ATTACHMENT #4

Design Analysis

Ginna Station

Structural Upgrade Program

ROCHESTER GAS AND ELECTRIC CORPORATION

89 EAST AVENUE

ROCHESTER, NEW YORK 14649

EWR #3296

Revision 0

January 19, 1989

Prepared By: L. A. Sucheski — Structural Engineering — 1/19/89 Date

Reviewed By: T. R. Lupi — Structural Engineering — 1-24-89 Date

Approved By: A. G. Gucwa — Manager, Structural Engineering — 1/24/89 Date

REVISION STATUS SHEET

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Design Analysis

1.0 Objective

The purpose of this calculation is to assess the impact on the seismic analysis that was performed for Ginna Station due to the modifications that were installed for the Structural Upgrade Program.

2.0 Design Inputs

2.1 Design Analysis, EWR #3296, Revision 1, May 22, 1987.

2.2 Safety Analysis, EWR #3296, Revision 0, May 22, 1987.

3.0 Referenced Documents

3.1 Gilbert Associates, Inc. Report "Seismic Upgrade Program Auxiliary Structures Seismic Analysis - May 15, 1980".

3.2 RG&E drawing #33013-1641, "Structural Upgrade Program - Auxiliary Building North Wall".

4.0 Assumptions

Listed as made. See Body.

5.0 Computer Codes

None.

6.0 Analysis

See Body.

7.0 Results

See Conclusions at the end of analysis.

LAS/A009

ROCHESTER GAS AND ELECTRIC CORPORATION

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JOB: STRUCTURAL UPGRADE EWC 3296		MADE BY: LAS	CK:

THE STRUCTURAL UPGRADE PROGRAM FOR EXTREME ENVIRONMENTAL LOADS INVOLVED MODIFICATIONS TO SOME OF THE MAIN STRUCTURAL ELEMENTS. SPECIFICALLY, 265 MODIFICATIONS WERE MADE. THE STRUCTURES OF THE MAIN PLANT CONSIST OF REINFORCED CONCRETE BELOW GRADE AND "SIMPLE" FRAMING, TRUSS TYPE STRUCTURAL STEEL FRAMING ABOVE GRADE. THE MODIFICATIONS TO THE STRUCTURE THAT WERE MADE CONSISTED OF LOCALIZED STRENGTHENING OF PRIMARY MEMBER, CONNECTIONS AND ANCHORAGE.

TYPICAL MODIFICATIONS WERE AS FOLLOWS:

PRIMARY MEMBERS

- STRENGTHENING OF TENSION FLANGES OF BENDING ELEMENTS

STRENGTHENING OF COMPRESSION FLANGES OF BENDING ELEMENTS

CONNECTIONS

STRENTHENING OF CLIP ANGLE CONNECTIONS TO INCREASE THEIR TENSION/SHEAR CAPACITY

ANCHORAGES

STRENGTHENING OF MAIN STEEL ANCHORAGES TO INCREASE THEIR TENSION/SHEAR CAPACITY

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ALL OF THESE TYPICAL MODIFICATION DO NOT ALTER THE OVERALL BUILDING STIFFNESS SINCE THEY ARE QUITE LOCALIZED. THE PRIMARY LATERAL LOAD RESISTING COMPONENTS FOR THE SUPERSTRUCTURE ARE CROSS BRACES LOCATED THROUGHOUT THE BUILDING. CROSS BRACING WAS NOT MODIFIED BY THESE TYPICAL FIXES.

HOWEVER, ADDITIONAL WEIGHT (MASS) WAS ADDED.

COMPARE THE ADDITIONAL WEIGHT WITH THE ORIGINAL WEIGHTS USED IN THE SEISMIC MODEL.

