REPORT ON THE
CONTAINMENT BUILDING LINER
PLATE BUCKLE
IN THE VICINITY OF THE
FUEL TRANSFER CANAL

INDIAN POINT GENERATING STATION

UNIT NO. 2

50-247

JANUARY, 1968

PREFACE

This summary has been prepared in order to accumulate in one place the background and corrective measures taken as related to the containment building liner bulge in the vicinity of the fuel transfer canal penetration at the Indian Point Generating Station, Unit No. 2.

Incorporated into this summary is a brief description of the containment building, the tests and test procedures used during construction and after repairs were made, conclusions, the measurements made and their evaluation, and a description of the corrective actions taken.

INTRODUCTION

During construction and erection of the welded steel liner on the Indian Point No. 2 containment structure a buckle or liner deformation was observed in the vicinity of the fuel transfer tube canal penetration. This report is aimed at identifying the resulting deformations, assessment of the problem as related to liner integrity and the remedial action taken to assure functional adequacy.

DESCRIPTION OF STRUCTURE

The reactor containment structure is a reinforced concrete vertical right cylinder with a flat base and a hemispherical dome. A welded steel liner with a minimum thickness of 1/4" is attached to the inside face of the concrete shell to assure a high degree of leak tightness. The liner is anchored to the concrete shell by means of anchors so that it forms an integral part of the entire composite structure under all loadings.

The plate steel liner is carbon steel conforming to ASTM Designation A442-65 "Standard Specification for Carbon Steel Plates with Improved Transition Properties," Grade 60. This steel has a minimum yield strength of 32,000 psi and a minimum tensile strength of 60,000 psi with an elongation of 22 per cent in an 8-in. gauge length at failure. The liner is 1/4-in. thick at the bottom, 1/2-in. thick in the first three courses except 3/8-in. thick for remaining portion of the cylindrical walls and 1/2-in. thick in the dome. The liner material was tested to assure an NDT temperature more than 30° F lower than the minimum operating temperature of the liner material.

Impact testing was done in accordance with Section N331 of Section III of the ASME Boiler & Pressure Vessel Code. A 100 per cent visual inspection of liner anchors was made prior to pouring concrete.

TESTS AND PROCEDURES

Qualification of welding procedures and welders on the containment liner is in accordance with Section IX, "Welding Qualifications of the ASME Boiler & Pressure Vessel Code." All welded joints in the liner have steel channels welded over them from the inside of the vessel. During construction, the channel welds were tested by means of pressurizing sections with Freon gas and checking for leaks by means of a Freon snifter. A strength test was performed on the liner plate weld and the channel weld by pressurizing the channel with air at 54 psig for 15 minutes. In addition, each zone of channel cover weld will be leak tested, using Freon-air mixture at 47 psig.

Following repair of the liner bulge, leak tests were performed on the channels in the affected area in accordance with the above test procedures. Magnetic particle inspection was made of all weld channel fillet welds in the same area. The magnetic particle test is not required by the specification but was utilized in this special situation as an additional feature to insure that the integrity of the liner was preserved. The weld channel system passed the leak and magnetic particle tests.

CONCLUSION

As shown by the preceding discussion and the following details, it is concluded that the integrity of the liner has not been violated.

Since the liner material (A-442) is highly ductile, and the liner is deflection limited by the reinforced concrete wall, strains in the liner will remain elastic and the leakproof integrity of the liner would be maintained under all anticipated conditions.

Technical data reports and quality control records referred to in the remainder of this report are available and on file in the UE&C field offices for review as required.

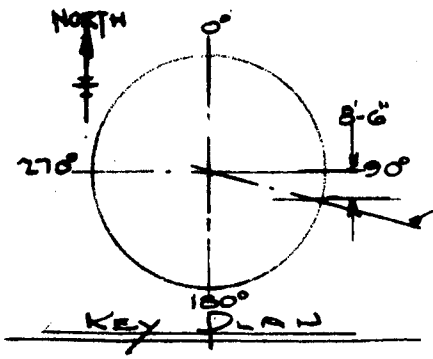
MEASUREMENTS AND EVALUATION

During a routine inspection of the Vapor Containment liner by Quality Control personnel on August 4, 1967, a buckle was noted in the liner plate near the fuel transfer tube between elevations 56'-7" and 59'-7". Chicago Bridge & Iron's drawing No. 5 designates these plates as 3H and 3J. Figure 1 shows the location of the plates.

Field measurements were taken at the buckled zone (elevations 56'-7" and 59'-7"). The measurements show the distance the liner had buckled from a normal position at various stations. This information is shown on the attached Figures 2 and 3. Figure 4 is a plot of this data in the form of a contour map of the buckled zone.

Specification 9321-01-225-3, Containment Building Liner, allows 2" tolerance for local buckling. From the above information, it is noted that points C and D at elevation 56'-7" were beyond the acceptable limits by 1/8" and 5/16", respectively.

