ADDENDUM 4

REPORT ON CONTAINMENT BUILDING RING GIRDER CONSTRUCTION AND REPAIR

THREE MILE ISLAND NUCLEAR STATION

UNIT NO. 1

METROPOLITAN EDISON COMPANY

September 22, 1972

Addendum 4

INTRODUCTION

On December 3, 1971 Metropolitan Edison Company filed with the AEC a document entitled "Report on the Containment Building Ring Girder Construction and Repair." Addenda 1, 2, and 3 to that report have subsequently been filed with AEC. The information included herein as Addendum 4 is compiled in response to questions raised by DRL during the meeting held on September 7, 1972 in Bethesda, Maryland. These questions were raised to clarify Addendum 3 which was written in response to Docket No. 50-289.

TEXT

The horizontal ring girder construction joints at elevations 443 ft-0 in. and 446 ft-9 in. have been investigated for transfer of shear under load combinations including normal operation, initial prestress, accident, pressure test, seismic, wind, and aircraft impact. As originally constructed, the joints at these elevations extended horizontally across the entire ring girder section. Visual examination and core-borings as documented in Addendum 2 indicated that part of the joint extending in from the outside face of the ring beam was questionable for load transfer. The questionable areas of the joint have been completely excavated as shown in Figures 1, 2, and 3.

Visual and core-bore examinations confirm that the remainder of these horizontal joints left as originally placed is sound. The construction joints required for the replacement of concrete in the excavated areas (see Figures 1, 2, and 3), will be carefully prepared by green-cutting and other suitable methods to ensure that a sound construction exists prior to concrete placement. The repaired ring beam will perform its structural function as part of the reactor containment building as intended in the original design.

Due to the specialized nature of the problem discussed in Addendum 2 where bond at the joint is questionable, shear transfer is conservatively assumed to occur solely by friction under a normal compressive force. The effect of the diagonal reinforcing steel across the joint is disregarded for the analysis. The joints in the repaired areas, as well as the part of the original joints that were not excavated, are deemed to be completely adequate for transferring compressive forces. In Addenda 2 and 3, it has been shown that the net membrane compression for all load conditions is sufficient to transfer the shear across the joints by friction assuming an allowable coefficient of friction, $\mu=1$.

A conservative minimum factor of safety for shear transfer at elevations 443 ft-0 in. and 446 ft-9 in. for all load combinations except the aircraft impact load is two. The greatest coefficient of friction required for either elevation is $\mu=0.686$. This occurs at elevation 446 ft-9 in. for the Accident Load Combination (see Table 2 in Addendum 2). A coefficient of friction $\mu=1.0$ was allowed for the joints. This coefficient of friction is used in conventional shear friction theory. Based on the evaluation of the remainder of these joints left in the ring beam after the concrete removal and on the expected effectiveness of the repair, an ultimate coefficient of friction of 1.4 is reasonable. Two times the greatest required coefficient of friction, 0.686, is less than 1.4. Therefore, two is considered as the minimum factor of safety for shear transfer at these two horizontal joints.

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Addendum 3 should be clarified to reflect that the effect of Aircraft Impact Loading on the entire ring beam is generally small for the majority of the ring beam. Figures 4 and 5 indicate the required coefficients of friction to transfer shear at elevations 443 ft-0 in. and 446 ft-9 in. due to Normal Operation plus Aircraft Impact. The coefficients are conservatively derived using the greater of the in-plane shear or radial shear along with the normal force in the conventional friction equation $F=\mu N$.

From Figures 4 and 5 the required coefficients of friction are seen to be less than or equal to the allowable value of one. For the majority of the ring beam, the minimum factor of safety is still two under this load. However, for part of the ring beam where the required coefficient of friction is greater than 0.7 (the ultimate coefficient of friction 1.4 divided by a factor of safety 2 is equal to 0.7), the minimum factor of safety will be less than 2.

