TURBINE BUILDING TORNADO EVALUATION

SEP TOPIC NO. III-2: WIND AND TORNADO LOADINGS

BY

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OYSTER CREEK NUCLEAR GENERATING STATION

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INTRODUCTION

10CFR50 (GDC 2), as implemented by Standard Review Plan Sections 3.3.1 and 3.3.2 and Regulatory Guides 1.76 and 1.117, requires that the plant be designed to withstand the effects of natural phenomena such as wind and tornados.

In January 1983, GPUN transmitted our tornado evaluation for the reactor building entitled "Responses to NRC Questions for Topic III-2: Wind and Tornado Loadings".

During the integrated assessment of the SEP Topic III-2, the NRC staff requested evaluation of the turbine building capacity and the effect of its failure on other structures (e.g., the control room).

The evaluation has recently been completed and the results are summarized below.

Calculation to support the results are given in Attachment I, II and III.

SUMMARY OF RESULTS

I. Turbine Building: Tornado Loading

Based on the redundancy of the structure, a three dimensional analysis of the Turbine Building steel frame was performed. This permitted evaluation of the structural system first yield through to postulated failure.

The weakest element in the steel frame system was determined to be the column anchor bolts.

The analysis for wind loading has indicated that anchor bolt overstress will first occur at 107 mph. This does not, however, endanger frame stability since the system is highly redundant and capable of sustaining substantial additional loading.

At a wind velocity of 139 mph all anchor bolts would be expected to reach yield. Again, this does not signify frame failure since lateral deflection is still minimal and the systems are still structurally stable.

At a wind velocity of about 158 mph, lateral deflection would have proceeded to a point where three steel frames are in contact with the Control Room/New Cable Spreading Room (NCSR) roof. At this point, the roof structure becomes a reaction point for three of the frames for additional wind loading.

At a wind velocity of about 212 mph, the first anchor bolt reaches ultimate strength. This is considered as a system failure since there will be a progressive anchor bolt failure and collapse of the steel structure.

The wind load reaction at the Control Room/NCSR roof at 212 mph was calculated to be lower than the lateral loads imposed by the OBE earthquake and therefore will not overstress the Control Room structure.

Based on the height of the steel structure with reference to grade, impact analysis for a torndao driven utility pole was considered as possible over the bottom seven feet of the building columns. The critical impact location would be at the base plate where the full energy of the impact must be absorbed by the anchor bolts. It was determined that the anchor bolts do not have sufficient energy absorption capacity to resist the impact and would shear upon impact.

Although able to induce base failure, the probability of a missile striking a column base is considered minimal. The subject missile, a utility pole, is an object 13 1/2 inches in diameter traveling in the upper limits of its height envelope and must impact an object approximately 12 inches wide to cause failure.

Consequences of a frame lateral failure, whethere wind or missile induced have been evaluated and found to have no affect on safety related structures. The collapse of the steel frames would potentially involve two targets of concern - the Control Room and the Reactor Building. These targets differ substantially in potential for impact and will be discussed separately.

Three steel frames span over the Control Room and have the potential to impact it upon failure of the anchor bolts. As calculated for wind induced failure, reaction of the frames on the Control Room would be well below the seismic capacity of the structure and would not cause structural distress. If the failure were induced by missile impact, it would be expected to occur after initial contact between the frames and the Control Room had occurred and the loading pattern would be similar to wind induced failure.

The second potential target for a laterally failed frame would be the Reactor Building. Based on the height of the steel frame, the separation between the frames and the Reactor Building, and assuming pure rotation of all frame joints, contact with the Reactor Building (concrete walls) is possible during frame collapse. However, prior to reaching the Reactor Building, the frame column would contact the Office Building roof spandrel and the point of rotation would be transferred from the column base to a point approximately 14 feet above the base. Working with this new rotation point, the frame will not reach the Reactor Building and no impact is considered possible.

The concrete portion of the Turbine Building has been reviewed and its structural capacity has been determined to be greater than the steel frames. No distress of the concrete portion of the structure is expected at loads beyond the capacity of the steel frame.

The ultimate depressurization capacity of the steel frame is 0.43 psi. This value is higher than the capacity of the siding 0.39 psi. Since the siding failure would precede frame overstress, there is no chance of the frame integrity being endangered by depressurization.

II. Turbine Building: Wind Load Combinations

All steel frame members, girts, purlins and decking were determined to be stressed below the allowable levels of NUREG 0800, Section 3.8.4 for combinations involving dead load, snow load and 80 mph wind load.

For load combinations including dead, snow and wind loads, all concrete bearing meets the original design criteria which allowed a one-third increase in allowable stress for combinations including wind load. One set of anchor bolts showed minor overstress for one wind direction based on original design criteria. Using current NUREG 0800 allowable stresses, nine sets of anchor bolts and eight base plate concrete bearing stresses exceed the allowable values. Based on satisfactory results using the original design criteria, the steel structure is judged to be adequate to safely resist the applied loading.

For the combination of dead load plus wind load, it has been determined that anchor bolt and concrete bearing stresses exceed the original design criteria at several columns and in one column, the anchor bolts are stressed beyond yield. In order to assess the affect of anchor bolt yield on the stability of the steel structure, a three dimensional analysis was performed for a model with three sets of column anchor bolts stressed to yield. From this analysis it was determined that the structure will retain its structural stability under 80 mph wind loading and will undergo small lateral deflections.

A review of the loadings imposed on concrete portions of the Turbine Building by wind loading has shown that the design is governed by operating basis earthquake and no additional wind load calculations are required.

From the above analyses, it is judged that the Turbine Building can safely sustain load conditions which include 80 mph wind loading.

III. Turbine Building Roof: Wind Load Analysis

The limiting elements in the roof assembly are the purlins. The safe sustainable wind velocity of the purlins is 134 mph based on allowable stress levels of NUREG 3.8.4. The roof deck and roof trusses have capacity for much higher wind velocities.

