT: Sample Project
Report Date: 11/06/02

CASE STUDY:
A 2.5 km long, 11 kV overhead line with ACSR 'DOG' conductor having 104 mm² equivalent aluminium area, delivers power to a certain works having an electrical load of 2000 kW at 0.9 power factor. The equivalent spacing between overhead line conductors is 700 mm and its temperature is 55°C. The annual load factor of the works is 0.5.

Generate report of this existing line suggesting Most Economical Conductor for the above system. Also generate information of the suggested line alongwith benefits over the existing one. Take cost of unit energy as Rs. 3.05, rate of maximum demand charge as Rs. 200 per kVA per month and conductor Area Index as 2300.

ANALYSIS REPORT:

The overhead line under examination is making an annual transmission loss of 113047 kWh of energy. This loss of energy is equivalent to Rs. 3.448 lakh(s) per annum at the rate of Rs. 3.05 per kWh energy charge.

Voltage Regulation in the existing overhead line is 1.96 percent. This Regulation is OK as per Indian Electricity Rules.

Loading capacity of the existing overhead line is 23.48 MWkm under the given peripheral conditions.

Current through the overhead line is 119 ampere(s) for the given load of 2000 kW.

Most Economical Conductor for the overhead line under the given boundary conditions is 2 circuit(s) of CAT conductor having cross sectional area of 95 mm² (Equivalent aluminium area) i.e. 55 mm² equivalent nominal copper area.

The Most Economical Conductor will reduce the annual line losses from 113047 kWh to 62348 kWh leading to an annual saving of 50699 kWh. In monitory terms this saving is equivalent to Rs. 1.546 lakh(s) per annum.

Equivalent loss part of kVA demand (rms) will reduce from 12.9 kVA (rms) to 7.1 kVA (rms). This reduction in kVA demand leads to a gain of 5.8 kVA. The loading capacity of the line increases accordingly within the same contract demand. Further this reduction in kVA is equivalent to a saving of Rs. 0.139 lakh(s) per annum at the rate of Rs. 200 per kVA of Maximum Demand per month.

Gross monitory saving will be Rs. 1.685 lakh(s) per annum.

One time investment on re-organization of 2.5 km overhead line will be Rs. 6.325 lakh(s) only towards the cost of conductors and its associated accessories. This amount does not include the cost of existing conductors, which will be about Rs. 3.738 lakh(s) only, had it been new conductors. However, it is to be noted that this Re-organization scheme has considered the continuation of the services of the existing overhead line and its conductor.

In the re-organized arrangement of Most Economical Conductor, the number of circuits/ parallel conductors/ bundled conductors per phase will be 2 and additional number of parallel overhead line structures (on rail poles) will be 0. Thus the additional cost of structures will be Rs. 0 lakh(s).

Estimated cost of exclusively new overhead line(s) as suggested above, with the Most Economical Conductors will be approximately Rs. 5.422 lakh(s) per km. This estimation is based on the Conductor Index of 2300 and rail pole structure for the overhead line.

Assuming the production losses due to the downtime of the overhead to be 25% of the additional investment in re-organization, the downtime losses come to Rs.0.647 lakh(s) only.

The total cost of re-organization, comprising of investment on additional conductors & related accessories, investment on additional overhead line structures and downtime losses, comes to Rs.3.235 lakh(s).

Loading capacity of the line with the most economical conductor will be 42.246 MWkm.

Voltage Regulation in the new overhead line will be 1.09 percent. This Regulation is BETTER than that in the existing line and is OK as per Indian Electricity Rules.

For more details, the following annexed result sheets, obtained from the computerized program, may be consulted:

1. RESULTS OF REGULATION & DROP WHEN SENDING VOLTAGE IS KNOWN
2. RESULTS OF MOST ECONOMICAL CONDUCTOR SELECTION

Pay Back period of this re-organization scheme will be 1.92 years.

RECOMMENDATION: IMPLEMENT THE FINDINGS

REGULATION AND VOLTAGE DROP IN SINGLE CONDUCTOR OHL
(Vs GIVEN)

INPUT DATA :

1. Sending end voltage in kV	11.000
2. Receiving end Load in kW	2000
3. Power factor of the load	0.900
4. Load factor of the system	0.500
5. Name of overhead line Conductor	DOG
6. Length of the overhead line in km	2.5
7. Equiv.spacing between conductors in mm	700
8. OHL Conductor temperature in °C	55.0

R e s u l t s :

1 Receiving end load shared by conductor path	kW	2000.0
2 Receiving end voltage of the OHL	kV	10.8
3 Sending end power factor	Factor	0.8970
4 Percentage voltage regulation	%	1.96
5 Voltage drop in the overhead line/ phase	Volts	131.70
6 Annual energy losses in the overhead line	kWh	113047
7 Total line losses (Maxm.)	kW	33.04
8 Total line losses (rms value)	kW	12.90
9 Resistance/ conductor of the OHL at 55°C	Ohms	0.7781
10 Inductive React./ conductor of the OHL.	Ohms	0.7875
11 Capacitive React./ conductor of the OHL.	Ohms	-