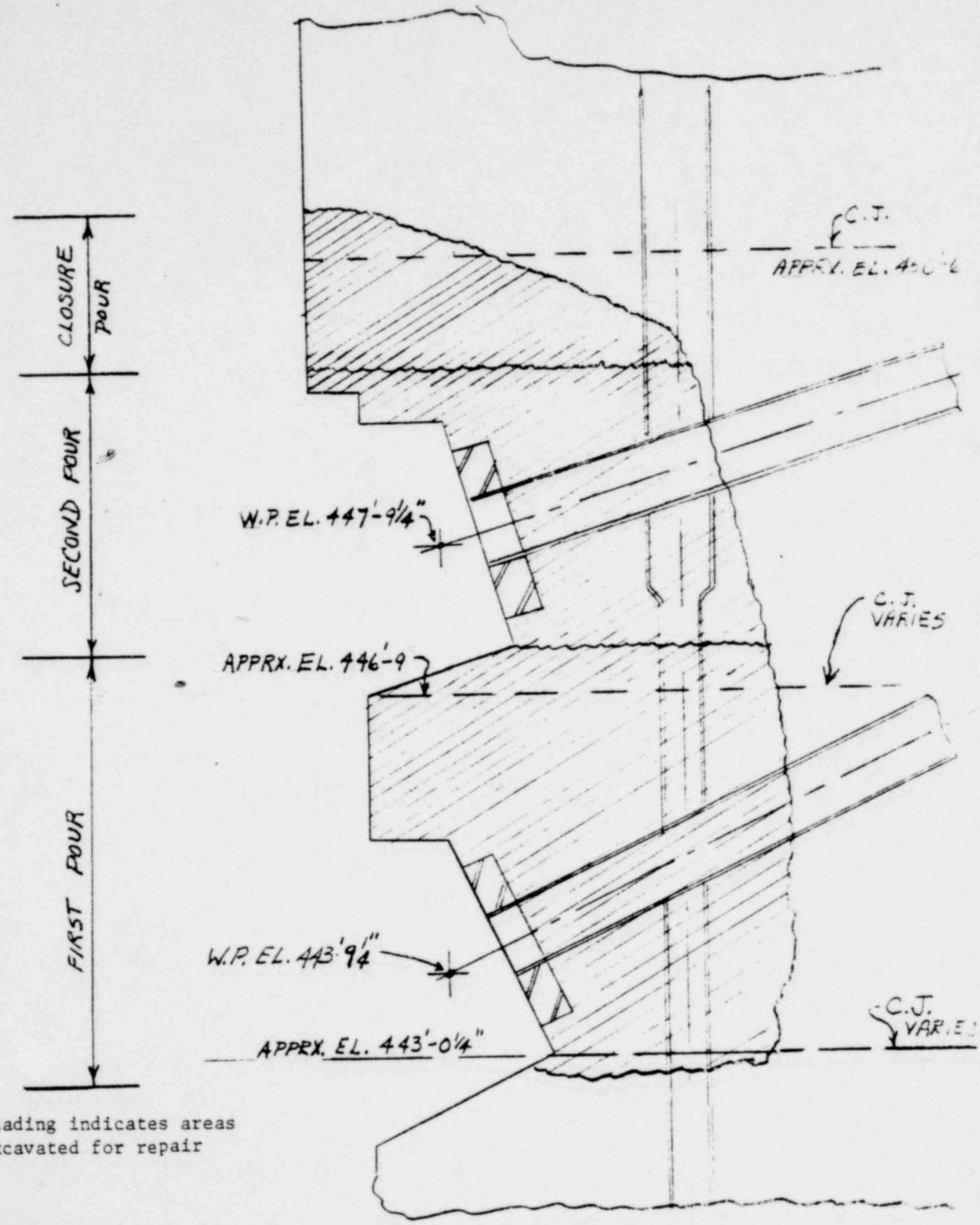
The lowest factor of safety will be 1.4 in the area around 140° shown on Figure 5. At that location the required coefficient of friction is $\mu=1.00$. A factor of safety of 1.4 is derived by dividing the assumed ultimate coefficent of friction 1.4 by the required value of $\mu=1.00$. Since it has been conservatively assumed that the shear is carried across the joint only by friction under a normal compressive stress, a minimum factor of safety of 1.4 for a limited portion of the ring beam is considered adequate under the Aircraft Impact Loading.

Except for the local area of the aircraft impact where the factor of safety at the joint elevations 443 ft-0 in. and 446 ft-9 in. is 1.64 minimum (1.4/0.855=1.64), the rest of the ring beam at these two joints has a minimum factor of safety of 2. The immediate area of aircraft impact is considered to be less than 40° of the perimeter or smaller than 11.2 percent of the entire perimeter. A minimum factor of safety of 1.64 is considered adequate for this limited portion of the ring beam for the Aircraft Impact Loading.