Purlin failure will occur due to lateral buckling of the bottom flange which is unsupported when considering wind uplift loading. It is postulated that the purlin deflections from lateral buckling will cause failure of the roof deck/purlin connection and release the decking. The decking would be carried up and away from the Turbine Building which would relieve the purlins from further loading and stabilize their condition. The released decking would form tornado driven missiles which would be of small mass and of less consequence than missiles required for consideration by design codes.

ATTACHMENT I

TURBINE BUILDING: TORNADO LOADING

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SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. 6.1302.151.5320-001
SHEET NO. 1 OF 59
DATE 11/7/83
COMP. BY/DATE TH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

PROBLEM TWO DIMENSIONAL FRAME ANALYSIS OF THE TURBINE BUILDING STEEL FRAME INDICATES RESISTANCE CAPACITY LESS THAN TORNADO VELOCITY OF 250 MPH. PROVIDE THREE DIMENSIONAL FRAME ANALYSIS TO DETERMINE ACTUAL CAPACITY WHEN ADJACENT FRAME INTERACTION IS CONSIDERED AND DETERMINE EFFECT OF FRAME FAILURE ON THE CONTROL BUILDING.

RESULTS BASED ON A 3 DIMENSIONAL FRAME ANALYSIS, THE TURBINE BUILDING STEEL FRAME WAS FOUND TO HAVE A DEPRESSURIZATION CAPACITY OF 0.43 PSI BASED ON THE ALLOWABLE STRESS VALUES OF NUREG 0800 SECT 3.8.4 THIS IS IN EXCESS OF THE SIDING CAPACITY WHICH WAS PREVIOUSLY CALCULATED AS 0.39 PSI AND THEREFORE DOES NOT LIMIT FRAME SERVICEABILITY.

EAST/WEST TORNADO CAPACITY —

ANALYSIS HAS INDICATED THAT AT A TORNADO VELOCITY OF 107 MPH, ONE SET OF COLUMN ANCHOR BOLTS WILL REACH THE ALLOWABLE STRESS VALUE OF NUREG 0800 SECT 3.8.4 ADDITIONAL COMPUTER ANALYSIS HAS SHOWN THAT PROGRESSIVE YIELDING OF COLUMN ANCHOR BOLTS WILL OCCUR WITHOUT EXCESSIVE LATERAL DEFLECTION TO A VELOCITY OF APPROXIMATELY 165 MPH. AT THIS POINT, THE STEEL COLUMNS WILL CONTACT THE CONTROL ROOM/MER ROOF AND PREVENT ADDITIONAL LATERAL DEFLECTION AT THOSE POINTS. TORNADO VELOCITY MAY THEN INCREASE TO AN ESTIMATED 212 MPH WHEN ONE SET OF ANCHOR BOLTS WOULD REACH ULTIMATE AND FRAME FAILURE IS INITIATED. THE FRAME REACTION ON THE CONTROL ROOM/MER ROOF IS CALCULATED TO BE LOWER THAN THE OSE REACTION AND WOULD NOT ADVERSELY AFFECT THE CONTROL ROOM INTEGRITY

REFERENCES

1.) NUREG 0800 SECT 3.8.4 "OTHER SEISMIC CATEGORY I STRUCTURES"
2.) ACI 349-1980 "CODE REQUIREMENTS FOR NUCLEAR SAFETY RELATED CONCRETE STRUCTURES"
3.) ACI HANDBOOK SP-3 "REINFORCED CONCRETE DESIGN HANDBOOK
4) BURNS AND ROE W.O. 2299 DRAWINGS 4208, 4209, 4214, 4213
5.) COMPUTER OUTPUT "PHSTRWJ"
6) CALCULATION Nº C-1302-151-5320-003
7) "STRUCTURAL STEEL DESIGNERS HANDBOOK" BY MERRIT
8) COMPUTER OUTPUT "PHSTROJ"
9) COMPUTER OUTPUT "PHSTRL9"
10) COMPUTER OUTPUT "PHSTRNI"
11) COMPUTER OUTPUT "PHSTRKZ"
12) STONE & WEBSTER CALCULATION Nº 13432.30-137 W.O. Nº 13432.30
13) NUREG 0800 SECTION 3.8.2 "TORNADO LOADINGS"
14) NRC DOCKET Nº 50-213 LSOD-81-11-033

THREE DIMENSIONAL FRAME ANALYSIS

FRAME MODEL

- REF CALC. Nº C-1302-151-5320-003 FOR TYPICAL FRAME COL LINES 2-10
- REF DWG Nº 4214 FOR FRAME ON COL LINE 1
- REF DWG Nº 4209 FOR ROOF TOP & BOTTOM CHORD TRUSSES
- REF DWG Nº 4209 FOR VERTICAL TRUSSING BETWEEN FRAMES
- REF DWG Nº 4213 FOR VERTICAL BRACING ON COL LINES (A) AND (E)