12	Capacitance/ conductor of the OHL.	MFD	0.0302
13	Form factor of the system.	Factor	1.25
14	Line efficiency of the OHL system.	% 98.38	
15	Surge impedance of the OHL.	Ohms	287.941
16	Current through conductor of the OHL	Amps.	119.0
17	Disruptive critical voltage/ phase	kV	56.3
18	Equivalent impedance/ phase of OHL	Ohms	1.1071
19	Equivalent Cu cs area of conductor	sq.mm.	65
20	Equivalent Al cs area of conductor	sq.mm.	104
21	Current carrying capacity of conductor	Amps.	240

RESULTS OF MOST ECONOMICAL CONDUCTOR SELECTION

INPUT DATA :

1. Limiting conductor size for the overhead line	LION (140 mm²)	
2. OHL system voltage in kV (Sending end)	11.000	
3. Loading capacity of OHL in kW	2000.0	
4. Power factor of the load on overhead line	0.900	
5. Annual Load factor of the system	0.500	
6. Length of the overhead line in km	2.5	
7. Average span of the overhead line in m	120	
8. Overhead line Conductor temperature in °C	55.0	
9. Permissible voltage regulation in percent (%)	9.000	
10. Inflated value of cond. area constant	2300.00	
11. Annual interest+depr. of conductor cost in %	15.00	
12. Cost of unit electricity in Rs.	3.050	

R e s u l t s :

1	Most economical number of OHL feeder(s)	2	Circuit(s)
2	Most economical Conductor selected for the OHL	CAT	55 mm²
3	Receiving end voltage of the OHL	10.882	kV
4	Sending end power factor of the OHL	0.8986	
5	Percentage voltage regulation of OHL	1.09	%
6	Voltage drop in the overhead line/phase	70.60	Volts
7	Total overhead line losses (rms)	7.12	kW
8	Line efficiency of the OHL system	99.6	%
9	Current through the overhead line	116.6	Amps
10	Disruptive critical voltage/phase	59.8	kV
11	Total corona loss in the OH Line	0.000	kW
12	Annual energy loss in the OH Line	62348	kWh
13	Total resistance/ phase of the OH Line	0.893	Ohms
14	Total inductive reactance/ phase of OHL	0.818	Ohms
15	Total capacitance of the line/ phase of OHL	0.027	MFD
16	Maximum sag of the overhead line	647	mm
17	Recommended spacing between conductors	1106	mm

18	Standard capacity of the selected OHL/feeder	21123	kWkm/ 9% rg
19	Cost of selected OHL & conductor /km in Rs.	542228	per km
20	Most economical conductor's equiv. Cu cs area	55 mm²	2 x CAT
21	Least no. of circuits for the given regulation	1	CAT
22	Cond. selected on the basis of max. load current	48 mm²	1 x RACOON

Report generated by Elect 7.xx

K. SAG AND TENSION IN OVERHEAD LINES

1.   DEFINITIONS OF SAG AND TENSION FACTORS

i.   Reliability Level:
Reliability level as defined in IS 802 (Part1/Sec1):1995 has been taken as 1 which is adopted for Transmission lines upto 400kV.

ii.   Basic Wind Speed (Vb):
Basic wind speed is different for different zones. In India, wind zones have been divided in six wind zones and can be accessed by pressing the button 'W' in the Sag and Tension interface of the program. The wind speed values are in m/s.

iii.   Meteorological Reference Wind Speed (Vr):
It is the maximum value of wind speed over an average ageing period of 10 minutes duration and is given by:

$Vr=Vb/1.375$

iv.   Design Wind Speed (Vd):
To take the effect of Terrain roughness and Risk factors, the design wind speed is given by:

$Vd= Vr \times K1 \times K2$

Where K1 = Risk coefficient
             K2 = Terrain roughness coefficient

The user will find Tables for finding Risk coefficient and Terrain roughness coefficient near the 'Input Box' of respective values in the 'Sag and Tension' program Interface.

v.   Design Wind Pressure (Pd):
Design wind pressure in Newton is given by:

Pd = 0.6 x Vd²

Where Vd = Design wind speed in m/s.

vi.   Wind Load on Conductor & Groundwire (Fwe):
Wind load on conductor in Newton is given by:

Fwe = Pd x Cdc x L x d x Gc

Where Pd = Design wind pressure in N/m²
      Cdc = Drag coefficient
                  (=1.0 for Conductor & =1.2 for Groundwire)
L = Wind span = Sum of half span on either side of tower in m.
d = Conductor diameter in m.
Gc = Gust response factor.

vii.   Gust Response Factor (Gc):
Gust response factor takes into account the turbulence of the wind and the Dynamic response of the conductor. It depends on height of conductor above ground, terrain category and span.