The "Report on Containment Building Ring Girder Construction and Repair" dated December 1, 1971 and subsequent Addenda allow for various options in the repair of the ring girder. For example repair of the reinforcing bars may be made by splicing, cadwelding, or with the approval of the Engineer butt-welding. All efforts are made to eliminate the use of the butt-welding procedure. In two sections of the North 180°; eight butt-weld repairs were used. These were removed and replaced with cadwelds or a full length bar at a later date. The final tabulation of the North 180° shows that no butt-welds were used in the repair.

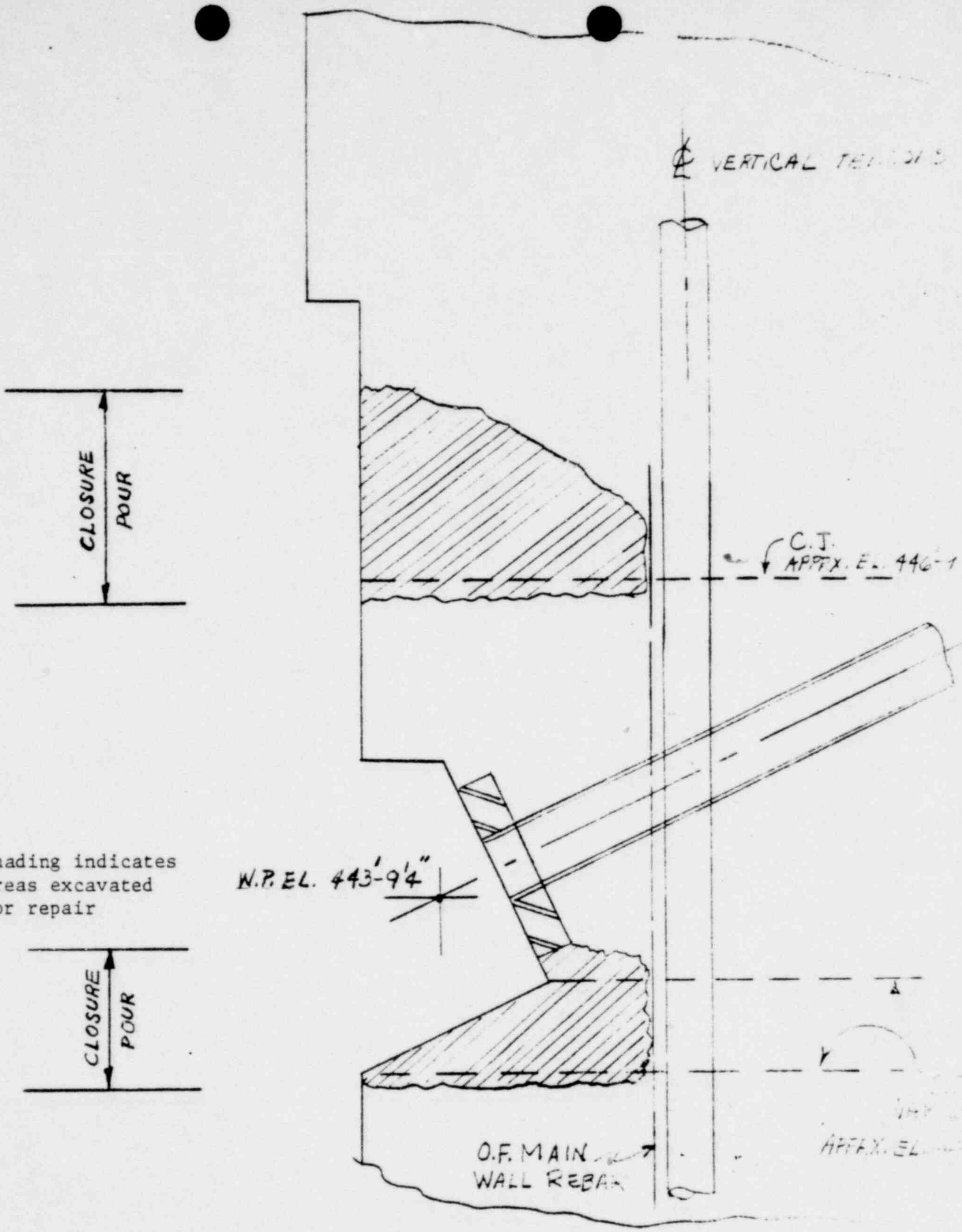
The same effort to eliminate the use of butt-welds will be made in the repair of the South 180°. At the present time, it is impossible to say that the butt-welding technique will be eliminated entirely.

