VALUE ANALYSIS

FLUORESCENT BALLAST CAPACITOR

Compiled By:

D. P. Barlow
November 3, 1950
Mr. L. D. Miles  
Value Analysis Division  
Purchasing Department  
Schenectady

Dear Larry:

Following your instructions, we have compiled herein our Value Analysis Report on the type 49FL Fluorescent Ballast Capacitor.

Using Value Analysis methods we have attacked the problem of cost reduction in this capacitor. We started by obtaining every pertinent fact obtainable and, with this information, the capacitor was broken into basic components for detailed consideration. The important foil and paper problems were analyzed and help was obtained from our Laboratories and from Vendors.

The container was then attacked and we sought answers for, "Was it worth the money?"; "Did it have proportional cost in relation to other parts?"; "Can a usable container be obtained at lower cost?" We went to specialists for every answer.

New types of capacitors were investigated and so were every variation of the present capacitor. Our results are recorded on the following pages.

We sincerely thank all those who have helped:

Mr. L. E. Gregory--Ft. Edward  
Mr. C. G. Montgomery--Ft. Edward  
Mr. M. Scoville--Pittsfield  
Mr. J. D. Stacey--Pittsfield  
Mr. W. D. Solberg--Pittsfield  
Mr. R. Russetta--Pittsfield  
Mr. F. M. Clark--GE&CL  
Mr. H. Rudoff----GE&CL  
Mr. D. A. Lupfer--GE&CL  
Mr. C. Doyle------GE&CL  
Mr. J. Helies--Mfg. Policy  
Mr. R. J. Bondley--Research Lab  
Mr. W. C. Buck--Purchasing  
Mr. G. E. Collins--Purchasing  
Mr. H. L. Schnell--Purchasing  
Mr. S. P. Skalski--Purchasing  
Mr. A. H. Uгла---Purchasing  
Mr. L. D. Miles--Value Analysis  
Mr. F. D. Nicol--Value Analysis  
Mr. E. C. Hovey--Value Analysis

This report on the capacitor is substantially finished except for some additional information which is being compiled. This will be added to the report upon completion.
If additional information is desired, we will supply the information upon your request.

Thank you very much, Larry, for the privilege of working for you on this report.

PURCHASING DEPARTMENT

D. P. Barlow
Value Analysis Division
After completing our Value Analysis of Ballast Capacitors, we find that a "Plug In" Capacitor shows the most promise. The following pages show its proposed construction and possible savings.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
November 1950

DPB: ARM
"PLUG IN" CAPACITOR

The ballast capacitor which must be kept cool, is mounted next to hot reactors, in potting compound, and enclosed in a steel case.

To keep the ballast capacitor cool, we propose to mount it external to the ballast and save some of the potting compound and steel of the case.

To make the maximum utilization of all components of an externally mounted capacitor, we suggest the "Plug In" Capacitor design shown on the following pages.

It is to be a plug in capacitor because it is easy to attach to the ballast. The terminals are like those of a radio tube and can be dip soldered. The socket to hold the capacitor is mounted in one end of the ballast and is just a portion of a large socket or junction board which also holds the external connections for the ballast. (This junction board suggestion was made in our Value Analysis Report on the Fluorescent Lamp Ballast by L. H. Gottlieben.)

The suggested manufacture of our proposed "Plug In" capacitor is as follows. The foil and paper are wound on a smaller mandrel but in a manner similar to that used at present except that the top straps are inserted at the beginning of each winding to take advantage of the new shorter and wider conductor. The completed capacitor roll is electrically tested and then is inserted into the new long case. The plastic cover with its molded inserts is coated around the edge with a resin adhesive; then is put in place with the top strap extending through the hollow terminals. The edge of the case is then rolled down giving a tight mechanical fit to the cover.