Values of Gust response factor can be obtained from the Table which can be accessed by pressing the button 'Gust' in the 'Sag and Tension' program interface.

viii.   Temperature:

The average everyday temperature for India is taken as 32°C or 15°C depending on region as defined in IS 802 (Part1/Sec1):1995. Maximum temperature for ACSR conductors is to be taken as 75°C and for Aluminum alloy conductor as 85°C. Maximum groundwire temperature is to be taken as 53°C.

2. METHODS FOR FINDING SAG AND TENSION

Sag and Tension have been carried out in accordance with IS 5613 (Part2/ Section1): 1985 for the following cases:

1. 100% wind load at everyday temperature and
2. 36% wind load at minimum temperature.

Additionally, Sag and Tension results can also be seen for the following cases:

1. 100% wind load with ice at minimum temperature
2. 100% wind load without ice at maximum temperature.
3. 36% wind load with ice at everyday temperature
4. 36% wind load without ice at maximum temperature.
5. No wind load with ice at minimum temperature
6. No wind load with/ without ice at everyday temperature.
7. No wind load without ice at maximum temperature.

3. STATUTORY TENSION LIMITS

Conductor/ Groundwire Tension at everyday temperature and without external load should not exceed the following limits as per IS 802 (Part1/Sec1):1995:

Initial unloaded Tension   35% of UTS
Final unloaded Tension   25% of UTS

Provided that the ultimate tension under:
    Everyday temperature and 100% wind load
          OR

Minimum temperature and 36% wind load
does not exceed 70% of UTS of conductor/ groundwire.

4. FACTORS AFFECTING SAG & TENSION

A number of factors are responsible in affecting the Sag and Tension of overhead lines. They are mainly as under:

Wind Speed,
Reliability Level,
Risk coefficient,
Drag Coefficient,
UTS of conductor material,
Terrain Roughness Coefficient,
Conductor properties like csa, wt/km etc.,
Gust Response Factor of conductor,
Coefficient of linear expansion of conductor material,
Modulus of Elasticity of conductor material.

In addition to above the conditions set for:

Limiting Tensions under worst load condition,
Limiting Tensions under initial load condition,
Span of overhead line,
Minimum conductor temperature,
Maximum conductor temperature,
Thickness of ice and
Specific gravity of ice.

All these considerations have been taken care of in the relevant IS discussed above.

5. THE INTERFACE AND DATA INPUT

From the main interface choose the option Determination of 'Sag and Tension of Overhead Line'. The Sag and Tension interface will appear in the screen. First of all check the input boxes. You will see a number of 'Help' commands against most of the input boxes.

Before inserting any input, check the helps provided by pressing various commands. A lot of help is available for the users.

By inspection you can observe that the entire screen is divided into two frames. The upper one requires specific type of input values while the lower one requires different type of input values. Here, it is to be noted that the upper frame inputs are not required if you decide to supply the final value of 'wind pressure at minimum temperature' directly.

Once the inputs required are supplied, press 'Execute' command button and get all the required results with comments.

6. SOLUTION OF THIRD DEGREE TENSION EQUATION

At the top menu, press the item 'TensionEquation'. A third frame will appear in place of second. Put the values of Tension Equation constants and press 'FIND F' to get the result.

L. HELP FILE

(i). TOPICS COVERED IN HELP FILE

This software provides help at nearly all interfaces of the different programs mentioned above. The following topics have been covered in the help file:

1. Utility of the MEConductor Software
2. Selection of Most Economical Conductor
3. Data Input Section Command keys
4. Adding new conductor data to the program
5. Adding new conductor data File to the program
6. Creating Data File for including a single conductor
7. Creating Data File for including a set of 20 conductors
8. Execution of input data by the program
9. Display of results in tabular form
10. Saving tabular results
11. Graphical display of comparative losses/ cost and

the most economical conductor cross sectional area.
12. Saving graphical results
13. Displaying existing results with '.zel' extn. in tabular form.
14. Displaying existing graphical results
15. The Elect Editor
16. Animations in the program
17. Download sites of the program
18. About the program and Authors
19. Establish Conductor Area Constant (k)

(ii). FOR MORE HELP

Users may contact the Authors of this program at the following address:

1. sofexindia@gmail.com
2. sofexindia@yahoo.com

M. ENERGY BILL CHECKING AND DATA ENTRY TO DATABASE (SPECIFIC TO A POWER SUPPLY CO.)

Before starting bill checking, one must have the concept of tariff structure. Power supply companies normally have their own methods and rules for raising energy bill. Normally HT & LT consumers are charged at different rates and by different methods.

For the Rates and Rules of different companies for different supply voltages, this program has a complete set-up, which works silently in background of the program.

We will see this tariff part of the program in the coming section.

Run the Application program and go to the Bill Checking and Database Entry section through the option in the opening screen.