Complete records of the repair are being kept by United Engineers and Constructors Incorporated Quality Control group at the job site.



Note: Shading indicates areas excavated for repair

FIGURE 1 Part Section through ring beam showing sequence of repair pours for double dome tendon area



Note: Shading indicates areas excavated for repair

FIGURE 2 Part Section through ring beam showing typical repair pours for single lower dome tendon areas

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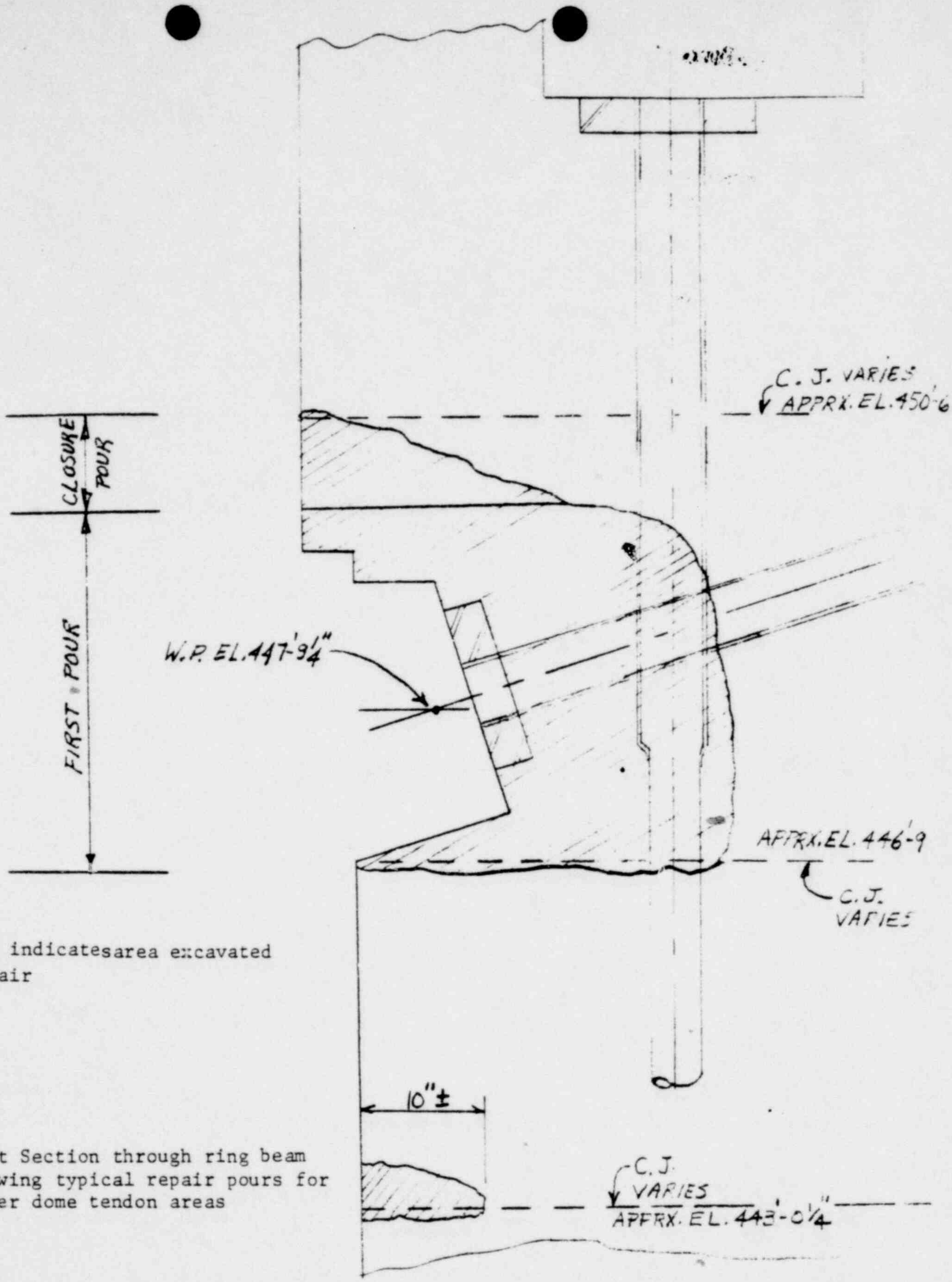
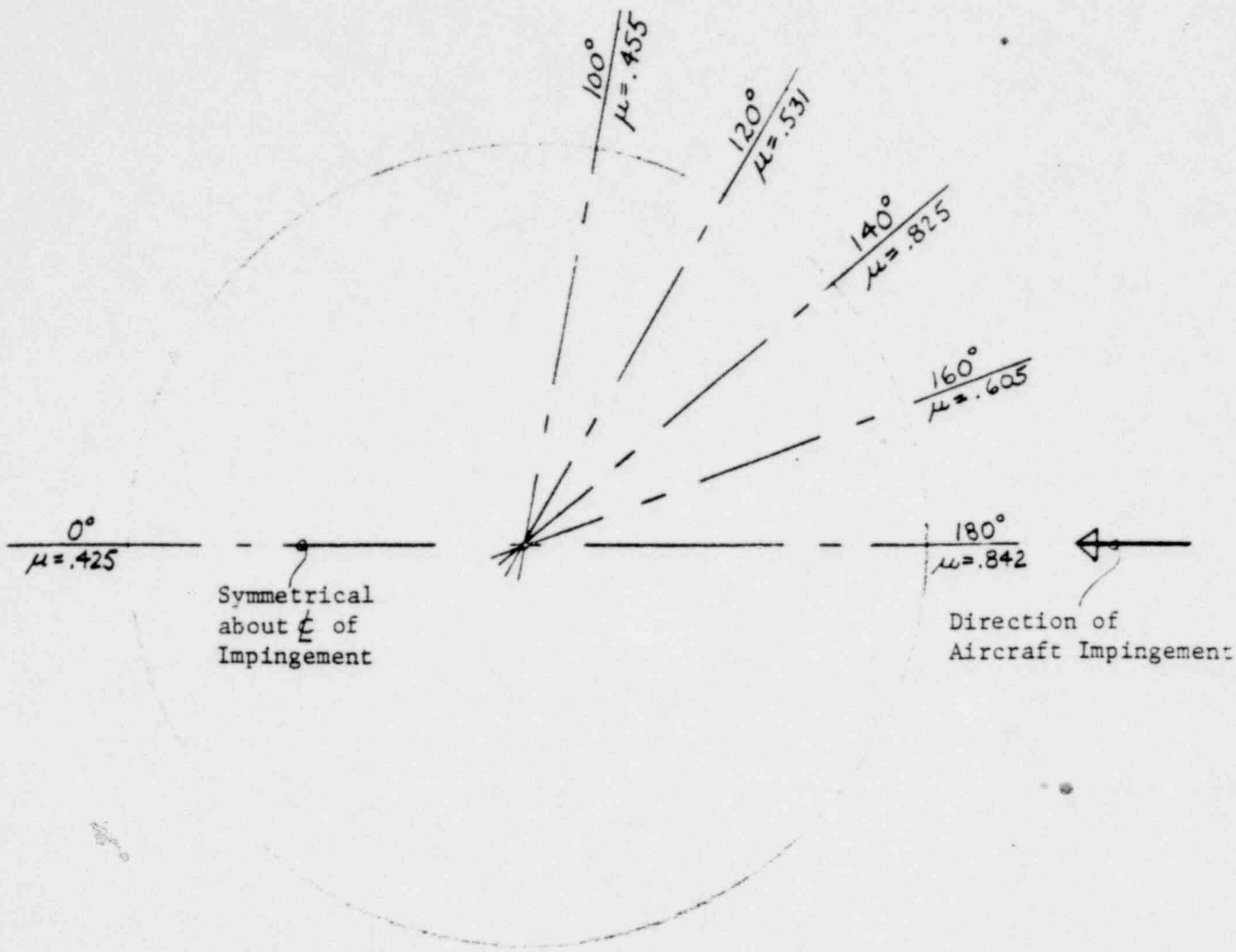


Note: Shading indicatesarea excavated for repair

FIGURE 3 Part Section through ring beam showing typical repair pours for upper dome tendon areas



PLAN
REACTOR BUILDING
EL. 443'-0

FIGURE 4 Coefficients of friction μ at various azimuths required to transfer shear at elevation 443'-0" due to normal operation plus Aircraft Impingement.