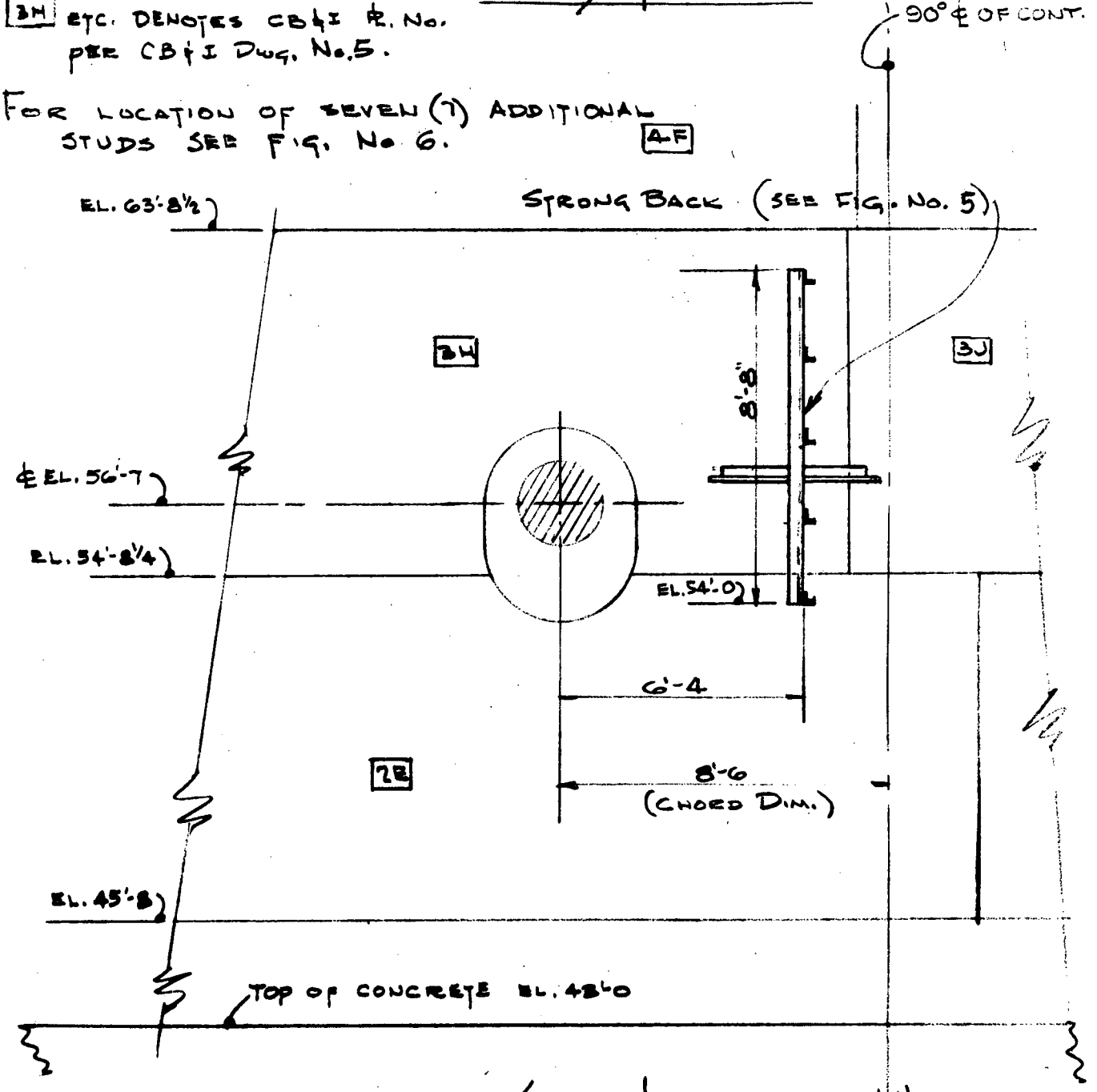
FIGURE 1



NOTES:

a.) [3H] ETC. DENOTES CB&I PL. NO. PER CB&I DWG. No. 5.

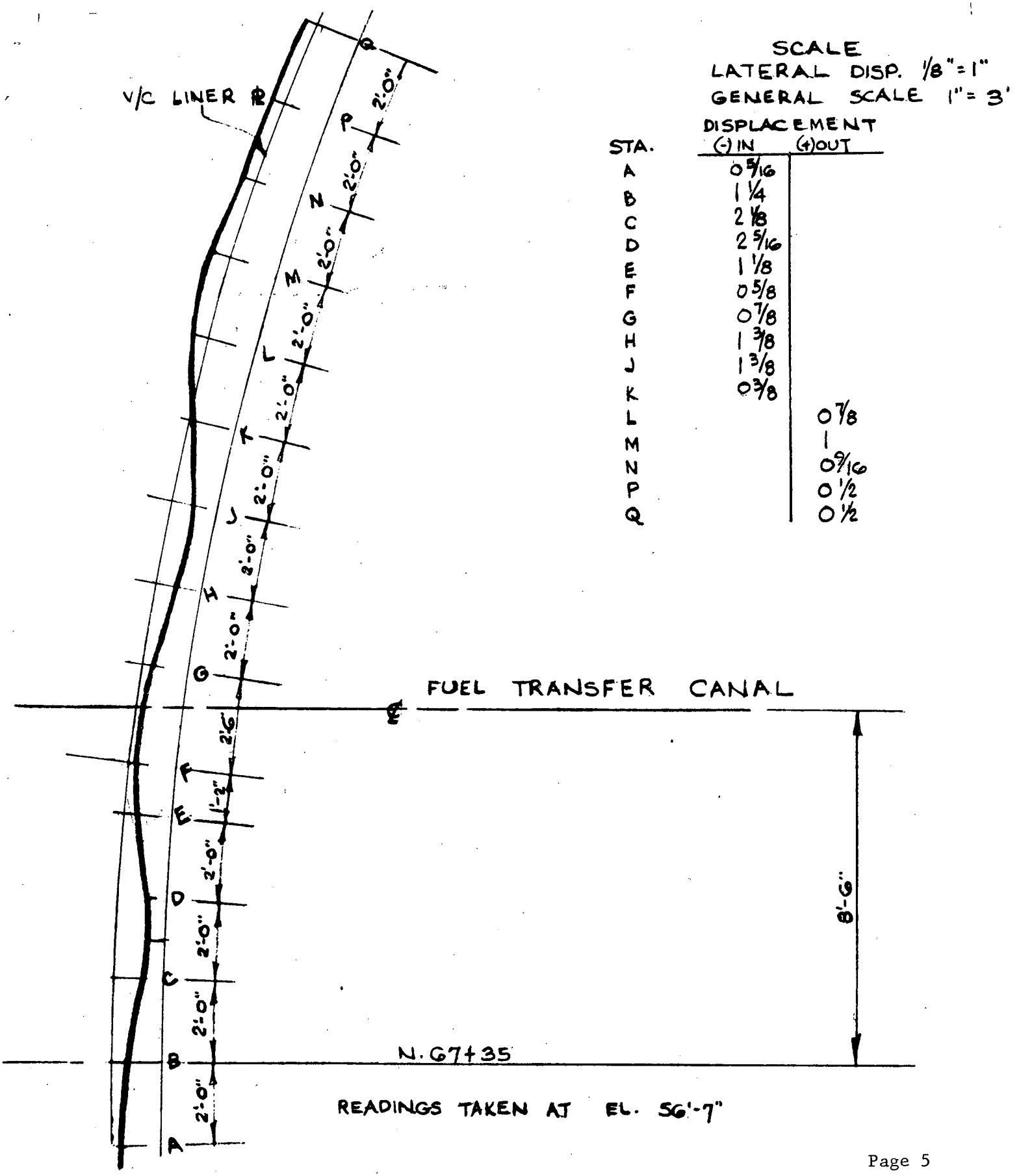
b.) FOR LOCATION OF SEVEN (7) ADDITIONAL STUDS SEE FIG. No. 6. [4F]