Look at the Bill Checking interface. You will find some menu items at the Top and a few Command buttons at the bottom part. In between the two a number of Data Entry/ Data Values boxes.

If your Database file is connected with the program, then you will see the present total number of records in the Database on the upper right part of the interface.

Various menu items and Command buttons are discussed hereunder as per the Functions they perform. The following functions can be performed through this part of the program:

1. Recording of Energymeter ID.
2. Energy Bill Data Entry, 'Inputs' only
3. Energy Bill Checking
4. Viewing Calculations
5. Appending Data to the Database
6. Saving results as a text file
7. Viewing individual bill details of the database
8. Viewing the list of Energymeters having records
9. Searching a 'Value or 'String' in the database
10. Opening an existing text file of bill records
11. Editing Energy Tariff and Rates
12. Deleting a record from the database
13. Clearing and Entering input 'Test Data'
14. Changing password (for removing a database record)

1. Recording of Energymeter ID

Follow these in sequence:

i. Go to 'Options' menu item
ii. Select 'Add Meter No.
iii. A small text box will appear. Write the meter ID in the textbox carefully and press 'Add'.
iv. New meter name will be included in the new Meter ID list.

2. Energy Bill Data Entry, 'Inputs' only

You will observe three frames on the screen. Two on the left part and one on the right part of the interface. Most of the input boxes on the left part frames are required to be supplied. Observe that three different colours have been used in the input boxes.

Those boxes with black color texts of values are to be supplied as input to the program. These values are to be read from the Energy Bill of the Power Supply Company and simply enter them. You will observe some combo boxes. These combo boxes have been used to avoid data entry errors.

Those boxes in deep red colors are locked and can not be filled through this interface. These deep red color boxes extract their input values from the Electricity Tariff & Rates part of the program. If the squeezed values are not correct, you can go to the Electricity Tariff & Rates part and make necessary changes by editing and updating that part. You can access the tariff part through the 'Options' menu item and 'Edit Electricity Tariff'.

Those boxes with blue texts/ values are not required to be filled up but they are meant for the resulting values after the input values are executed.

3.   Energy Bill Checking

After filling up the 'Input' values required by the program, go to left lower part and check for the 'Execute' command button.

Press the 'Execute' button. Your input will be checked and if no error is found it will be executed and resulting values will be displayed in the blue text boxes. The 'TOTAL' bill value box being one exception.

You can now; compare the resulting displayed values with those of the values of the Energy Bill.

4.   Viewing Calculations

If you observe any discrepancy in the resulting values then the back up calculations can be checked.

You can have access to the back up calculations only after the program is executed. To see the calculations go to the menu item 'Show Calculations'. Your 'Input' values will be re-executed and resulting calculations will be shown on the right side of the interface on a deep blue background. Check the calculations of the desired part, where you have observed any discrepancy.

You may observe, that the menu item 'Show Calculations' have changed to 'Hide Calculations'. Press this menu item again to hide the calculations.

5. Appending Data to the Database

Note the comments 'Checked Not OK' just after the 'TOTAL' box. If the results obtained after execution tallies with that with the Supply Company's total then just click on the 'Checked Not OK' text to change it to 'Checked OK'

After the Energy Bill is checked and found ok, one will desire to save these results in the Database.

To 'Append' the values obtained press the command button 'Save Record'. You will be prompted for the act you are going to perform. Reply in 'Yes' and observe that the Total number of records of the database have increased by one.

6. Saving Disputed Results in 'Disputed Bills' Directory

If the results obtained after execution does not tally with that of the Supply Company's total then do not click on the 'Checked Not OK'. This will prompt you to save the disputed results in separate directory viz. 'Disputed Bills' directory. Hard copy of the saved bill may be reproduced before the Supply Company alongwith the generated 'Calculations Sheet' in protest of their error.

7. Saving Results as a Text File

To save the current results in the form of text file, go to the menu item 'File' and click the option 'Save Data as Text File'. You will be prompted for a filename. Give a suitable filename and press 'OK' to save.

8. Viewing individual bill details of the database

To view all the bills of the database one by one or a particular bill number, you can opt for this view mode. To do this press 'Show bills' command button on the lower right part of the interface. A list of all bill numbers sorted in increasing order will be displayed in the list box above the command button.

Now, click the bill number you want to view. All the details of the clicked bill number will be displayed in the respective places of the interface.

9. Viewing the list of Energy meters having records

To view all the Meter IDs having records in the database press 'Meters' command button on the lower right part of the interface. A list of all Meter Numbers sorted in increasing order will be displayed in the list box above the command button.

10. Searching a 'Value or 'String' in the database

You have a number of fields (about 48 in the current version) in the database. The list of fields can be seen in the combo box located on the right lower part of the interface. Open this combo to view the field names of the database.