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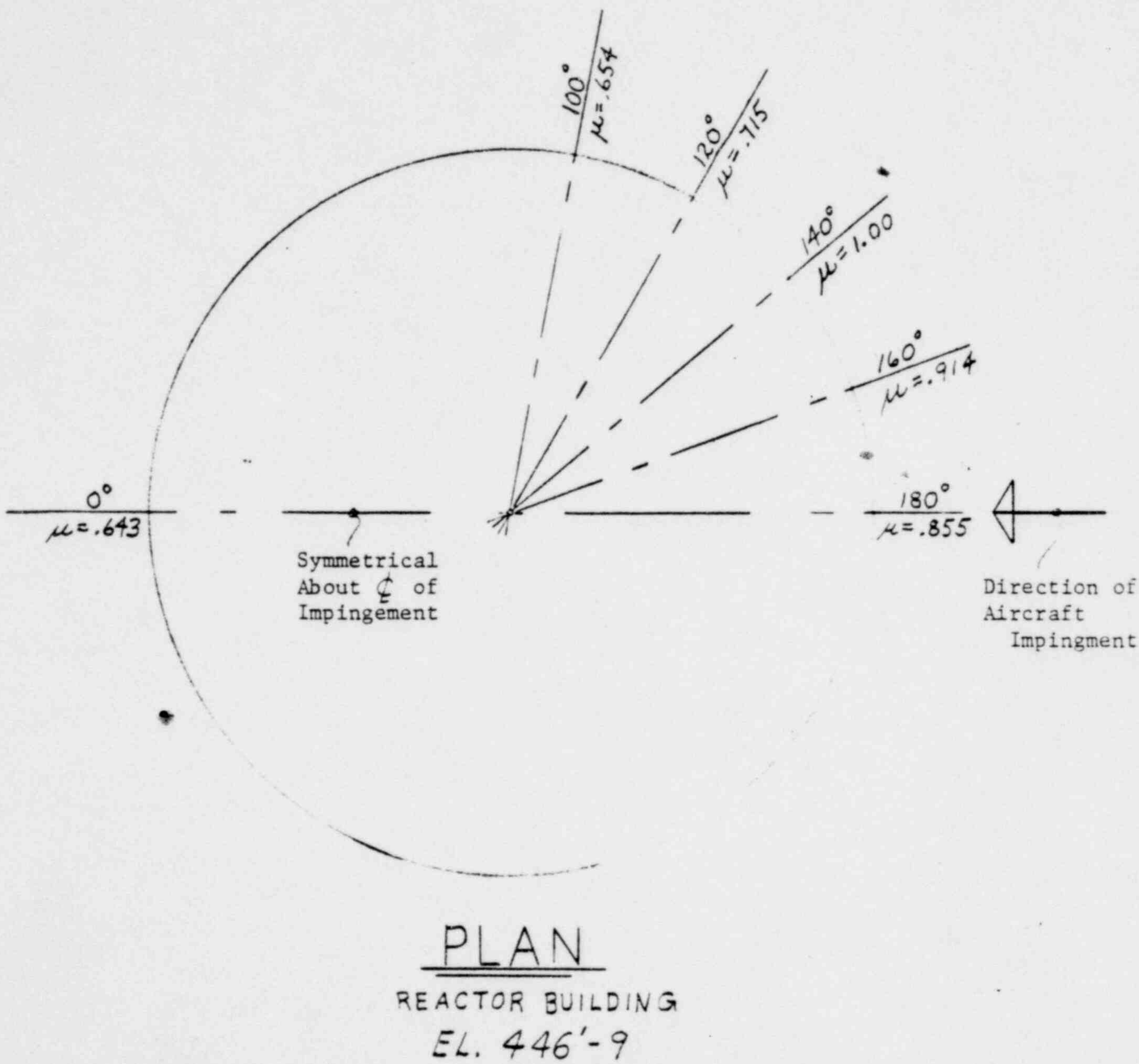

FIGURE 5 Coefficients of friction μ, at various azimuths required to transfer shear at elevation 446'-9" due to normal operation plus Aircraft Impingement.