VIEW LOOKING WEST

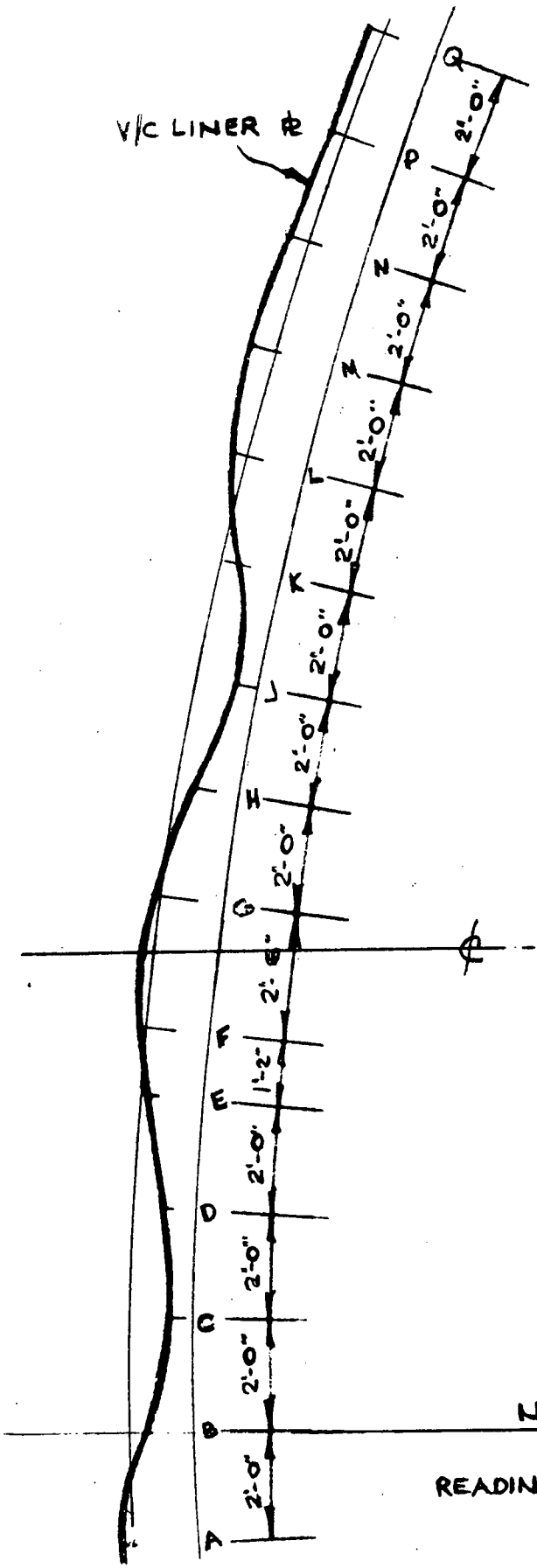
SCALE ¼" = 1'-0"

FIGURE 2



STA.	DISPLACEMENT (-) IN	(+) OUT
A	0 5/16	
B	1 1/4	
C	2 1/8	
D	2 5/16	
E	1 1/8	
F	0 5/8	
G	0 7/8	
H	1 3/8	
J	1 3/8	
K	0 3/8	
L		0 7/8
M		1
N		0 9/16
P		0 1/2
Q		0 1/2

FIGURE 3



SCALE
LATERAL DISP. 1/8" = 1"
GENERAL SCALE 1" = 3'

STA.	DISPLACEMENT (-) IN	(+) OUT
A		0 1/8
B	1	
C	2	
D	1 5/8	
E	0 3/8	
F		0 1/8
G		0 1/16
H	1 1/4	
J	1 15/16	
K	1	
L		0 3/8
M		1 1/16
N		0 7/8
P		0 1/2
Q		0 3/4

N. 67+35

READINGS TAKEN AT EL. 59'-7"