If you want to search for a string or a value in any of the fields listed in the combo box then just set the string after the 'Find' command located in the same line. You can write the full string or part of the string to search in the database fields. Press the

'Find' command button after writing the string to find. A list of bill numbers where the string has been found will be displayed in the right side list box. Now, click the bill numbers in the list box and check for the desired search string in the corresponding Bill Data in the text boxes.

With a little tactics a number of utility services can be obtained from this search system.

11. Opening an existing text file of bill records

Follow the process in sequence:

Go to menu item 'File'. Open it and click 'Open File Saved as Text'. You will be prompted to browse for Filename with extension '.bll'. Select the required file and press 'Open'. If the file is a valid one, it will be displayed in the respective text boxes.

12. Editing Energy Tariff and Rates

To view and edit this section, follow the steps hereunder in sequence:

a)   Press 'Options' menu item and click 'Edit Electricity Tariff'. A tabbed interface will appear.
b)   You will find a brief help tip in the default 'Info' tab. Below this help tip you have an option selection frame 'Set Power Supply Company's Name'.
c)   By default, the options (indicating menu of the Power Supply Company's Names) are named as 'Com A', 'ComB'… and 'Com F'.
d)   Each option has a tab of its name.
e)   The selection of company name will decide the tariff that will be used by the program.
f)   You can edit company name of your own choice. Care should be taken that the name should be short that will accommodate in the tab text space.
g)   Now, press the tab of the company name of your interest.

h) You will find a number of Rate Items. The default values of rates of ComA are based on chart of DPS (Dishergarh Power Supply Company)

i) You may edit any of the Rate values and Update, with the help of 'Edit' and 'Update' command buttons.

Press 'Info' tab after updating and then press 'Close' to exit this section.

13. Setting Value of Ideal Power Factor

Some additional calculations are performed based on resulting data of the energy bill, like the additional kVAr required for attaining a desired power factor. For this maximum value of power factor desirable may be set. For setting this value open the menu item 'Options' and press 'Set Ideal PF (Max)' item. Present set value will be shown, If you desire, this value may be changed to any valid value. Press 'OK' after the change. Now, your ideal pf value is set to new value.

14. Deleting a record from the database

Deleting a database record is needed when a wrong entry has been made in the database. To perform this action you need current password for deleting records.

The original value of the Password is 'delete'. You are advised to change this password for safety reasons.

To delete a record perform the following procedure in sequence:

  a. First of all Select the bill number to be deleted. To select the desired bill you have number of options.
     i. By pressing the Command button 'Show bills' and selecting from the sorted list of bills in the list box.
     ii. By typing the Bill number in the Find section and setting Field as 'BillNumber'.

b.   Press the command button 'Delete'. You will be prompted for the action you are going to perform. Click 'Yes' in reply.

c.   A frame has appeared on the left upper part of the interface. Type the current password and press 'OK'. This will remove the selected record from the database.

15.   Clearing and Entering input 'Test Data'

Pressing the 'ClearCells' command button on the left lower part of the interface will set all the input text box values to '0' except the combo boxes, 'Due date' value and the Rates & Tariff part which are not directly editable.

To fill a set of 'Test Data' go to the menu item and press 'Test Data'. This will fill up the required input boxes for execution.

16.   Changing password (for removing a database record)

As discussed at Sl. No. 12 above, password may be changed for protection of your database. To change the Current Password follow these steps in sequence:

a.   Go to menu item 'Password' and select the only option 'Change Delete Password'.

b.   A frame will appear asking for 'Enter Current Password'.

c.   Type current password in the box and press 'OK'

d.   If your current password is correct then you will be asked to give new password.

e.   Type new password in the text box and press 'OK'.

f.   You will be prompted of the successful change of password.

N.   REPORT PREPARATION AND ANALYSIS

You can come to this 'Report Presentation Interface' section through the main menu option 'Presentation and Graphical Display'.

The following Types of Reports may be required for presentation and Analysis of Database Records:

      1.   Viewing one Particular Record (All Fields)
      2.   Viewing Selected Fields of one Record
      3.   Viewing Records of Selected Meter(s) of a set period
      4.   Viewing Selected Fields of Selected Meter(s) of a set period

The procedure for viewing each of the above types of presentation is given hereunder.

From the interface view of the Records, it can be copied and pasted in an 'Excel' or 'Lotus' worksheet for better formatting and obtaining hard copy:

1.   VIEWING ONE PARTICULAR RECORD (ALL FIELDS)

   Follow the procedure given below in sequence:

      a.   Run the Application and go to Report Section.
      b.   Select the presentation period. (In this case 'FROM' and 'TO' dates will be same) e.g.

                   FROM   ->   January 2004
                   TO   ->   January 2004

 This setting will search for a bill having Bill Cycle value as 'January 2004'.

      c.   Select Fields - In this case selection must be 'ALL FIELDS'.
      d.   Select Meter(s) - In this case only ONE Meter number is to be checked.

e. Now, after setting up at (b), (c) and (d) press 'Show Report' command button.