FRAME LOADING-

- PROPORTION FROM 2-D ANALYSIS BASED ON CONTRIBUTORY WIDTH

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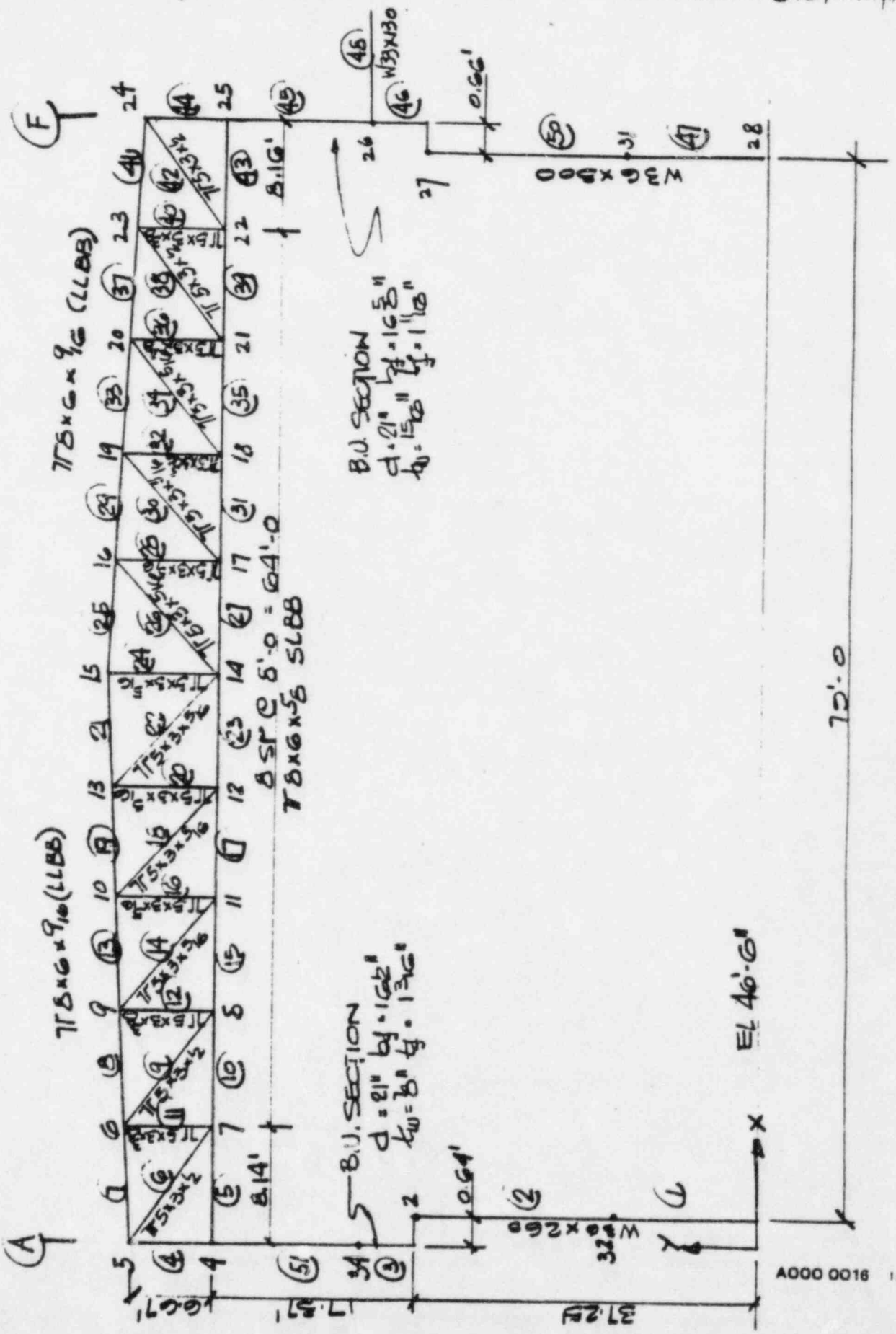
TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1202-151-5320-001
SHEET NO. 4 OF 59
DATE 11/21/83
COMP. BY/DATE TH 11/28/83
CHK'D. BY/DATE DBT 12/12/83



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TURBINE BUILDING TORNADO CAPACITY