REFERENCE "PIPING SEISMIC PROGRAM - AUXILIARY STRUCTURES SEISMIC ANALYSIS" EWR 2512

ORIGINAL MODEL (STEEL) WEIGHTS

BUILDING	WEIGHT
SERVICE	940 K
TURBINE	113 + 563 + 472
AUXILIARY	340 + 553
INTERMEDIATE	280
TOTAL	3260 K

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ADDITIONAL WEIGHT DUE TO STRUCTURAL UPGRADE = 36.8 K

PER CENT CHANGE = $36.8/3260 \times 100\%$
$= 1.1\%$

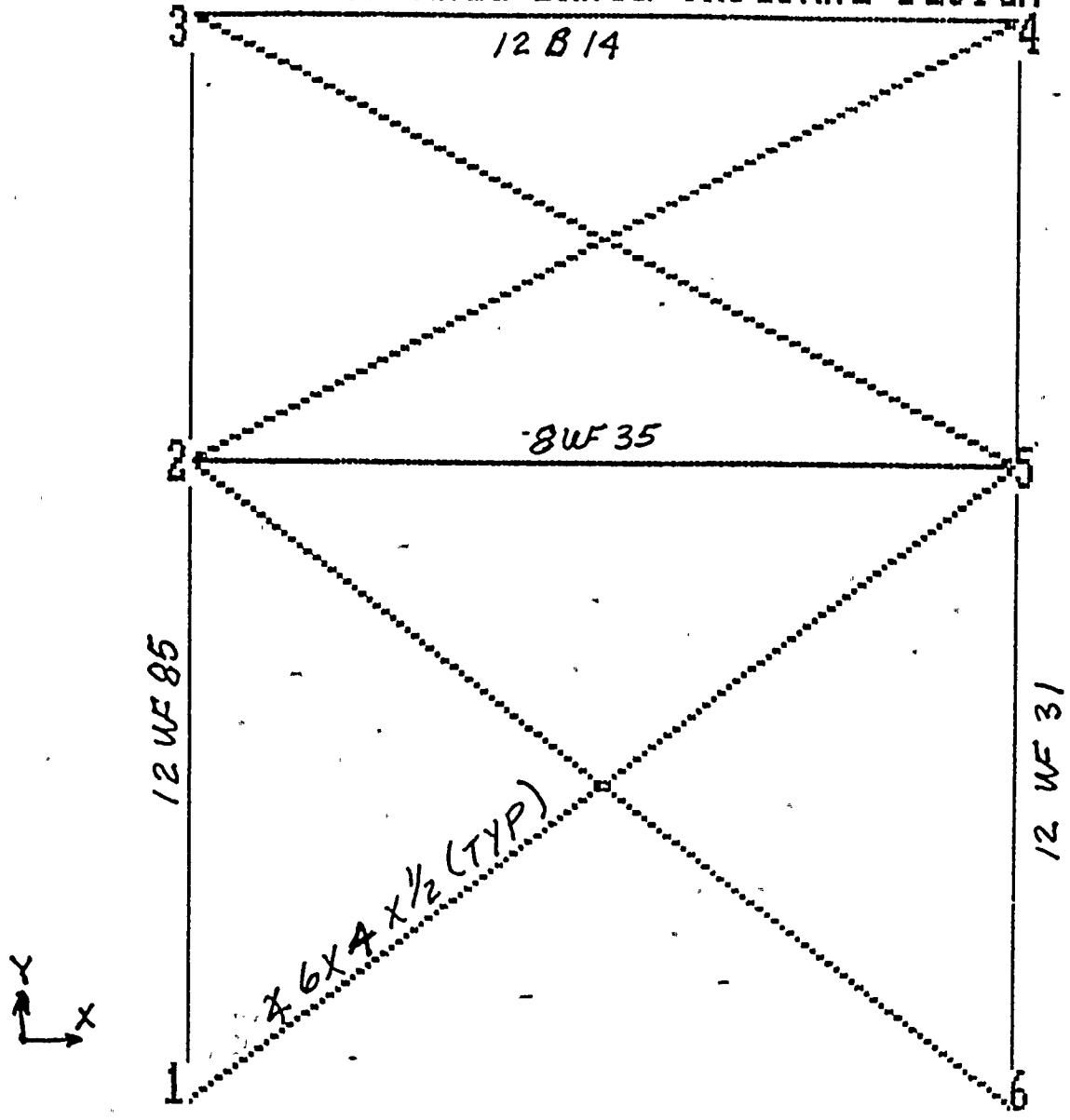
THIS SMALL CHANGE IS NOT SUFFICIENT TO ALTER THE BUILDING RESPONSE.

ONLY ONE MODIFICATION IN THE PROGRAM HAS RESULTED IN A STIFFNESS CHANGE (REF. DWG 33013-1641). THIS MODIFICATION OCCURS IN THE NORTH WALL OF THE AUXILIARY BUILDING. THE ORIGINAL AND REVISED DESIGNS ARE SHOWN ON THE FOLLOWING PAGES WHICH SHOW ANALYTICAL STRESS MODELS OF EACH.