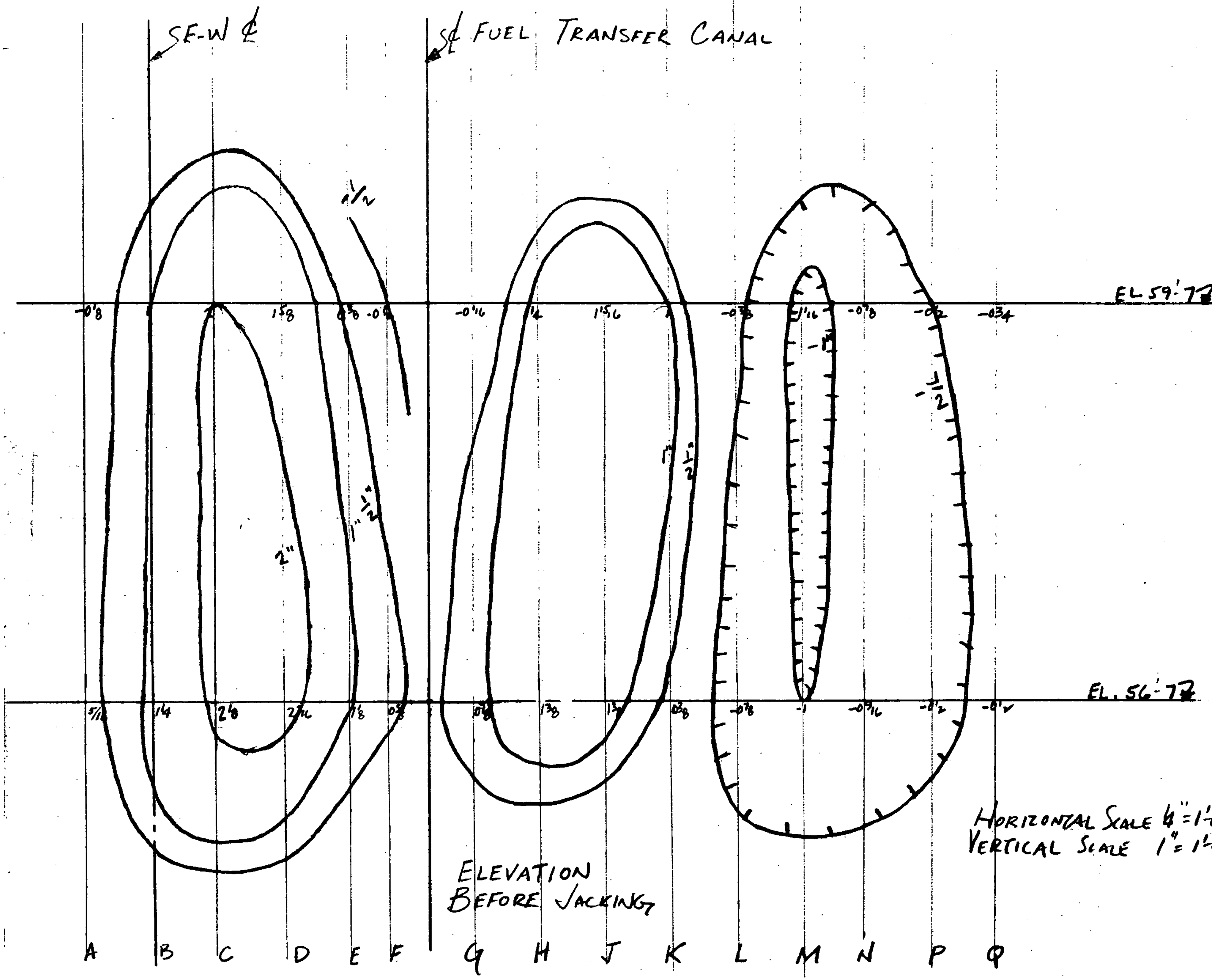

SE-W ℄
℄ FUEL TRANSFER CANAL
EL 59'-7
EL. 56'-7
2"
ELEVATION
BEFORE JACKING
HORIZONTAL SCALE 1/4"=1'-0
VERTICAL SCALE 1"=1'-0
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q