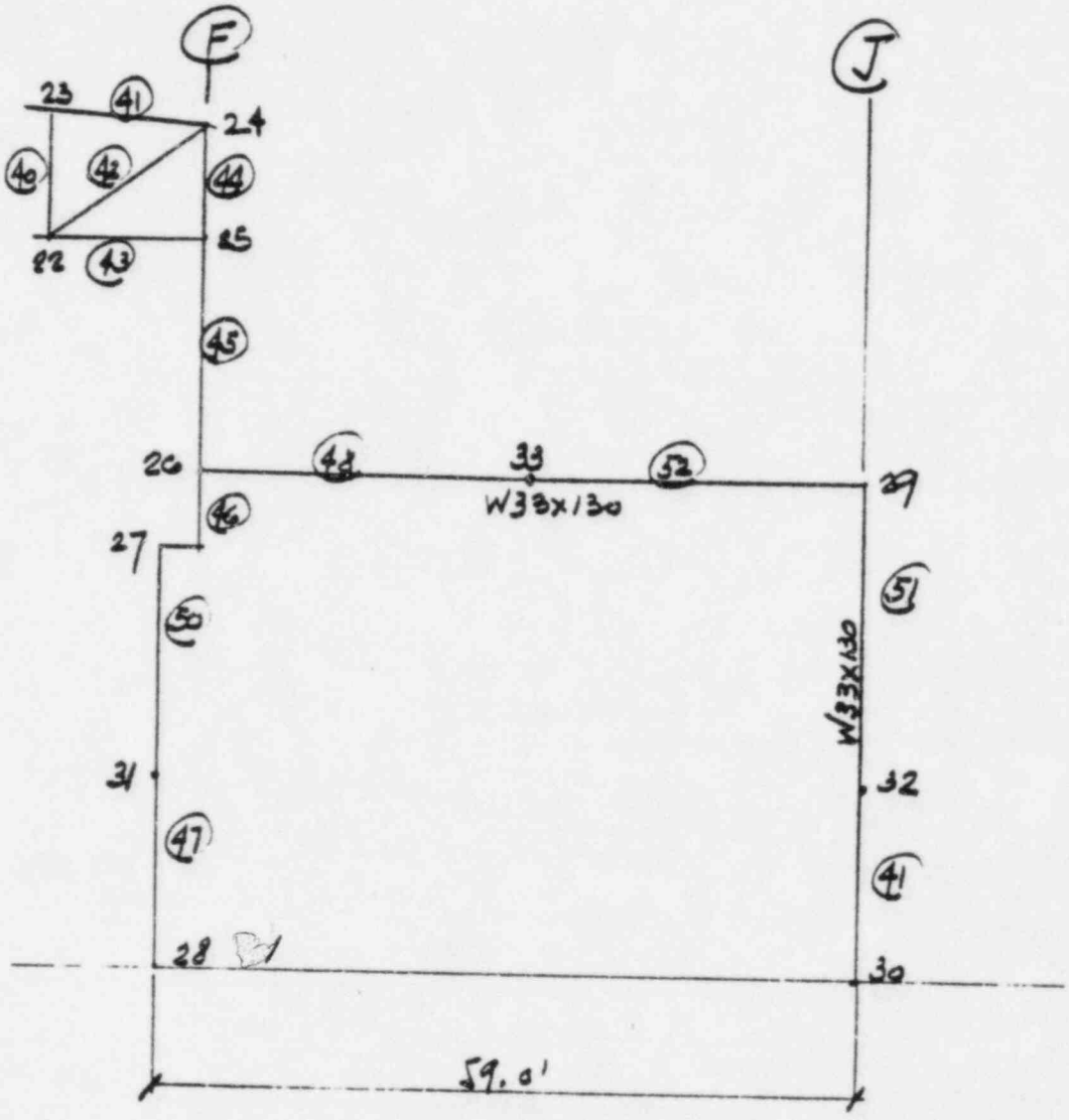
CALC. NO. G-1307-121-2220-001

SHEET NO. 5 OF 59

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE DBT 12/2/83



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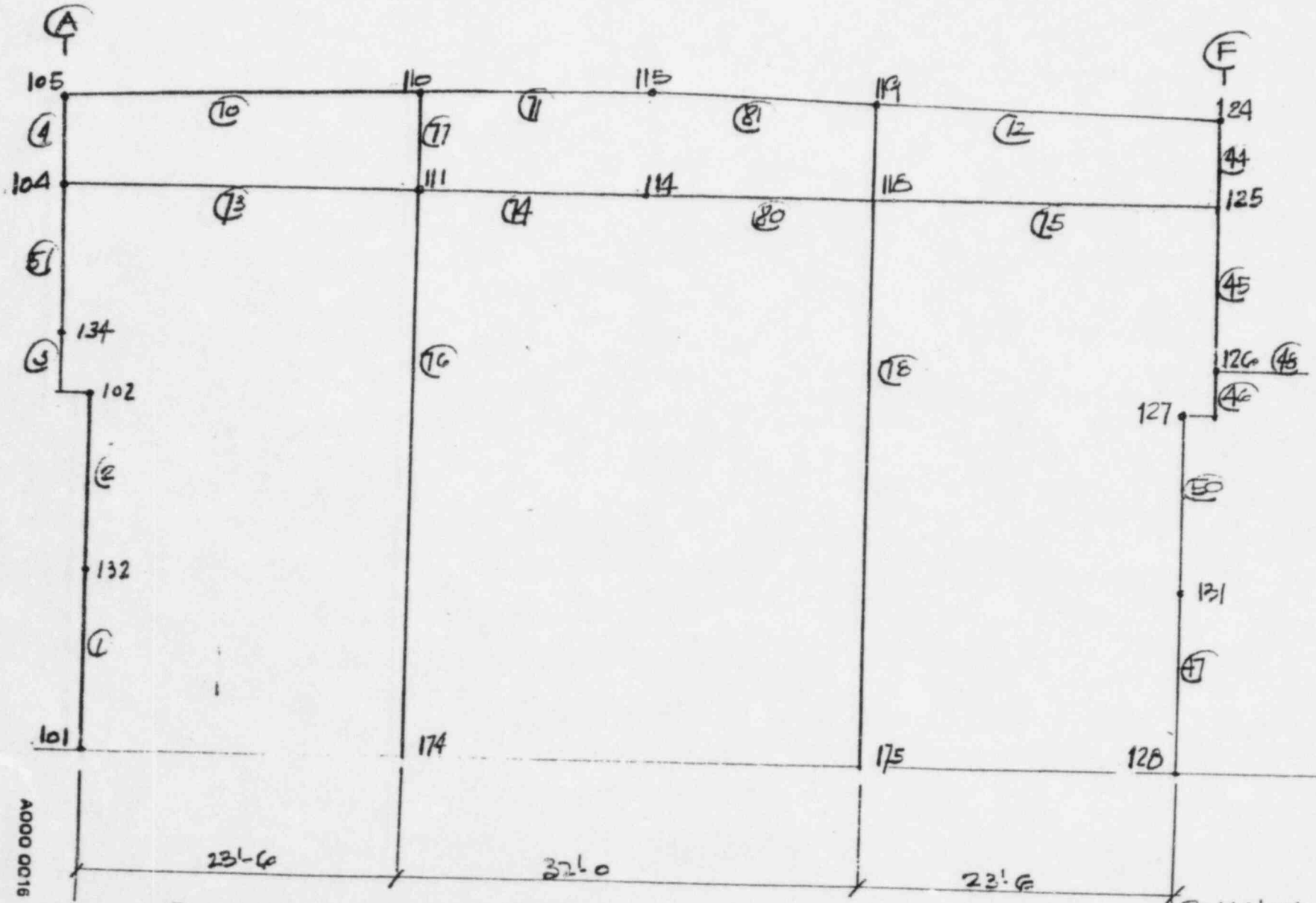
SHEET NO. 6 OF 59
DATE 11/7/83
COMP BY/DATE PH 11/28/83
CHK'D BY/DATE DBT 12/12/83