THE BRACED BAY IN QUESTION ACTS IN THE EAST-WEST DIRECTION. IN ORDER TO DETERMINE THE INFLUENCE OF THE MODIFICATION THE FOLLOWING STEPS WILL BE TAKEN:

1. DETERMINE THE ORIGINAL STIFFNESS OF THE AUXILIARY BUILDING IN THE EAST-WEST DIRECTION.

A/B NORTH WALL BRACE ORIGINAL DESIGN



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TITLE STIFFNESS CHANGE AUX BLDG NORTH WALL BRACING ORIGINAL DESIGN
NODAL POINT LOCATION 1
1 0 0 0
2 0 292 0
3 0 492 0
4 [redacted] 492 0
5 [redacted] 292 0
6 308 0 0

MATERIAL PROPERTIES 30E6 11.6E6 0 0.3 36000
BEAM TYPE 1 24.98 1 723 235
CONNECT 1 TO 2
CONNECT 2 TO 3
BEAM TYPE 1 9.12 1 238 19.8
CONNECT 4 TO 5
CONNECT 5 TO 6
BEAM TYPE 1 10.3 1 126 43
RELEASE V.W
CONNECT 2 TO 5
BEAM TYPE 1 4.14 1 68.2 2.25
RELEASE V.W
CONNECT 3 TO 4
BEAM TYPE 1 4.8 1 17.4 6.3
RELEASE V.W
CONNECT 1 TO 5
BEAM TYPE 1 4.8 1 17.4 6.3
RELEASE V.W
CONNECT 2 TO 6
BEAM TYPE 1 4.8 1 17.4 6.3
RELEASE V.W
CONNECT 2 TO 4
BEAM TYPE 1 4.8 1 17.4 6.3
RELEASE V.W
CONNECT 3 TO 5
ZERO 1
RX 1 THROUGH 6
RY 1 THROUGH 6

ELIMINATE

END DEFINITION
```

STIFFNESS CHANGE AUX BLDG NORTH WALL BRACING ORIGINAL DESIGN

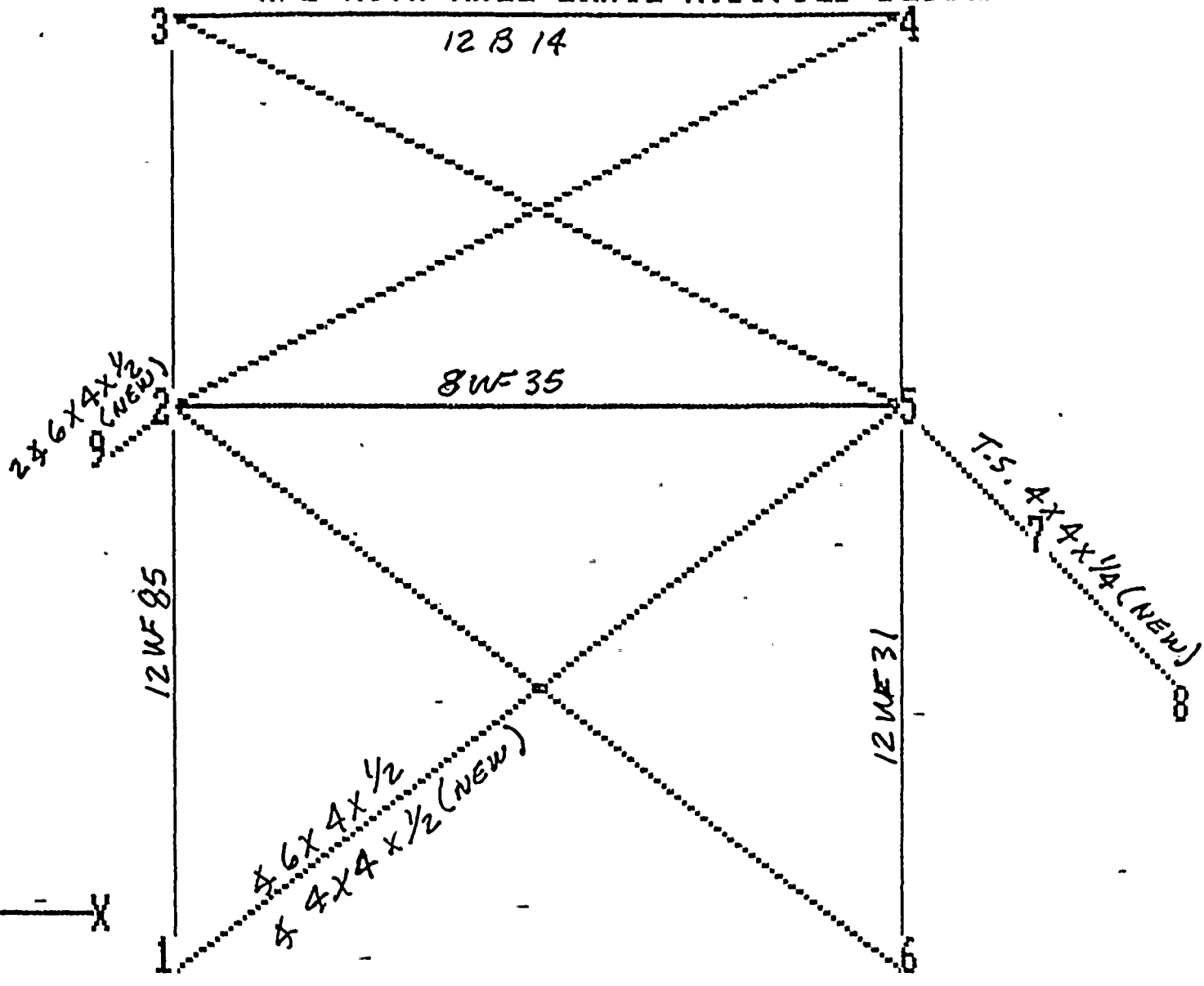
STATIC ANALYSIS SUBCASE NO. 1 APPLIED FORCES

NODE	DIR	VALUE	NODE	DIR	VALUE	NODE	DIR	VALUE
4	X T	1.000E+04						

STATIC ANALYSIS SUBCASE NO. 1 DISPLACEMENTS

NODE	X TRANS	Y TRANS	Z TRANS	X ROT	Y ROT	Z ROT
1	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	-1.2247E-04
2	3.5783E-02	4.6041E-03	0.0000E-01	0.0000E-01	0.0000E-01	-1.2269E-04
3	6.0342E-02	5.2833E-03	0.0000E-01	0.0000E-01	0.0000E-01	-1.2285E-04
*4	7.0060E-02	-1.4253E-02	0.0000E-01	0.0000E-01	0.0000E-01	-1.8731E-04
5	3.5321E-02	-1.1368E-02	0.0000E-01	0.0000E-01	0.0000E-01	-1.0847E-04
6	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	-1.1856E-04

A/B NOTH WALL BRACE MODIFIED DESIGN