The above procedure will fetch and Display ALL FIELDS of the Selected Meter of Bill Cycle 'January 2004'.

2.   VIEWING SELECTED FIELDS OF ONE RECORD

Follow the procedure given below in sequence:

a. Run the Application and go to Report Section.
b. Select the presentation period. (In this case 'FROM' and 'TO' dates will be same) e.g.

    FROM   -> January 2004
    TO   -> January 2004

This setting will search for a bill having Bill Cycle value as 'January 2004'.

c. Select Fields - In this case you must not select 'ALL FIELDS'. However, you have the following other options for selection:

  ➢ Units Consumed
  ➢ Total Bill
  ➢ Units Consumed(Industrial)
  ➢ Units Consumed(Domestic)
  ➢ Contract Demand
  ➢ Total Hours
  ➢ Production
  ➢ Maximum Demand
  ➢ Transformer Loading
  ➢ Power Factor
  ➢ Demand Penalty
  ➢ Load Factor
  ➢ Transformer(s) kVA
  ➢ Specific Energy Consumption

    d. Select Meter(s) - In this case only ONE Meter number is to be checked.

    e. Now, after setting up at (b), (c) and (d) press 'Show Report' command button.

The above procedure will fetch and Display SELECTED FILEDS of the Selected Meter of Bill Cycle 'January 2004'.

3. VIEWING RECORDS OF SELECTED METER(S) OF A SET PERIOD

Follow the procedure given below in sequence. Take an example of Finding all records of 3 Selected Meters for the period between April 2003 and March 2004.

    a. Run the Application and go to Report Section.

    b. Select the presentation period. (In this case 'FROM' and 'TO' dates will be different) e.g.

        FROM   ->   April 2003
        TO   ->   March 2004

This setting will search for all bills having Bill Cycle value between 'April 2003' and 'March 2004'.

    c. Select Fields - In this case our selection must be 'ALL FIELDS'.

    d. Select Meter(s) - Select Meter(s) by checking the squares just before the meter numbers in the meter list display box. Any number of meter(s) can be checked (In this case of the example only 3 meters are to be checked).

    e. Now, after setting up at (b), (c) and (d) press 'Show Report' command button.

The above procedure will fetch and Display SELECTED FILEDS of the 3 selected Meters of Bill Cycle from 'April 2003' to 'March 2004'.

4.   VIEWING SELECTED FIELDS OF SELECTED METER(S) OF A SET PERIOD

Follow the procedure given below in sequence:

Take an example of Finding all records of 2 Selected Meters for the period between May 2003 and July 2003.

- a. Run the Application and go to Report Section.
- b. Select the presentation period. (In this case 'FROM' and 'TO' dates will be different) e.g.

  FROM   ->   May 2003
  TO   ->   July 2003

This setting will search for all bills having Bill Cycle value between 'May 2003' and 'July 2003'.

- c. Select Fields - In this case you must not select 'ALL FIELDS'. However, you have the following other options for selection:

  - ➢ Units Consumed
  - ➢ Total Bill
  - ➢ Units Consumed(Industrial)
  - ➢ Units Consumed(Domestic)
  - ➢ Contract Demand
  - ➢ Total Hours
  - ➢ Production
  - ➢ Maximum Demand
  - ➢ Transformer Loading
  - ➢ Power Factor
  - ➢ Demand Penalty
  - ➢ Load Factor
  - ➢ Transformer(s) kVA
  - ➢ Specific Energy Consumption

Select Fields as per your requirement.

d. Select Meter(s) - Select Meter(s) by checking the squares just before the meter numbers in the meter list display box. Any number of meter(s) can be checked (In this case of the example only 2 meters are to be checked).

e. Now, after setting up at (b), (c) and (d) press 'Show Report' command button.

The above procedure will fetch and Display SELECTED FILEDS of the Selected Meters of Bill Cycle between 'May 2003' and 'July 2003'.

O.   VISUAL DISPLAY OF ENERGY BILL ANALYSIS RESULTS

You can come to this section through the main menu option 'Presentation and Graphical Display' and then pressing the menu item 'Chart Section' or the command button at the lower left part of the 'Report Presentation Interface'.

The following chart options based on PERIOD, FIELD and METER are available in this program for visual display:

1.   SF/SM/12M (Trend - Twelve months One Meter Data)
2.   SF/MM/Pd-TT (Trend - Multiple Meters for Given Period)
3.   MF/MM/1M-SY (Sharing - Multiple Meters Same Month)
4.   SF/SM/1M-DY (Comparison - Same Month of two Years)
5.   SF/SM/DY-TT (Comparison - Same field in different Years

1. **SF/SM/12M (Trend - Twelve months One Meter Data)** - This option stands for display of 'Single Field', 'Single Meter' and a 'Period' of 12 months.