The capacitor is now started on its standard pyranol treatment cycle. The initial bake out, cures the adhesive and gives the plastic a hermetic seal. The pyranol enters the capacitor through the space around the top strap in the hollow terminals and not through an extra fill hole. On completion of the treating cycle, the terminals are dip soldered and the capacitor is now ready for electrical and base deflection test.

The following pages show the planned saving of our proposed capacitor from which we too can expect better performance.
Resin Adhesive

Capacitor Roll

Plastic Cover

Dip Solder Terminals (Molded Inserts)

Note #1—Pyranol enters the container through the hollow terminals. The seal is then completed by dip soldering the terminals.
Kraft Capacitor Paper
(A1A5 A)

Present Proposed

Present Cost .0005" x 1.75 x 93' $8.35
Proposed Cost .0004" x 5.25 x 28.1' $6.85

Proposed Reductions

Cost/C $1.50

COMMENTS:

The use of thinner capacitor paper may be justified by the increase in heat dissipation which is possible because of the smaller diameter, extra length, and external mounting.

The reduction in cost is due to the increase in capacity with thinner paper and the decrease in selvage which is proportional to length of the paper.

Many other advantages are to be obtained in making the proposed "Plug In" capacitor. The winding time per capacitor is reduced because the number of turns are reduced 50% and the wider paper allows a faster winding speed. The present roll of paper will wind four times as many capacitors without the reloading of the winding machine and this can be increased because the wider roll lends itself to larger diameter rolls.

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VALUE ANALYSIS DIVISION
October 27, 1950

DPI: AEM
Present Reductions

<table>
<thead>
<tr>
<th>Present</th>
<th>Planned</th>
<th>Cost/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00025 x 1.5&quot; x 92'</td>
<td>.00025 x 5&quot; x 22'1&quot;</td>
<td>$6.30</td>
</tr>
</tbody>
</table>

Planned Reductions

**COMMENTS:**

The planned saving is due to the decrease in area resulting from the use of thinner dielectric and due to the elimination of the size extra for the present 1.5 inch width.

Four times as many capacitors can be wound because of the decreased length of foil. The winding time can be reduced because the foil is over three times as wide. The diameter of rolls may be increased to further reduce the time lost due to reloading.

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October 27, 1950

DPE: AEM
The plug-in capacitor requires a flat strap for foil contact and a round lead for insertion into the dip solder terminal. We suggest the flattening of a portion of the length of circular wire be used to meet these requirements. This will eliminate the higher material cost or the special flat conductor and substitute standard tinned copper wire. With proper machine design, the cost of the strap should not be greater than present cost.
Insulation
9267345-22

Cost/C

<table>
<thead>
<tr>
<th>Material</th>
<th>Labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>$.05</td>
</tr>
<tr>
<td>Std. Shop Cost</td>
<td>$.095</td>
</tr>
<tr>
<td>Planned Cost</td>
<td>.15</td>
</tr>
<tr>
<td>Planned Saving</td>
<td>.00</td>
</tr>
</tbody>
</table>

We believe the 1/8" width of kraft paper which extends beyond the foil is sufficient to insulate the conductors from the case and an extra piece of paper will not be necessary. An investigation will have to be made to determine if the paper can be eliminated or if the paper is necessary or if the 1/8 inch extrusion can be reduced and a saving of kraft paper be made.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
November 1950

DPB: ABM
The number of turns per capacitor is reduced 50% and the increased width allows faster speeds in winding. The winding machine down time is reduced because four times as many capacitors can be wound for a roll of the present diameter and this factor can be increased if rolls of larger diameter are used. The wider rolls make the use of rolls of larger diameter feasible.
This slight increase in cost of the case is necessary to obtain the cost advantages of the "Plug-In" Capacitor. The proposed case is made by impact extruding aluminum. The aluminum case provides the corrosion protection that is necessary for the capacitor when mounted external to the ballast. The tooling charge is $1800.00 and set-up charge is $35.00 for less than 25,000 pieces. Detailed sketch on the next page.