```
TITLE STIFFNESS CHANGE AUX BLDG NORTH WALL BRACING MODIFIED DESIGN
NODAL POINT LOCATION 1
1 0 0 0
2 0 292 0
3 0 492 0
4 [redacted] 492 0
5 [redacted] 292 0
6 308 0 0
7 367 221 0
8 427 148 0
9 -28 264 0

MATERIAL PROPERTIES 30E6 11.6E6 0 0.3 36000
BEAM TYPE 1 24.98 1 723 235
CONNECT 1 TO 2
CONNECT 2 TO 3
BEAM TYPE 1 9.12 1 238 19.8
CONNECT 4 TO 5
CONNECT 5 TO 6
BEAM TYPE 1 10.3 1 126 43
RELEASE V,W
CONNECT 2 TO 5
BEAM TYPE 1 4.14 1 88.2 2.25
RELEASE V,W
CONNECT 3 TO 4
BEAM TYPE 1 8.5 1 26.6 42.6
RELEASE V,W
CONNECT 1 TO 5
BEAM TYPE 1 4.8 1 26.6 42.6
RELEASE V,W
C[redacted]ECT 2 TO 6
B[redacted] TYPE 1 8.5 1 26.6 42.6
RELEASE V,W
CONNECT 2 TO 4
BEAM TYPE 1 8.5 1 26.6 42.6
RELEASE V,W
CONNECT 3 TO 5
BEAM TYPE 1 3.6 1 8.22 8.22
RELEASE V
CONNECT 5 TO 7
BEAM TYPE 1 3.6 1 8.22 8.22
RELEASE V
CONNECT 8 TO 7
BEAM TYPE 1 9.5 1 34.6 26.2
RELEASE V
CONNECT 2 TO 9
ZERO 11
RX 1 THROUGH 9
RY 1 THROUGH 9