In this option one can view monthly trend of Energy Bill (or any other field listed below) of a particular energymeter for a period of 12 months. It may be noted that the selection of period 'From'

- 'To' be done carefully with the help of combo boxes of 'From' and 'To' sections.

If the selected period is less than 12 months then Trend of only the selected months will be displayed. However, if the selected period is more than 12 months then the graphical display will start from 'From' date and continue upto the next 11 months. In other words, selection beyond 12 months will not be displayed.

In the similar way, user can view the graphical display of the following 'Fields':

- **Tot. Bill** (Monthly Bill Amount)
- **Units Cons.** (Units Consumed)
- **Units Indus.** (Industrial Units)
- **Units Dom.** (Domestic Units)
- **Cont. Demand** (Contract Demand in kVA)
- **Tot. Hours** (Total Hours of power supply)
- **Production** (Coal Production in Te)
- **MD** (Maximum Demand in kVA)
- **% Tr. LOading**(Percentage Transformer loading)
- **PF** (Power Factor)
- **Penalty_Dmd** (Penalty due to over drawal of power)
- **LF** (Load Factor)
- **Trans_kVA** (Sum of Transformers kVA)
- **Sp.Cons**. (Specific Energy Consumption)

Process: In the graphics section:
> - Open Menu item 'Chart Options'
> - Select Option-1 (SF/SM/12M)
> - Select 1-Field from 'Select Fields' section
> - Select 1-Meter from 'Select Meter(s)' section
> - Set 'From' date to 'January 2004' or other
> - Set 'To' date to 'December 2004' or other

Now, Press the command button 'Show Chart'.

2. **SF/MM/Pd-TT (Sharing - Multiple Meters for Given Period) -** This option stands for display of 'Single Field' of 'Multiple Meters' for any set *Period's* cumulative data.

In this option one can view trend/ share of Energy Bill (or any other field listed below) of a one or more energymeters for set period of any number of months.

The display screen will indicate the meter ID numbers and in bracket of each ID the cumulative value of Energy Bill amount (or as the case may be) will be indicated in *Bar Chart* mode of view. These values will be shown as percentage share in case if *Pie Chart* mode of view. One should see that the change from cumulative value to percentage takes place only on pressing the *Show Chart* command button.

In the similar way, user can view the graphical display of the following 'Fields':

- **Tot. Bill** (Monthly Bill Amount)
- **Units Cons.** (Units Consumed)
- **Units Indus.** (Industrial Units)
- **Units Dom.** (Domestic Units)
- **Cont. Demand** (Contract Demand in kVA)
- **Tot. Hours** (Total Hours of power supply)
- **Production** (Coal Production in Te)
- **MD** (Maximum Demand in kVA)
- **% Tr. LOading**(Percentage Transformer loading)
- **PF** (Power Factor)
- **Penalty_Dmd** (Penalty due to over drawal of power)
- **LF** (Load Factor)
- **Trans_kVA** (Sum of Transformers kVA)
- **Sp.Cons**. (Specific Energy Consumption)

It is important to note here that the display with fields as *Cont. Demand, MD, PF, LF and Sp. Cons.* may not be meaningful analysis.

Process: In the graphics section:

- Open Menu item 'Chart Options'
- Select Option-2 (SF/MM/Pd-TT)
- Select 1-Field from 'Select Fields' section
- Select Meter(s) from 'Select Meter(s)' section
- Set 'From' date to 'January 2004' or other
- Set 'To' date to 'December 2004' or other

Now, Press the command button 'Show Chart'.

3.   **MF/MM/1M-SY (Sharing - Multiple Meters Same Month)** - This option stands for display of 'Multiple Fields', 'Multiple Meters' and a 'Period' of 1 month of the same year.

In this option one can view sharing of Energy Bill (and/or any other field listed below) of one or more than one energymeter for same month of a year. It may be noted that in this selection only the period 'From' date is enabled. This is to avoid any mistake in selection because only one moth and year is to be selected in this case.

This option is useful for viewing graphical display of values of one or more fields of different meters for a particular month. Suppose we want to view the energy consumption by different meters in the month of February 2003. To find this follow the process below:

Process: In the graphics section:

- Open Menu item 'Chart Options'
- Select Option-3 (MF/MM/1M-SY)
- Select one or more Fields from 'Select Fields' section
- Select Meter(s) from 'Select Meter(s)' section
- Set 'From' date to 'January 2004' or other

Now, Press the command button 'Show Chart'.

In the similar way, user can view the graphical display of the following 'Fields':

- **Tot. Bill** (Monthly Bill Amount)
- **Units Cons.** (Units Consumed)
- **Units Indus.** (Industrial Units)
- **Units Dom.** (Domestic Units)
- **Cont. Demand** (Contract Demand in kVA)
- **Tot. Hours** (Total Hours of power supply)
- **Production** (Coal Production in Te)
- **MD** (Maximum Demand in kVA)
- **% Tr. LOading**(Percentage Transformer loading)
- **PF** (Power Factor)
- **Penalty_Dmd** (Penalty due to over drawal of power)
- **LF** (Load Factor)
- **Trans_kVA** (Sum of Transformers kVA)
- **Sp.Cons**. (Specific Energy Consumption)

4. SF/SM/1M-DY (Comparison - Same Month of two Years) - This option stands for display of 'Single Field', 'Single Meter' and any 'one month of two different years'.