SUBJECT SEP TOPIC III.2
TURBINE BUILDING TORNADO CAPACITY



REMAINDER SAME AS COL 2-10

PREFIX ALL MEMBER NUMBERS 100 +

ELEVATION ON COLUMN LINE 1

A000 0016 12-80

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SUBJECT SEP TOPIC III-2

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302-151-5310-001

SHEET NO. 7 OF 59

DATE 11/7/83

COMP. BY/DATE FH 11/28/83

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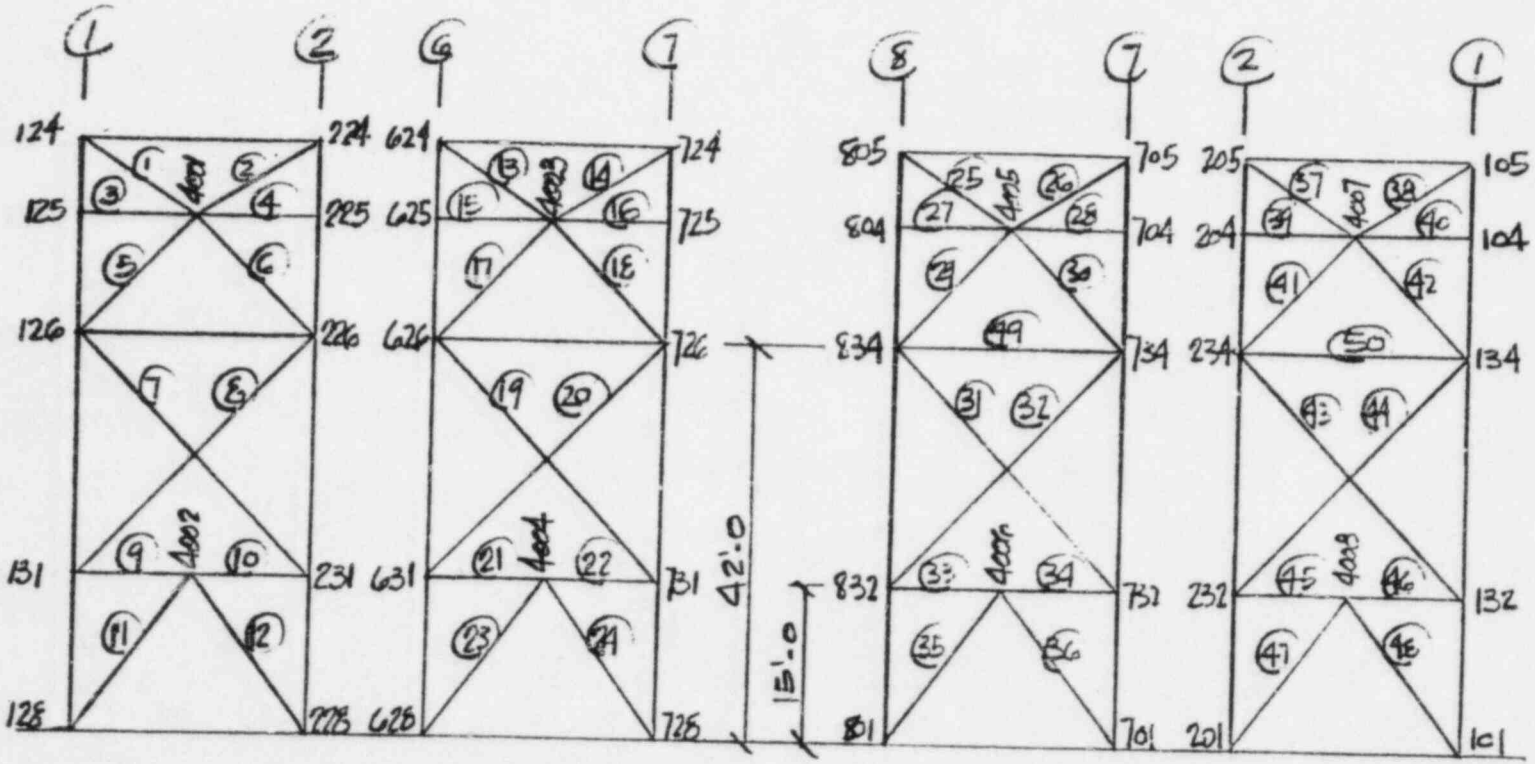

COLUMN LINE (F)

COLUMN LINE (A)

PREFIX ALL MEMBER NUMBERS 5000+

VERTICAL FRAMES @ COLUMN LINES (A & F)

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TURBINE BUILDING TORNADO LOADING

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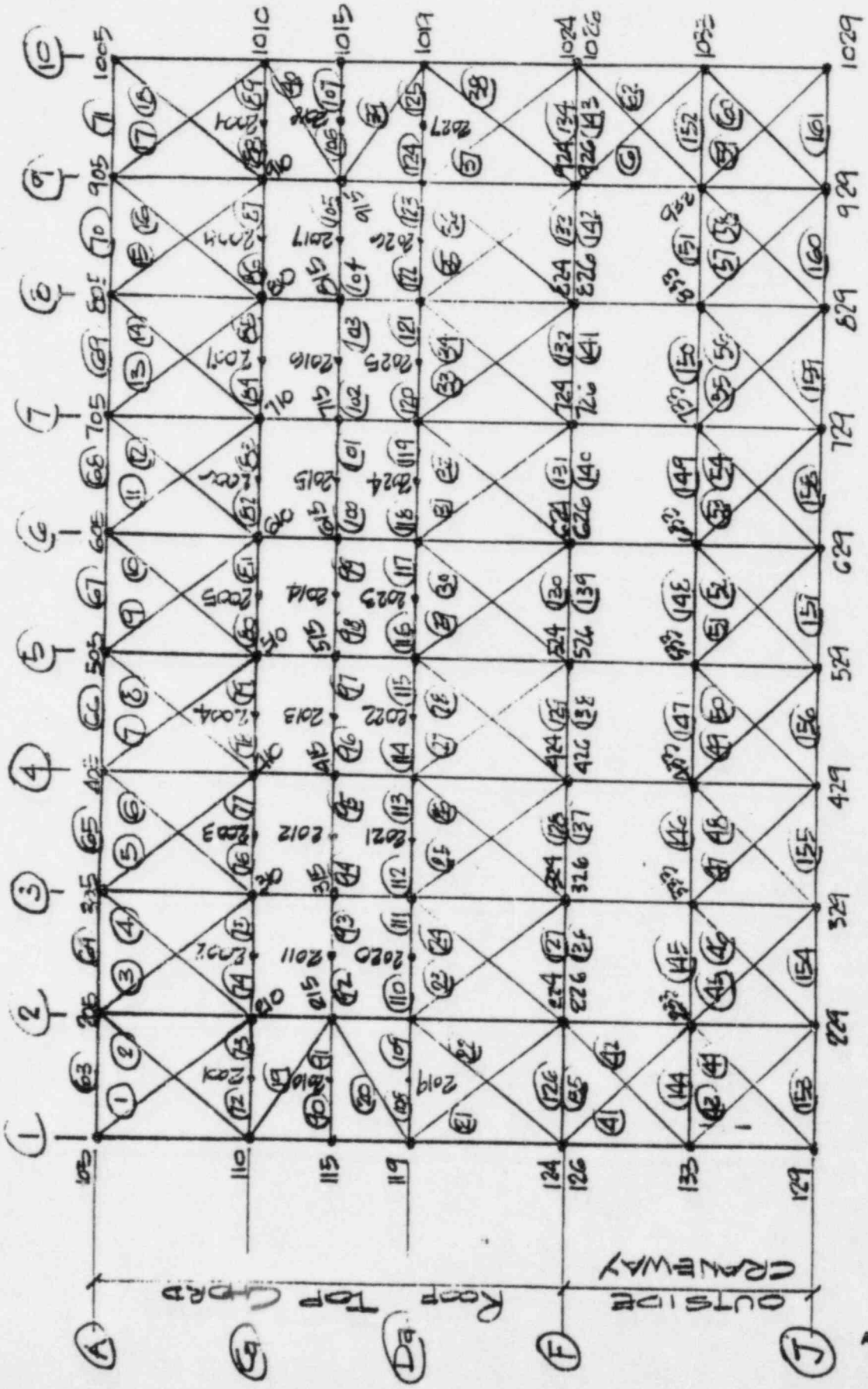
SHEET NO. 8 OF 59
DATE 11/7/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE D.B.T. 12/12/83