FIGURE 4

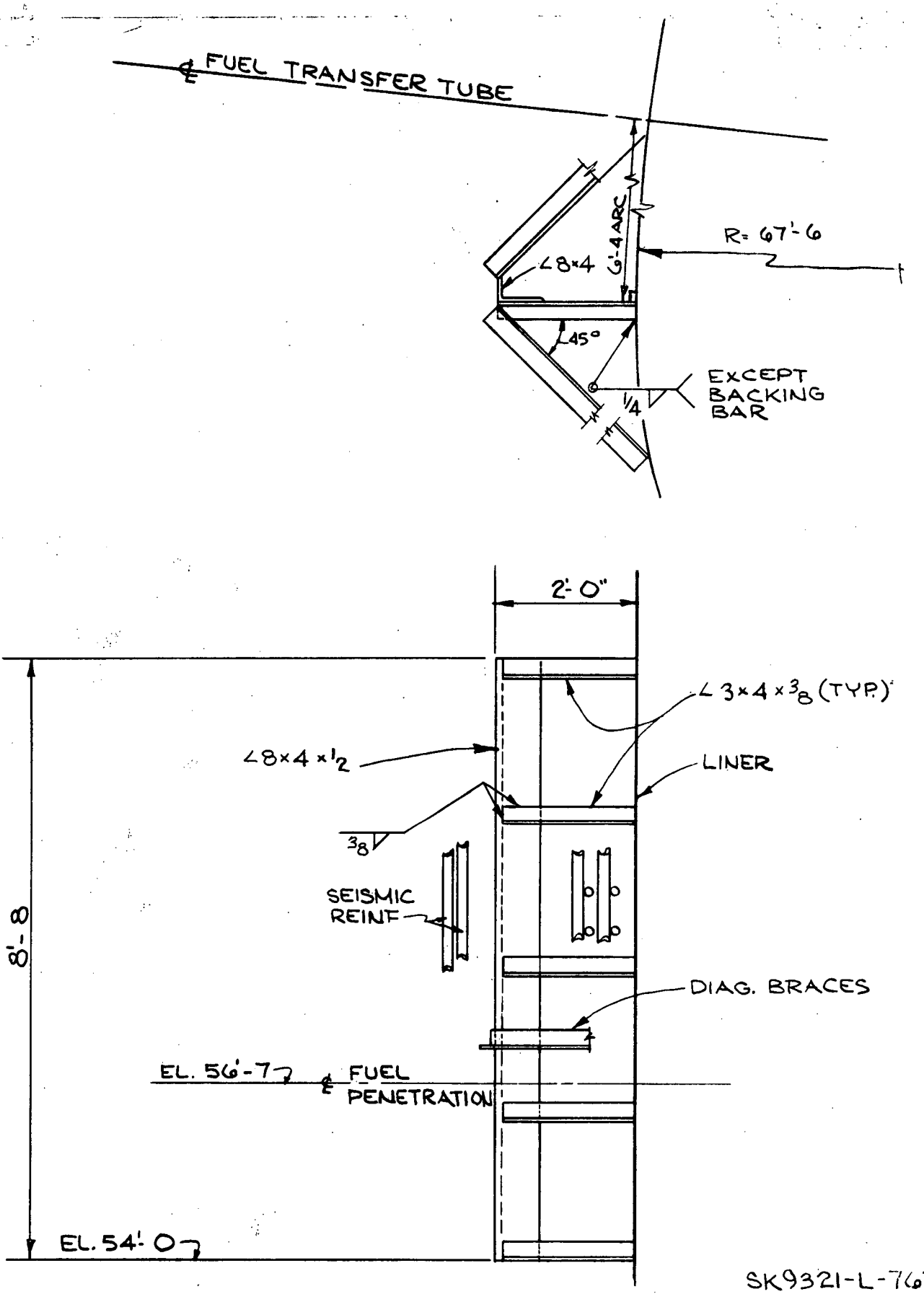
CORRECTIVE ACTION

Various approaches, independent of support from exterior concrete, were examined. The adopted solution was a system consisting of a combination of a strongback and stud anchors, as illustrated in Figures 5 and 6. The liner was jacked to within tolerances prior to strongback installation.

The stud anchors were installed at the high points of the buckles on a judgment basis, in order to prevent additional buckling of these points under compressive loadings by holding the liner to the concrete.

Figures 7, 8 and 9 show the liner configuration after corrective action was taken. Figure 10 is a contour map of the buckled zone after corrections and in addition, all of the studs including the original installation and the additional studs are shown. At all points the liner is within the allowable tolerances.