In this option one can view comparison of one field say, Energy Bill, or any other field listed below, of a particular energymeter for a particular month in two different years. It may be noted that on selecting this option the month value in 'To' date section disappears and the only choice left in this 'To' section is selection of 'year' only. This has been done to avoid any human error in selection. 'From' section may be used to select the month of a year as usual.

Suppose we want to view the energy consumption in the same month and same meter in two different years. To find this follow the process below:

Process: In the graphics section:

- Open Menu item 'Chart Options'
- Select Option-4 (SF/SM/1M-DY)
- Select a Field from 'Select Fields' section
- Select a Meter from 'Select Meter(s)' section
- Set 'From' date to 'January 2004' or other
- Set 'To' date to '2005' or other

Now, Press the command button 'Show Chart'.

In the similar way, user can view the graphical display of the following 'Fields':

- **Tot. Bill** (Monthly Bill Amount)
- **Units Cons.** (Units Consumed)
- **Units Indus.** (Industrial Units)
- **Units Dom.** (Domestic Units)
- **Cont. Demand** (Contract Demand in kVA)
- **Tot. Hours** (Total Hours of power supply)
- **Production** (Coal Production in Te)
- **MD** (Maximum Demand in kVA)
- **% Tr. LOading**(Percentage Transformer loading)
- **PF** (Power Factor)
- **Penalty_Dmd** (Penalty due to over drawal of power)
- **LF** (Load Factor)
- **Trans_kVA** (Sum of Transformers kVA)
- **Sp.Cons**. (Specific Energy Consumption)

5. **SF/SM/DY-TT (Comparison - Same field in different Years) -** This option stands for display of 'Single Field', 'Single Meter' and any 'two different years'.

In this option one can view comparison of one field say, Energy Bill (*Total of the selected years*), or any other field listed below, of a particular energymeter in two different years. It may be noted that on selecting this option the month values in both 'From' and 'To' date sections disappear and choice left are selection of 'Years' only. This has been done to avoid any human error in selection.

Suppose we want to view the energy consumptions by the same meter in two different years. To find this follow the process below:

Process: In the graphics section:

   - Open Menu item 'Chart Options'
   - Select Option-5 (SF/SM/DY-TT)
   - Select a Field from 'Select Fields' section
   - Select a Meter from 'Select Meter(s)' section
   - Set 'From' date to '2004' or other
   - Set 'To' date to '2005' or other

Now, Press the command button 'Show Chart'.

In the similar way, user can view the graphical display of the following 'Fields':

- **Tot. Bill** (Monthly Bill Amount)
- **Units Cons.** (Units Consumed)
- **Units Indus.** (Industrial Units)
- **Units Dom.** (Domestic Units)
- **Cont. Demand** (Contract Demand in kVA)
- **Tot. Hours** (Total Hours of power supply)
- **Production** (Coal Production in Te)
- **MD** (Maximum Demand in kVA)
- **% Tr. LOading**(Percentage Transformer loading)
- **PF** (Power Factor)
- **Penalty_Dmd** (Penalty due to over drawal of power)
- **LF** (Load Factor)
- **Trans_kVA** (Sum of Transformers kVA)
- **Sp.Cons**. (Specific Energy Consumption)

ELECT 7.07   *SofexIndia*

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Third Edition September 2004

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S A V E   E N E R G Y
USE MOST ECONOMICAL CONDUCTOR IN YOUR SYSTEM

SOME OF OUR SOFTWARES

Elect 7.00 Software deals with Electrical Engg. of Overhead Transmission lines and Selection of Most Economical Conductor. Unique software for Energy Audit.

AliView is useful for viewing all types of images, creating animations, obtaining image information etc. etc.

Multimedia player, useful for playing sound files of any format, video files like dat and avi etc., Shockwave files etc. etc

Address Book 'Pataa Saaz' is a database, useful for family persons with individual Address Book for each with password facility, FIND facility etc. etc.

Calendar: 200 years HIJRI and Gregorian Calendar from 1900-2100.

Happy Birthday program. If installed, will wish respective persons on their Birthday.

Happy Wedding Anniversary program. If installed, will wish respective couples on their Wedding Anniversaries.

Cable Selection Software deals with selection of most suitable cable for a specific purpose. Unique software for Energy Audit.

File Navigator, useful for music lovers, video and audio editors, business personnel etc. Database of Songs and other information can be created and located afterwards at ease.

Loan Calculator. Small program for your day to day use for finding interest, EMI, duration etc. of a loan.