ADDENDUM

In recent correspondence, the vendor quotes on the similar containers with different diameters as follows:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Cost/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; O. D.</td>
<td>$3.22/C</td>
</tr>
<tr>
<td>1-1/8&quot; O. D.</td>
<td>$3.34/C</td>
</tr>
</tbody>
</table>

The set-up charge for quantities less than 25,000 is $35.00. For these there will be no tooling charge. The final design of the "Plug In" Capacitor can make use of these standard sizes and save the tooling charge.
CROSS SECTION

5 9/16

1 3/32 ID

1 ID

1/4

(a) Impact Aluminum Extrusion
(b) .015 Wall
(c) Closed end is concave to compensate for expansion and contraction of dielectric with temperature

END VIEW
Assembled Cover
9532121-9

Present Cost

<table>
<thead>
<tr>
<th>Material</th>
<th>Material Cost/C</th>
<th>Labor Cost/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>$.94</td>
<td>$.076</td>
</tr>
<tr>
<td>Degrease Cover &amp; Hdwe</td>
<td>.02</td>
<td>.134</td>
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<tr>
<td>Plate Cover</td>
<td>.03</td>
<td>.095</td>
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<tr>
<td>Insulation</td>
<td>2.84</td>
<td>.095</td>
</tr>
<tr>
<td>Bushing (200)</td>
<td></td>
<td>.053</td>
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<tr>
<td>Loading</td>
<td></td>
<td>.220</td>
</tr>
<tr>
<td>Assemble</td>
<td></td>
<td>.935</td>
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<tr>
<td>Weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Material</td>
<td>.04</td>
<td></td>
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</tbody>
</table>

 Std. Shop Cost -- $7.49

Planned Cost

Plastic Cover in lots of 100
Inserts (200)

Planned Saving

Mold Cost--$4,800.00

COMMENTS:

The above cost for plastic covers has been tentatively quoted by our Plastic group at Pittsfield. Investigation must be made into the method of sealing the plastic to the metal case. For this there are several adhesives that may give the desired seal but life tests must be made to guarantee a satisfactory seal.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
Assemble Complete

<table>
<thead>
<tr>
<th></th>
<th>Cost/C</th>
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</thead>
<tbody>
<tr>
<td>Present Labor Cost</td>
<td>$3.19</td>
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<tr>
<td>Planned Labor Cost</td>
<td>$2.50</td>
</tr>
<tr>
<td>Planned Saving</td>
<td>$0.69</td>
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</tbody>
</table>

**COMMENTS:**

The new dip solder terminals eliminate the welding of the top straps to the terminal bushings. The former double roll of the cover to case is eliminated in favor of a single roll of the case edge over the plastic cover to give it a mechanical seal.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
November 1950

DPB: AFM
Pyranol 1499

<table>
<thead>
<tr>
<th></th>
<th>Cost/C</th>
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<tbody>
<tr>
<td>Present Cost</td>
<td>$3.39</td>
</tr>
<tr>
<td>Planned Cost</td>
<td>1.66</td>
</tr>
<tr>
<td>Planned Saving</td>
<td>$1.73</td>
</tr>
</tbody>
</table>

COMMENTS:

The decrease in amount of foil and paper and the use of a case of smaller volume reduces the required amount of pyranol by 51%.

PURCHASING DEPARTMENT VALUE ANALYSIS DIVISION
November 1950

DPB: AEM
Degreasing Material  
D5B56A  
Tri-Clene D.

<table>
<thead>
<tr>
<th>Material Cost/€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Cost</td>
</tr>
<tr>
<td>Planned Cost</td>
</tr>
<tr>
<td>Possible Reduction</td>
</tr>
</tbody>
</table>

Saving -- $820/year

Concluding ENTS:

The degreasing material is purchased at present in drums in carload lots. The proposed material cost saving may be had by purchasing the material in tank cars. We believe the savings in handling would more than offset the cost of the required equipment.