PREFIX ALL MEMBER NUMBERS 2000 +

ROOF TOP CHORD HORIZONTAL TRUSS
OUTSIDE CRANEWAY HORIZONTAL TRUSS

A000 0016 12-80

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SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

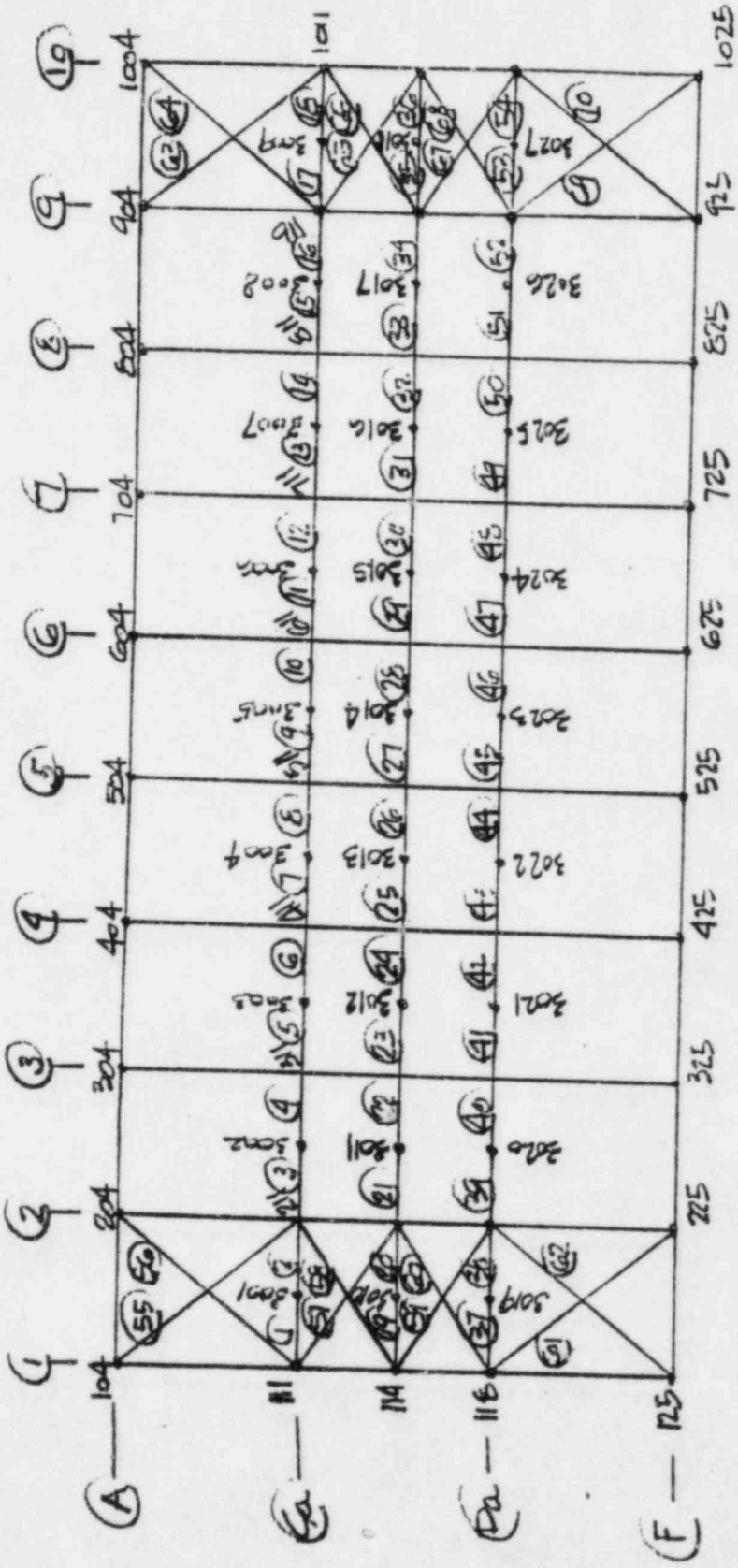
CALC. NO C-1302-151-5320-007

SHEET NO. 9 OF 59

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE DBT 12/12/83



PREFIX ALL MEMBER NUMBERS 3000 +

BOTTOM CHORD HORIZONTAL TRUSS

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TURBINE BUILDING TORNADO CAPACITY