FIGURE 5



SK9321-L-7677

FIGURE 6

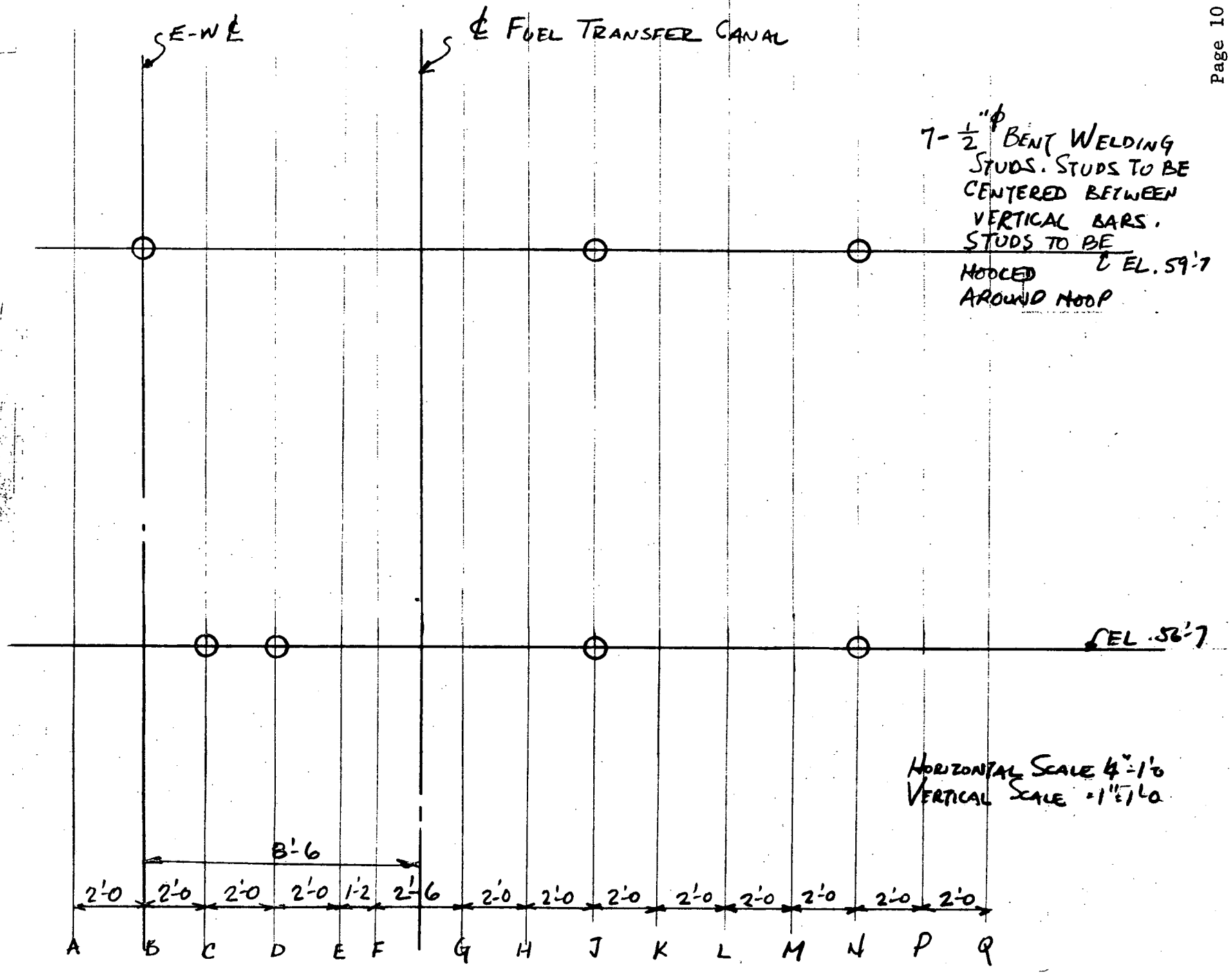
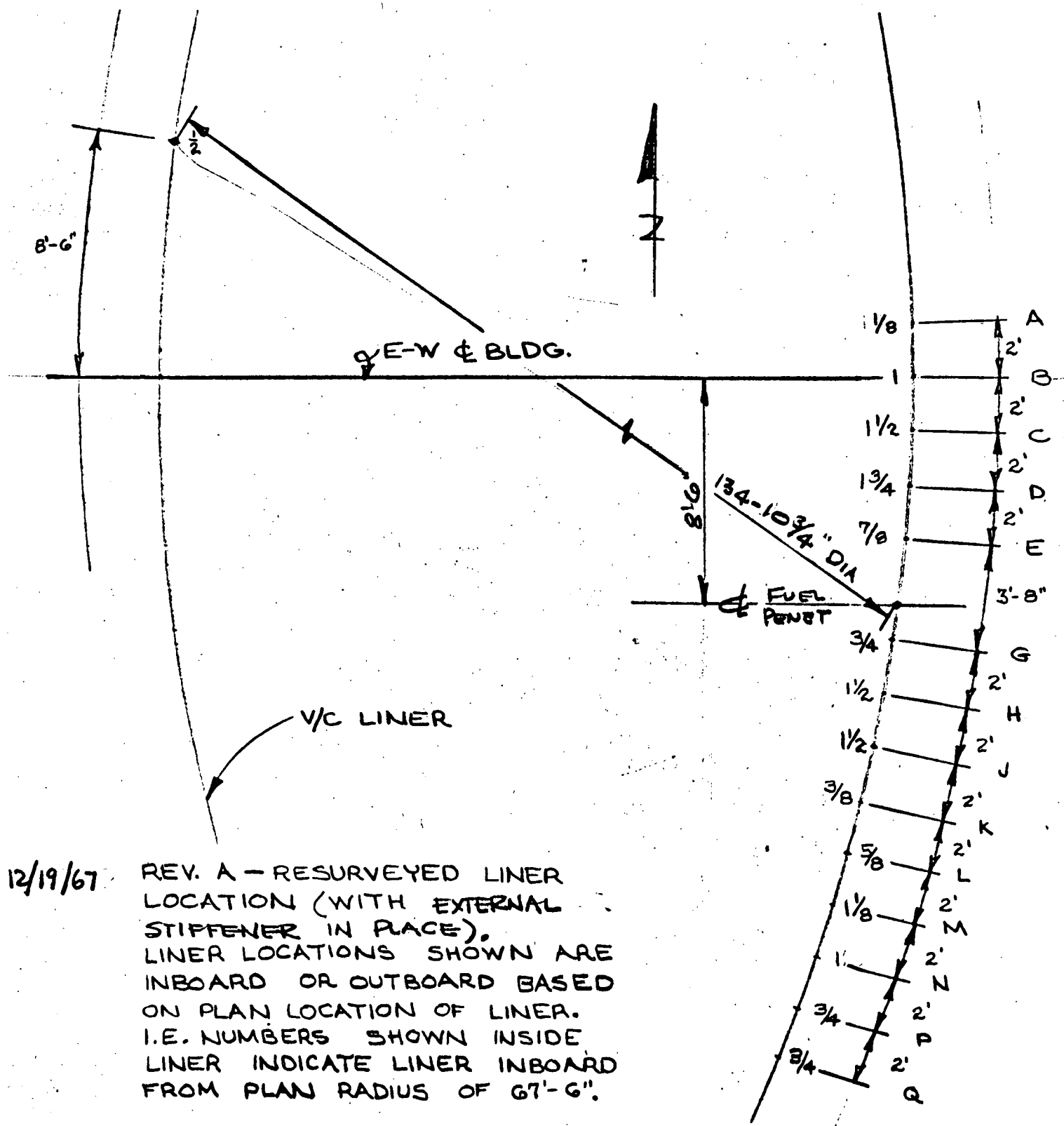

℄ E-W ℄
℄ FUEL TRANSFER CANAL
7-½"ϕ BENT WELDING STUDS. STUDS TO BE CENTERED BETWEEN VERTICAL BARS. STUDS TO BE HOOKED AROUND HOOP
℄ EL. 59'-7
℄ EL. 56'-7
HORIZONTAL SCALE 4"=1'0
VERTICAL SCALE 1"=1'0
8'-6
2'-0 2'-0 2'-0 2'-0 1'-2 2'-6 2'-0 2'-0 2'-0 2'-0 2'-0 2'-0 2'-0 2'-0
A B C D E F G H J K L M N P Q