ELIMINATE

END DEFINITION
```

[redacted]

STIFFNESS CHANGE AUX BLDG NORTH WALL BRACING MODIFIED DESIGN

STATIC ANALYSIS SUBCASE NO. 1 APPLIED FORCES

NODE	DIR	VALUE	NODE	DIR	VALUE	NODE	DIR	VALUE
4	X T	1.000E+04						

STATIC ANALYSIS SUBCASE NO. 1 DISPLACEMENTS

NODE	X TRANS	Y TRANS	Z TRANS	X ROT	Y ROT	Z ROT
1	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	-8.3908E-05
2	1.7296E-02	3.3489E-03	0.0000E-01	0.0000E-01	0.0000E-01	-9.8823E-06
3	2.7018E-02	4.0183E-03	0.0000E-01	0.0000E-01	0.0000E-01	-6.7978E-05
*4	3.6649E-02	-7.1921E-03	0.0000E-01	0.0000E-01	0.0000E-01	-1.0659E-04
5	1.3714E-02	-4.2913E-03	0.0000E-01	0.0000E-01	0.0000E-01	-2.8471E-05
6	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	-5.3048E-05
7	1.4164E-02	3.7888E-03	0.0000E-01	0.0000E-01	0.0000E-01	1.5433E-07
8	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	-2.1197E-04
9	2.0607E-02	0.0000E-01	0.0000E-01	0.0000E-01	0.0000E-01	1.8333E-04

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2. DETERMINE THE CHANGE IN THIS STIFFNESS DUE TO THIS MODIFICATION

3. DETERMINE THE PER CENT CHANGE IN THE FUNDAMENTAL FREQUENCY OF THE BUILDING.

REF. INFORMATION IS TAKEN FROM THE "AUXILIARY STRUCTURES SEISMIC ANALYSIS" EWR 2512

THE AUX. BLDG STEEL IS REPRESENTED BY TWO LUMPED MASSES IN THE SEISMIC MODEL.

WEIGHT OF LOW ROOF = 340 K

EAST-WEST ACCELERATION OF THE LOW ROOF = 0.473g

MAX. E-W DISPLACEMENT OF THE LOW ROOF = 0.652 IN

E-W STIFFNESS OF THE LOW ROOF $= K_{LR} = \frac{(340^K)(0.473)}{0.652\ IN}$

$= 247\ ^K/_{IN}$

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JOB: STRUCTURAL UPGRADE EWR 3296		MADE BY: LAS	CK:

WEIGHT OF THE HIGH ROOF = 554 K

E-W ACCELERATION OF THE HIGH ROOF = 0.496 g

MAX E-W DISPLACEMENT OF THE HIGH ROOF = 0.638 IN

E-W STIFFNESS OF THE HIGH ROOF = $K_{HR} = \frac{(554^K)(0.496g)}{0.638\ IN}$

$= 430\ ^K/IN$

WEIGHT TOTAL = $340^K + 554^K$
$= 894^K$

$K_{TOT} = 247 + 430$
$= 677\ ^K/IN$

DETERMINE STIFFNESS CHANGE DUE TO MODIFICATION
(REFER TO THE STRESS MODEL AND OUTPUT)

ORIGINAL DESIGN

APPLIED LOAD = 10^K @ NODE 4
DISPLACEMENT = 0.070 IN

$K_{ORIG} = 10^K/0.070\ IN = 143\ ^K/IN$

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JOB: STRUCTURAL UPGRADE EWR 3296		MADE BY: LAS	CK:

REVISED DESIGN

APPLIED LOAD = 10 ^{K} @ NODE 4
DISPLACEMENT = 0.037 IN

$$K_{REV} = 10^{K} / 0.037 \text{ IN} = 270\ ^{K}/_{IN}$$

STIFFNESS CHANGE = 270 − 143 = 127 $^{K}/_{IN}$

ESTIMATE THE INFLUENCE ON THE AUX. BLDG FUNDAMENTAL FREQUENCY

$$f = \frac{1}{2\pi}\sqrt{K/M}$$

$$f_{ORIG} = \frac{1}{2\pi}\sqrt{\frac{677}{894/g}} = 2.77 \text{ CPS}$$

$$f_{REV} = \frac{1}{2\pi}\sqrt{\frac{(677+727)}{(894+1)/g}} = 2.96 \text{ CPS}$$

$$\% \text{ CHANGE} = \frac{2.96-2.77}{2.77} \times 100\% = 7\%$$

THIS SMALL CHANGE IN FREQUENCY IS CONSIDERED NOT SIGNIFICANT BECAUSE IT IS WELL WITHIN THE

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JOB: STRUCTURAL UPGRADE EWR 3296		MADE BY: LAS	CK:

BROAD BANDING GUIDELINE FOR RESPONSE SPECTRA (±15%) SET FORTH IN USNRC REGULATORY GUIDES, AND WELL WITHIN FACTORS OF SAFETY INHERENT IN ANY STRUCTURAL OR COMPONENT DESIGN.