

Subject 1978

December 22, 2017

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Grease Ducts, UL 1978, are being proposed:

1. Revisions to Clauses 11.1 and 12.5

STP BALLOTS AND ALL COMMENTS DUE: FEBRUARY 5, 2018

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

1. Revisions to Clauses 11.1 and 12.5

RATIONALE

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Requiring maximum conditions in a test standard, without providing examples or guidance, often leads to misunderstandings or misapplications, or both, of test data. There appears to be a technical paradox contained in Clause 11.1 and Clause 12.5 of UL 1978. Typically test methods either: [1] do not set conditions to the size of the test specimen; or [2] do require the worst-case test specimen be tested for use to qualify other conditions. Clause 11.1 and Clause 12.5 require two maximums to be tested. Therefore, it is presumed and inferred that other conditions would also be acceptable for use when these maximum conditions are tested.

UL 1978, Grease Ducts, makes two statements regarding horizontal grease duct sections related to the maximum grease duct cross-sectional size and the maximum width-to-height ratio. There are two types of ducts covered by UL 1978: elliptical and rectangular. Clause 11.1 and Clause 12.5 will be examined for application to elliptical and rectangular ducts. The Commenter from the recent UL 1978 reaffirmation ballot believes that the issue is far more complicated than currently presented. Further, the Commenter believes that the current text was developed based solely on round ducts and does not truly address all elliptical ducts and rectangular ducts.

General Observations – Suggest the following changes to Clause 11.1 because:

- [1] Round grease ducts are more stable than elliptical and rectangular grease ducts.
- [2] Elliptical grease ducts react differently to applied loads than rectangular grease ducts.
- [3] The current wording appears correct (using the maximum width-to-height ratio) for assessing round ducts.
- [4] The current wording implies that the maximum width-to-height ratio is also correct for assessing all other elliptical ducts.

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[5] The current wording implies that the maximum width-to-height ratio used for elliptical ducts applies equally to rectangular grease duct configurations.

[6] In some cases, the two maximum conditions, dimensions and ratios, stated are being construed as limitations.

The existing text, maximum grease duct cross-sectional size and the maximum width-to-height ratio, in Clause 11.1 may be, or may not be, correct for all elliptical and rectangular ducts. An elliptical duct, which would include a round duct, is normally defined as an ellipse with four quadrant Cartesian point symmetry, centered at the origin, with semi-major axis a , semi-minor axis b (refer to the Figure 1 in Supporting Documentation).

A rectangle is typically defined as a plane figure with four straight sides and four right angles, which would include a square shape.

Elliptical Ducts – In order to understand the application of these two maximum conditions various elliptical ducts should also be assessed to demonstrate that these two maximum conditions are references for assessing other ducts rather than limitations to approve other ducts. To demonstrate that these two conditions are not limitations, but rather assessment tools, consider the following elliptical ducts.

Consider the following elliptical steel ducts subjected to the same lateral longitudinal load and having the same wall thickness (refer to Figure 2 in Supporting Documentation):

- View A measures 36" wide by 36" high
- View B measures 36" wide by 9" high
- View C measures 36" wide by 18" high
- View D measures 9" wide by 36" high
- View E measures 9" wide by 18" high

The text in Clause 11.1 appears to have been created based on an ellipse. The following equation establishes the area as well as the width (a) and height (b) of an ellipse.

$$A = \pi ab$$

Where:

A = area

a = width

b = height

The Commenter believes that deflection has less to do with " a " and " b " ratio as currently stated and more to do with the eccentricity of the ellipse. The more eccentric an ellipse the more susceptible to deflection it becomes. "This is as expected: the more eccentric the ellipse, the greater the maximal deflection should be. Conversely, the closer the ellipse is to a circle, the closer the radial and normal directions will be, and so the smaller the maximal deflection will be."¹ Refer to The Maximal Deflection on an Ellipse² by Dr. Dan Kalman for information regarding deflection of an ellipse.

The following equation provides comparative maximum deflection values of an ellipse.

$$\sigma_{max} = a^2 - b^2/2ab$$

Where:

σ_{max} = Maximum Deflection

Configuration	Width (a)	Height (b)	σ_{max}
View A	36	36	0
View B	36	9	1.875
View A	36	18	0.75

Based on Dr. Kalman's equation, the round duct in View A deflects less than either elliptical duct in View B and C. Further, the larger elliptical duct in View C deflects less than the smaller elliptical duct in View B. If the maximum deflection (σ_{max}) was an absolute value it could be applied to View D and View E as well. However, when an elliptical grease duct is has height (b) greater than width (a) other considerations must be assessed.

Under current Clause 11.1 text, when "a" and "b" are equal then a circular duct with 1:1 ratio is created. A 36" diameter circular duct (1017.88 in²) with a 1:1 ratio, View A-A, is more resistant to deflection than any elliptical duct with a width (a) or height (b) of less than 36": View B and View C. Therefore, testing a circular duct limits the test results to other circular ducts having dimensions less than those tested but having the same ratio of 1:1. The current text in Clause 11.1 is sound science and correct for this particular assessment of round ducts.

Under current Clause 11.1 text, when testing an elliptical duct with dimension "a" greater than dimension "b", such as in View B and View C, would not approve a 36" diameter circular duct, View A, because View B and View C have a maximum allowed height (b) less than 36" even though the ratio of View A is 1:1 and less than View B and View C maximum ratios of 4:1 or 2:1, respectively. This is not sound science because the more eccentric the ellipse, the greater the maximum deflection should be. Technically, it appears that testing either View B or View C should also approve View A, which is more resistant to deflection, but they do not. Therefore, Clause 11.1 does not accurately apply to all elliptical ducts.

Since we are now discussing elliptical horizontal duct sections, the Commenter believes that using the following new proposed text will help resolve the existing incongruity and would not change the round duct sound science stated above. First, the larger dimension of an elliptical duct will always be the width (a) as in Views A, B, and C. Next, the elliptical duct's dimensions should be expressed as a minimum height-to-width ratio. This means that all elliptical ducts will have a height-to-width ratio of 1:1 or less. Using this new proposed text, View A's ratio remains the same at 1:1. Dr. Kalman's equation emphasizes that the closer the ellipse is to a circle, which has a ratio of 1:1, the smaller the maximum deflection will be. Using a minimum height-to-width ratio with the larger dimension as the width (a) accentuates this fact. Now the closer an elliptical duct's ratio is to a round duct's ratio of 1:1 the more resistant the elliptical duct is to deflection. However, View B would have a new ratio of 1:4 and View C would have a new ratio of 1:2. Therefore, testing View B would now allow use of View A and View C, which is consistent with Dr. Kalman's equation. This minimum height-to-width ratio is sound science because View B will deflect more than View A and View C. This new ratio expression will also avoid misunderstandings concerning less stable elliptical configurations in View D with a ratio of 4:1 and View E with a ratio of 2:1. Under the new ratio expression and limitation View D and View E configurations will not be allowed unless tested due to their stability issue.