FIGURE 7

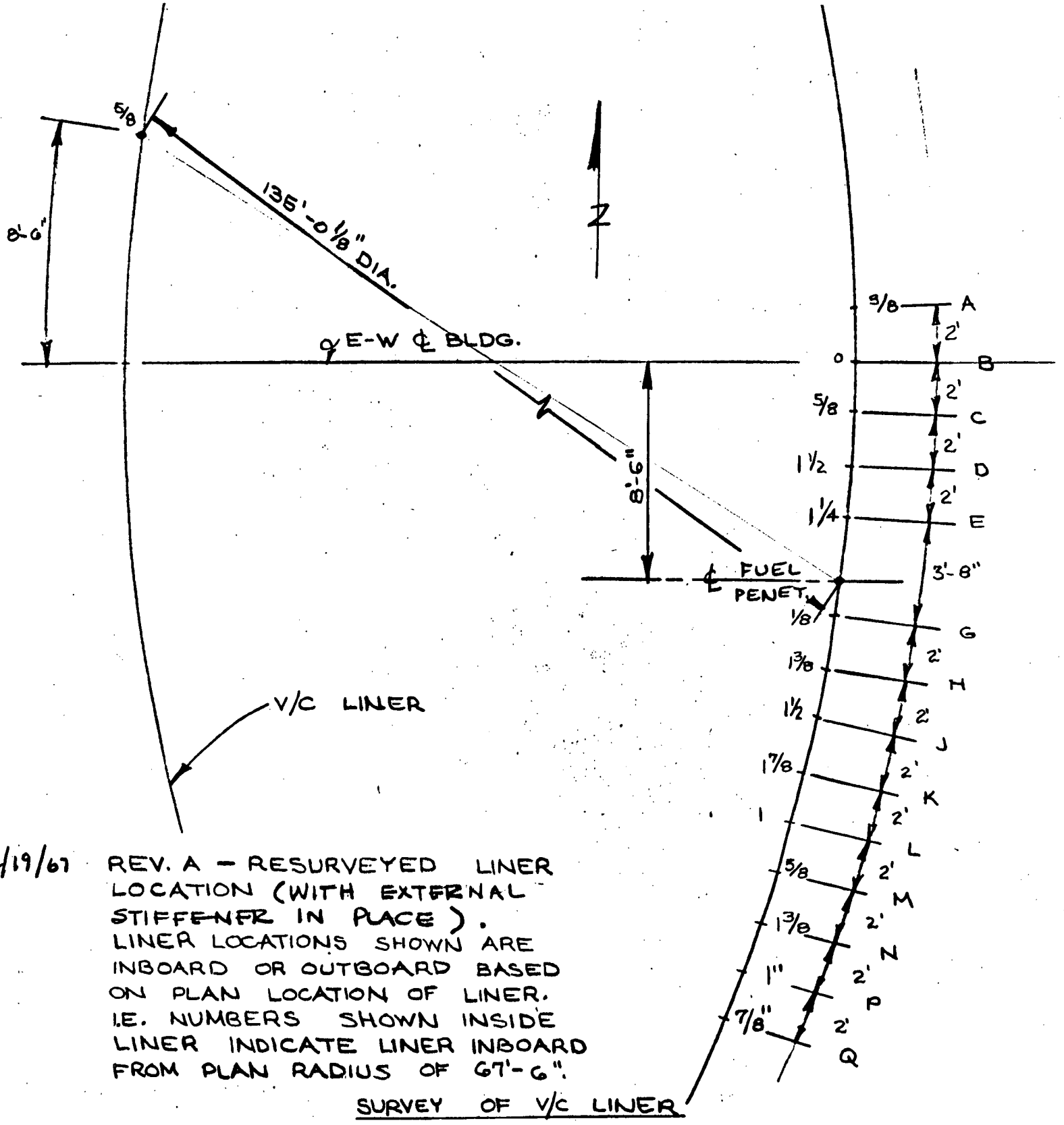


12/19/67 REV. A – RESURVEYED LINER LOCATION (WITH EXTERNAL STIFFENER IN PLACE). LINER LOCATIONS SHOWN ARE INBOARD OR OUTBOARD BASED ON PLAN LOCATION OF LINER. I.E. NUMBERS SHOWN INSIDE LINER INDICATE LINER INBOARD FROM PLAN RADIUS OF 67'-6".

SURVEY OF V/C LINER

EL. 56'-7"

FIGURE 8



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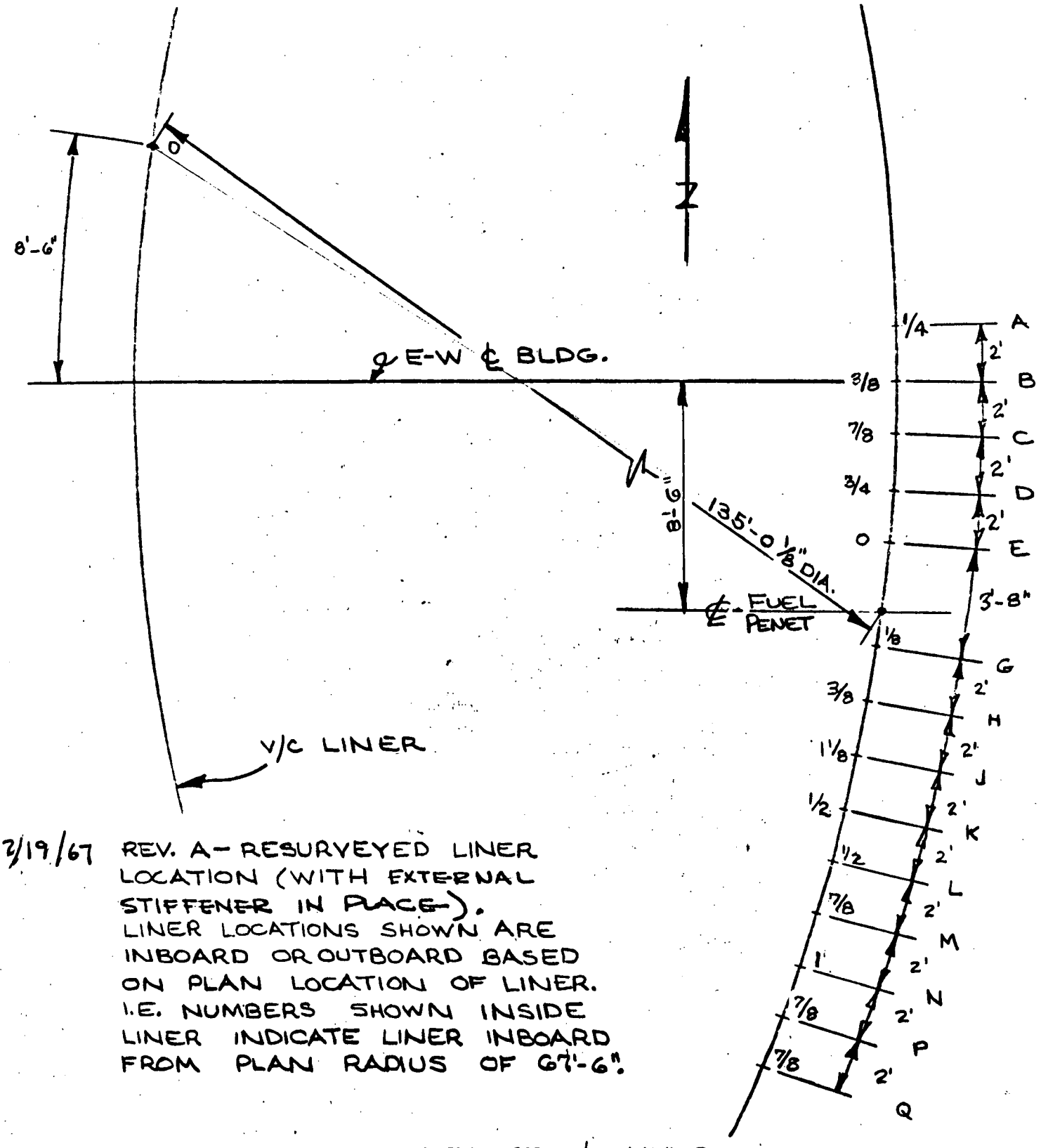
SURVEY OF V/C LINER