PURCHASING DEPARTMENT  
VALUE ANALYSIS DIVISION  
October 26, 1950

DPB: AFM
PYRANOL CAPACITOR

The following pages suggest sources of possible saving in the manufacture of the present pyranol capacitor design.
Considering the low raw material cost of these parts, it is believed that a possible saving may be obtained if we make the parts ourselves. Mr. John Helies of the Manufacturing Policy Group was shown our problem and is considering the feasibility of making this container and also similar containers for other capacitors. They are presently contacting tool and machining designers for quotations on the necessary equipment.

Purchasing Department
Value Analysis Division
October 27, 1950

DPB: AEM
Pyranol is purchased from the Monsanto Chemical Company who, until December 1949, were the sole vendors because of a patent situation.

Our buyers in the Purchasing Department have contacted vendors interested in supplying Pyranol. The Korean situation has interrupted negotiations because of raw material shortages.

When the raw materials become more plentiful, competition in the supplier field should lower the cost.
CAPACITORS OTHER THAN THE PYRANOL TYPE

In our investigation of the Ballast Capacitor, many types of capacitor were considered other than the present pyranol type.

The following pages give a brief summary and suggestions for each type. As you will note on reading our report on these different types of capacitors, the voltage rating generally must be raised.

If the required 285 volts were lowered to 220 volts, many of these different types could be used satisfactorily in their present state of development. An increase in capacity from 4 mfd to 5 mfd would compensate for the decrease in voltage. The use of a lower voltage capacitor means the redesigning of the ballast but the capacitor can be obtained at lower cost.

This problem should be investigated thoroughly because the results look promising.
Paper foil capacitor rolls can be impregnated with Permafil and baked to give a solid dielectric capacitor. The Capacitor Engineering Division at Pittsfield is ready to market this Permafil impregnated capacitor with a 250 volt a.c. rating which is a little less than the 285 volt a.c. rating required for our ballast applications. Capacitors with higher rating are now on life test.

Because of higher temperature ratings, the 3% power factor rating is not a serious drawback for this application.

Permafil capacitors will stand high temperatures but very low temperature cycling will crack the resin. The Permafil capacitor can eliminate the case, cover, terminals, and much of the labor which now makes up 40% of the present capacitor cost. This saving will offset the higher Permafil cost.

With further development to raise the voltage rating and to make the Permafil crack-resistant in low temperature cycling, a Permafil capacitor may be produced in large quantities by the following suggested schedule.

a. The capacitor, after winding and dry test, is placed in a multi-cavity mold.

b. The roll is dried by baking under vacuum.

c. The roll is impregnated with Permafil and baked.

d. The result is a capacitor whose solid dielectric is its container.

e. After electrical testing and labeling, the capacitor is boxed for shipping.

The estimated cost of this capacitor is equal to the present capacitor cost. The development of the Permafil capacitor should continue at an accelerated pace and techniques for manufacturing must be worked out because the cost of Permafil should decrease as it becomes more in demand and the Korean situation is eliminated. This should, in the future, result in a capacitor of lower cost than our present ballast capacitor.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
October 27, 1950

DPB: AEM
EPOXY CAPACITORS

Epoxy resin adhesives have been used as a dielectric im-
pregnant for paper-foil capacitors. The results obtained by
Mr. W. M. Clark of the Insulation Division of the G. E. Lab-
oratory have been very encouraging. Some epoxy resins have a
much lower shrinkage on curing which reduces voids and permits
voltage ratings above 220 volts a.c., the corona point. Some
of the resins have high power factor but some have a power fac-
tor less than .8% even up to a temperature of 100°C. Because
of the highly viscous resin and fast curing, new methods of
impregnation must be developed to take full advantage of these
epoxy characteristics.

Estimated capacitor cost in large-quantity production is
20% higher than the cost of the present ballast capacitor.
Probable reduction in epoxy resin cost will put the Epoxy Ca-
pacitor in competition with the pyranol ballast capacitor.