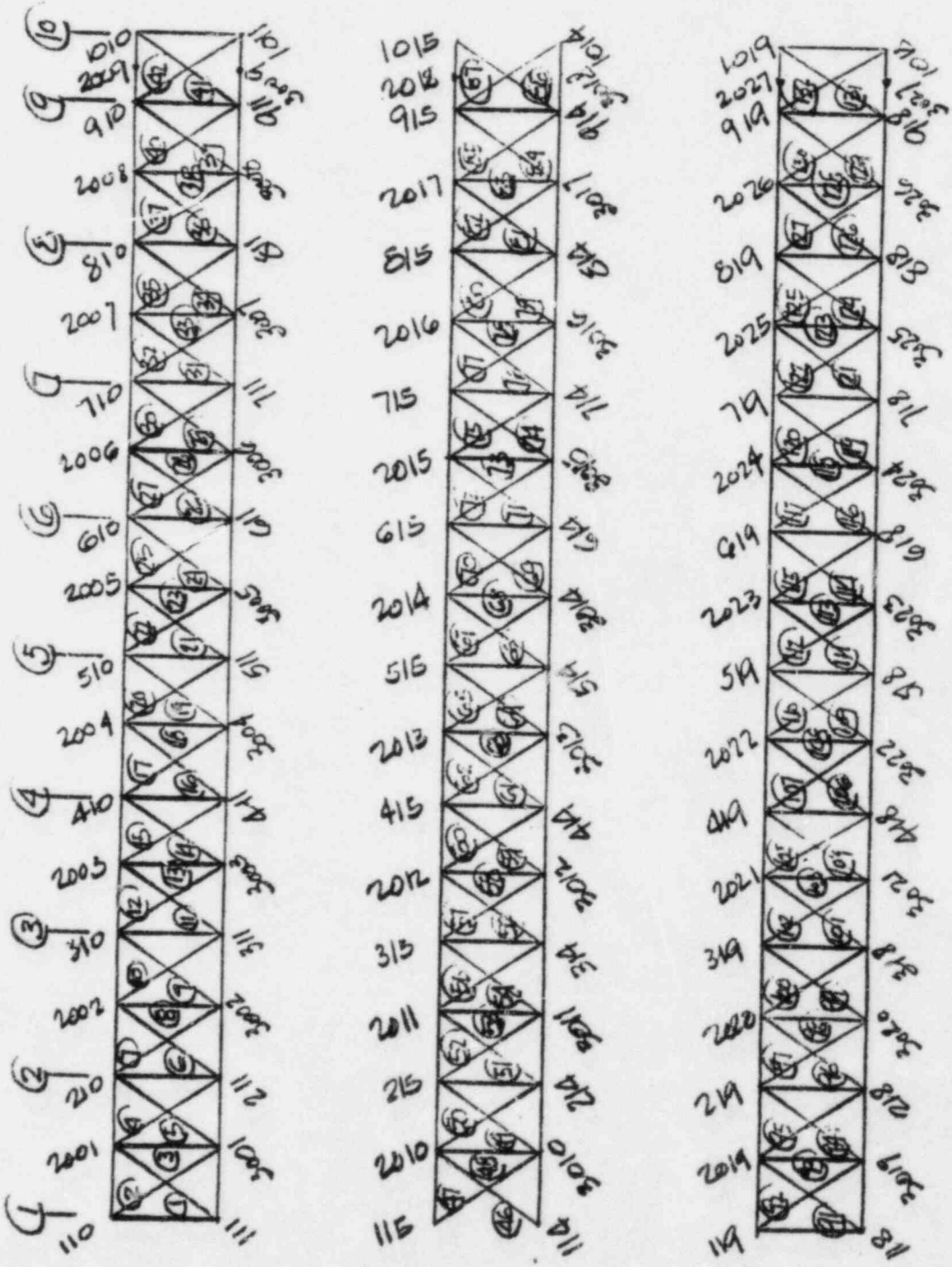
CALC. NO C-1302-151-5320-

SHEET NO. 10 OF 59

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE DBT 12/12/83



PREFIX ALL MEMBER NUMBERS 4000 +

ROOF VERTICAL TRUSSES

TORNADO LOADING

ALLOWABLE STRESS CONC. BEARING

ACI 10.16.1 $F_p = \phi (0.85 f'_c)$

9.3.2 e $\phi = 0.70$

$F_p = (0.70)(.85 \times 3) = 1.785^{KSI}$

BASED 10.16.1.1 w/ $A_2 > 4A_1$, $\sqrt{\frac{A_2}{A_1}} = 2$.

$F_p = (1.785)(2) = 3.57^{KSI}$

ALLOWABLE STRESS - ANCHOR BOLTS

NUREG 0800 SECT 3.8.4

PARAGRAPH 5.b for 3.6.(ii)(a)(2)

ALLOWABLE = 1.6S = 1.6 x 22 = 35.2 KSI

FOR ANCHOR BOLT STRESS DETERMINATION, USE METHOD OF "ACI REINFORCED CONCRETE HANDBOOK" (SP-3) FOR SINGLY REINFORCED CONCRETE BEAMS.

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SUBJECT: SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-302-151-5320-007
SHEET NO. 12 OF 57
DATE 10/24/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

REF COMPUTER OUTPUT "PHSTRWJ"

CHECK ANCHOR BOLTS FOR W36x260 $b = 26''$ $A_T = 5\ \square''$ $d = 47''$
COLUMN LINE A
MEMBER 501 @ JOINT 501

LOADING	P	M
(a) 17	95 K T	49245 K"
(b) 189	237 K T	49684 K"