EL. 59'-7"

FIGURE 9

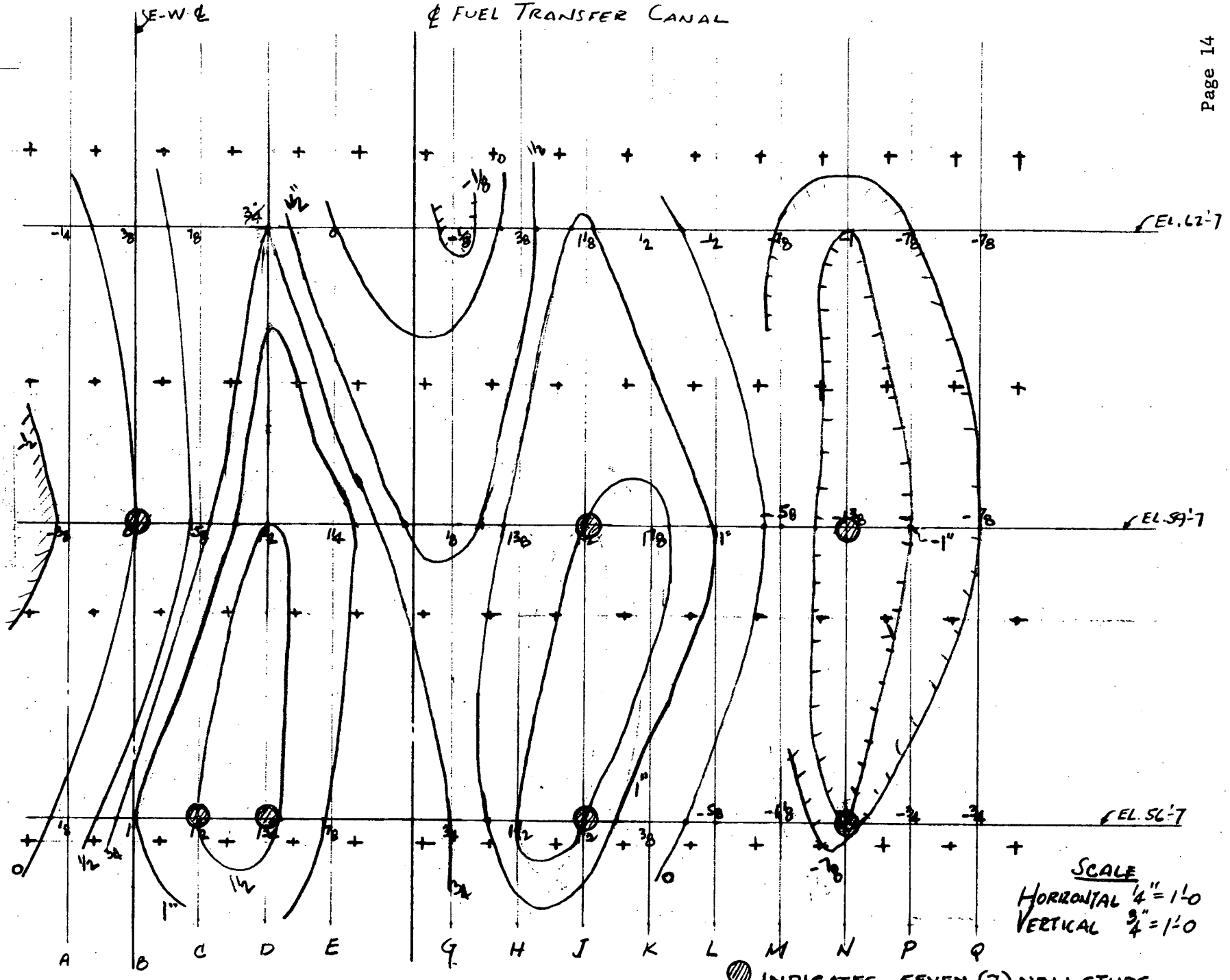


12/19/67 REV. A- RESURVEYED LINER LOCATION (WITH EXTERNAL STIFFENER IN PLACE).
LINER LOCATIONS SHOWN ARE INBOARD OR OUTBOARD BASED ON PLAN LOCATION OF LINER.
I.E. NUMBERS SHOWN INSIDE LINER INDICATE LINER INBOARD FROM PLAN RADIUS OF 67'-6".

SURVEY OF V/C LINER

EL. 62'-7"

FIGURE 10



ELEVATIONS AFTER JACKING