An analysis of resin impregnated capacitors such as Per-
mafil and Epoxy has indicated there is much promise in this
field and development must be accelerated.

The results might be a better capacitor at lower cost.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
October 27, 1950

DFB:AEM
Permalytic capacitors have been developed which are one-third the present size, one-third the present cost, but have a voltage rating of 220V a.c. and power factor of 3 to 4%.

A Permalytic capacitor is an impregnated paper dielectric capacitor. The impregnant is a semi-conducting liquid whose specific resistance is chosen to give a marked decrease in power factor.

This is a new principle in capacitor design and with basic research to raise the voltage rating, a ballast capacitor might be manufactured at a very large saving.

Purchasing Department
Value Analysis Division
October 27, 1950

DPB: ABM
Nitro-Clor-Di-Phenyl Capacitor

By replacing the present pyranol dielectric with nitro-clor-di-phenyl, a ballast capacitor may be manufactured that is one-half the present size, two-thirds the present cost, have a voltage rating of 440 volts and a power factor of .5%.

In the past, the use of this dielectric was not practical because of chemical reactives which increased the power factor. This disadvantage has been largely overcome by the use of chemical stabilizers. These stabilizers enter into the reactive and eventually are completely used. This allows the power factor to increase.

From our investigation we believe a nitro-clor-di-phenyl capacitor with its stabilizers can be utilized as a ballast capacitor. The power factor will increase eventually but failure will not occur in many years.

The nitro-clor-di-phenyl will save in money and size.

PURCHASING DEPARTMENT
VALUE ANALYSIS DIVISION
October 27, 1950

DPB: AFM
The use of high dielectric ceramics in capacitor construction permits a large capacity to be contained in a small package. The material cost is low but the present manufacturing cost is very high.

High dielectric ceramic capacitors are being used more and more in radio work because of their small size, low power factor, and high voltage rating. For power frequencies as 60 c.p.s. the various ceramics have their limitations due to non-linearity of power factor, and of capacity, with temperature variations but, in many cases, the non-linearity will fall outside the range of requirements for ballast capacitors.

Techniques have been developed to manufacture the ceramic in the desired size sheets but more work must be done to develop a suitable method of assembly into a capacitor. Such an assembly may be similar to the type used in present mica capacitor construction.

The present cost is too high but research should be encouraged in this field. The results can be a capacitor small in size and of less cost than the present ballast capacitor.
SUPPLEMENT FOR THE CONVENIENCE OF THOSE NOT FAMILIAR WITH THE BALLAST CAPACITOR PROGRAM WHO WISH TO PERUSE THIS REPORT.

Annual Production
This particular capacitor 2,000,000
All ballast capacitors (approx.) 10,000,000

Suggested Cost Reductions By Using The Plug In Capacitor
(Based on the standard shop cost)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kraft Paper</td>
<td>1.50¢</td>
</tr>
<tr>
<td>Foil</td>
<td>1.67¢</td>
</tr>
<tr>
<td>Insulation</td>
<td>.15¢</td>
</tr>
<tr>
<td>Winding</td>
<td>1.23¢</td>
</tr>
<tr>
<td>Cover</td>
<td>3.89¢</td>
</tr>
<tr>
<td>Assembly</td>
<td>.69¢</td>
</tr>
<tr>
<td>Pyranol</td>
<td>1.73¢</td>
</tr>
<tr>
<td>Degrease Material</td>
<td>.04¢</td>
</tr>
<tr>
<td>Case (increase cost)</td>
<td>10.95¢</td>
</tr>
<tr>
<td></td>
<td>.20¢</td>
</tr>
</tbody>
</table>

POSSIBLE SAVING $200,000 per year

Not included in these items are the alternate suggestions some of which overlap but which would produce greater reduction.

VALUE ANALYSIS DIVISION
PURCHASING DEPARTMENT
November 3, 1950

DPB: AEM