Q. [ELG] – Please provide the complete section of Iowa Engineering Experimental Station, Bulletin 155 (1942) including at least page 71 relating to the reference by Robley Winfrey that ELG is the only mathematically correct procedure, as referenced on page 3 of Mr. Wiedmayer's rebuttal testimony.

A. Attachment A contains the section of Bulletin 155 in which author Robley Winfrey states that ELG is the only mathematically correct procedure.

Attachment B contains an excerpt from the National Association of Regulatory Utility Commissioners' (NARUC) *Public Utility Depreciation Practices - August 1996*, which also references Winfrey's quote.

Excerpt from
Iowa Engineering Experiment Station
Bulletin 155 (1942)

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BULLETIN 155 1942

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Depreciation of Group Properties

By
ROBLEY WINFREY

IOWA ENGINEERING EXPERIMENT STATION
BULLETIN 155
1942

THE IOWA STATE COLLEGE BULLETIN
AMES, IOWA

the unit based upon units of service rather than upon depreciable value as condition percent was previously defined. The service condition percent is identical with condition percent based upon depreciable value when the straight-line method is used. As shown by Eq. 24, when $r=0$,

$$\frac{(1+r)^n-(1+r)^x}{(1+r)^n-1}=\frac{n-x}{n}$$

This indicates that for *one unit of property* there is only one possible ratio of service factors that may be used to express present value.

The original group of case 2 offers more possibilities since average life must be considered in addition to the other three factors. The ratios of expired and remaining service may be written:

$$A.\ \frac{\text{Age}}{\text{Probable life}},\quad B.\ \frac{\text{Expectancy}}{\text{Probable life}},\quad \text{and } C.\ \frac{\text{Expectancy}}{\text{Average life}}.$$

A ratio of age to average life cannot be used because at ages above those equal to average life the ratio exceeds unity. As before, A and B are equal if A is subtracted from unity. The expression C, however, is another measure of remaining value unlike that obtained from A or B and is considered in later analyses.

The same fundamental ratios may be applied to continuous properties of case 3, when proper consideration is given to the differences in ages of the units.

For a given case the ratios A and B may each vary when applied to a group of units of like age, depending upon whether the probable life of the average survivor at a given age or the average of the probable lives of the survivors is used. In the first case the survivors are incorrectly considered as one unit, while in the latter case each surviving unit is correctly considered separately and each given its proper weight. The same is true of ratio C for the expectancy.

When considering groups of units instead of single units of property it is necessary to consider ratios B and C (ratio A may be reduced to ratio B) and two possible selections of the probable life (or expectancy). For a group of units of same age, three solutions exist:

1. The *average-life procedure* from ratio C, wherein the service base is chosen as the average life m of the group, and the variable factor which measures the remaining service is the average expectancy of the group.

2. The *probable-life procedure* from ratio B, wherein the probable life n is chosen as that for the average survivor of the group.

3. The *unit-summation procedure* from ratio B, wherein the probable life n is determined for each unit (or for the retirements of each age-interval), and the condition percent is then calculated for each retirement frequency group to find the weighted condition percent of the survivors.

The average-life procedure (1) results in the condition percent of the survivors measured in terms of the average life of the original group, rather than the probable lives of the survivors. The probable-life procedure (2) results in the condition percent of the average survivor which really is equivalent to considering all survivors as one unit. The unit-summation procedure (3), the only mathematically correct procedure, results in the average of the condition percents of the survivors because it considers separately each surviving unit.

Equations for the condition percent of the survivors of an original group for these three procedures are:

Average-life procedure,

$$C_x = 100\,\frac{(1+r)^m-(1+r)^{m-e}}{(1+r)^m-1} \qquad [54]$$

Probable-life procedure,

$$C_x = 100\,\frac{(1+r)^L-(1+r)^x}{(1+r)^L-1} \qquad [55]$$

Unit-summation procedure,

$$C_x = \frac{\sum_x^M 100\,\dfrac{(1+r)^n-(1+r)^x}{(1+r)^n-1}\,(f)}{\sum_x^M f = P} \qquad (56)$$

C_x = condition percent of survivors at age x.
r = rate of return, or rate of interest, expressed as a decimal.
m = average life of original group, years.
e = average expectancy of survivors at age x, years.
x = age of group (all survivors of same age), years.
L = average probable life of survivors (probable life of the average survivor) at age x, years.
n = probable life in years of a given unit at age x; each unit has its own probable life.
M = maximum life in years of group = age of last survivor.
f = frequency, or units retired during each 1-year-age interval.
P_x = survivors at age x.

The three equations above are special adaptations of the general equation,

$$C_p = 100\,\frac{(1+r)^n-(1+r)^x}{(1+r)^n-1}, \qquad [22]$$

derived for a single unit, in which n and x can have only one interpretation. When units are considered in groups, Eqs. 54, 55, and 56 may be used, although correct results are obtained only with Eq. 56.

The analysis on pages 21-27 shows that the straight-line assumption, the sinking-fund assumption, and the present-worth principle

Excerpt from
National Association of Regulatory Utility Commissioners
Public Utility Depreciation Practices
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History and Current Use of ELG

History of the ELG Procedure

The use of ELG was discussed as early as March 1938 during an ICC hearing.[3] Robley Winfrey studied ELG during the 1930s and called it the unit summation procedure. In 1942, Winfrey published a detailed discussion of the procedure in "Depreciation of Group Properties," Bulletin 155 and considered it "the only mathematical (SIC) correct procedure."[4]

The procedure was primarily of academic interest until the early 1970s when American Telephone and Telegraph filed a petition on September 23, 1973, requesting the FCC to amend its rules and regulations to allow the use of ELG for property placed in service after December 31, 1974. Following a public notice and comments, the FCC adopted its Report and Order (Docket No. 20188) on November 6, 1980. This Order, released on December 5, 1980, ordered the use of ELG for the telephone industry on new plant additions beginning in 1981 over a three-year phase-in period.

The ICC approved the use of ELG in the railroad industry in 1986. The ELG procedure approved by the ICC was based on whole-life techniques for use on all plant—both embedded investment and future additions. The use of the ELG procedure has not been approved by the Federal Energy Regulatory Commission (FERC) for use in the gas, oil, and electric industries.

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[3] "Telephone Engineer and Management," (1967), 55.

[4] Winfrey, R., *Depreciation of Group Properties*. Originally printed as "Bulletin 155," (Ames, Iowa: Engineering Research Institute, Iowa State University, 1942), 71.