$e = \frac{49245}{-95} + 21 = -497.4''$

$e/d = -497.4/47 = -10.58$

$e = \frac{49684}{-237} + 21 = -188.6''$

$e/d = -188.6/47 = -4.01$

TRY $j = 0.92$

$i = \frac{1}{\left(1 - \frac{0.92}{-10.58}\right)} = 0.920$

$i = \frac{1}{\left(1 - \frac{0.92}{-4.01}\right)} = 0.813$

$m = \frac{g}{\delta} = 0.03388$

$k = 0.2286$

$m = \frac{g}{\delta} = 0.02995$

$k = 0.2466$

$C = 0.924$

$C = 0.918$

$f_s = \frac{(95)(-10.58)}{(0.924)(5)(0.920)} = 232.4^{KSI} > 35.2^{KSI}$

$f_s = 254.1^{KSI} > 35.2^{KSI}$

$f_c = \frac{(232.4)(0.2286)}{(9)(1-0.2286)} = 7.654^{KSI} > 3.57^{KSI}$

$f_c = 9.241^{KSI} > 3.57^{KSI}$

OVERSTRESS = $254.1/35.2 = 7.219$ ← governs
$= 9.241/3.57 = 2.589$

BASED ON OVERSTRESS WITH WIND ALONE, DETERMINE MAX ALLOWABLE VELOCITY WITHOUT DEPRESSURIZATION

WIND LOAD COMPONENTS

	P	M
1 = DL	+74.2 k (C)	-584.2 k"
4 = WL	-10.6 k (T)	+3114.3 k"

(@ 10 psf STAGNATION PRESS)

COMBINATION 17 IS BASED ON 1×1.0 + 7×16.0

TRY 1×1.0 (DL) + 7×2.5 (WL)

P = (74.2) + (2.5)(-10.6) = 47.7 k C
M = -584.2 + (2.5)(3114.3) = 7201.6 k" C

e = 171.98 e/d = 3.66
TRY j = 0.92 L = 1.336 m = q = 0.0442 k = 0.268 j = 0.911

$f_s = \frac{(47.7)(3.66)}{(.911)(5)(1.336)} = 28.69^{ksi} < 35.2^{ksi}$ OK

TRY 1×1.0 + 7×3.0

P = 74.2 + (3)(-10.6) = 42.4 k
M = -584.2 + (3)(3114.3) = 8758.7 k"

e = 227.6" e/d = 4.842
TRY j = 0.92 L = 1.2346 m = q = 0.0455 k = 0.259 j = 0.913

$f_s = \frac{(42.4)(4.842)}{(0.9135)(5)(1.2346)} = 36.40^{ksi} > 35.2^{ksi}$ NG

TRY 1×1.0 + 7×2.93

P = 74.2 + (2.93)(-10.6) = 43.14 k
M = -584.2 + (2.93)(3114.3) = 8590.7 k"

e = 218.98" e/d = 4.659
TRY j = 0.92 L = 1.246 m = q = 0.0459 k = 0.261 j = 0.913

$f_s = \frac{(43.14)(4.659)}{(0.913)(5)(1.246)} = 35.3^{ksi} \sim 35.2^{ksi}$ ok

$f_c = \frac{(35.3)(0.261)}{(9)(1-0.261)} = 1.386^{ksi} < 3.57^{ksi}$ OK

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SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 14 OF 59
DATE 11/3/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

$$\text{VELOCITY} = \sqrt{\frac{293}{0.00256}}$$ 107 MPH COL A-5 (CRITICAL FOR COLUMN LINE A)

AT 107 MPH, ANCHOR BOLTS REACH ALLOWABLE STRESS LEVEL OF NUREG 0800 SECT 3.8.4

CHECK DL + DEPRESSURIZATION

$P = 276^k$ T
$M = 30479^{k''}$

$$e = \frac{30479}{-276} + 21 = -89.43'' \qquad e/d =$$

$$w/\gamma = 0.92 \qquad i = \frac{1}{\left(1 - \frac{0.92}{-1.753}\right)} = 0.656 \qquad m = \frac{q}{\gamma} = 0.02226$$

$$k = 0.1899 \qquad \gamma = 0.937$$

$$f_s = \frac{(-276)(-1.753)}{(0.937)(5)(0.656)} = 157.43^{ksi} \text{ NG} \qquad f_c = \frac{(157.43)(0.1899)}{(9)(1-0.1899)} = 4.10^{ksi} \text{ NG}$$

OVERSTRESS $157.43/35.2 = 4.472$ — governs.
$4.10/3.57 = 1.148$

COMPONENTS

		P	M
1	DL	74.2^k	$-584.2^{k''}$
9	DEP	-13.9^k	$-1186.3^{k''}$ (BASED 10 PSF)

1.75 psi = 25.2 × (10PSF DEP)

TRY DEP × 5.7

$P = 74.2 - (5.7)(13.9) = -5.03$ (T)
$M = -584.2 - (5.7)(1186.3) = -7346.11^{k''}$

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DATE 11/3/83
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CHK'D. BY/DATE DBT 12/12/83

$e = \frac{7346}{-5.03} + 21 = -1439.4''$ $\quad e/d = -28.22$

w/ $j = 0.92$ $\quad c = 0.9683$ $\quad m = g = 0.03286$ $\quad k = 0.2256$ $\quad j = 0.9248$

$f_s = \frac{(5.03)(-28.22)}{(0.9683)(5)(0.9248)} = 31.70 < 35.2$ OK

$f_c = \frac{(31.70)(0.2256)}{(9)(1-0.2256)} = 1.026 < 3.57$ OK

TRY DEP × 6.2

$P = 74.2 - (6.2)(13.9) = -11.98^K$ (T)
$M = -584.2 - (6.2)(1186.3) = -7939.3^{k''}$

$e = \frac{7939.3}{-11.98} + 21 = -641.7''$ $\quad e/d = -12.58$

w/ $j = 0.92$ $\quad c = 0.932$ $\quad m = g = 0.0316$ $\quad k = 0.2218$ $\quad j = 0.926$

$f_s = \frac{(-11.98)(-12.58)}{(0.926)(5)(0.932)} = 34.9^{ksi} < 35.2^{ksi}$

$f_c = \frac{(34.9)(0.2218)}{(9)(1-0.2218)} = 1.105^{ksi} < 3.57^{ksi}$

$DEP = \frac{(6.2)(10)}{144} = 0.431$ psi

AT 0.43 psi DEPRESSURIZATION, ANCHOR BOLTS REACH THE ALLOWABLE STRESS LEVEL OF NUREG 0800 SECT 3.8.4

THIS STRENGTH EXCEEDS THE CAPACITY OF THE SIDING TO RESIST DEPRESSURIZATION (0.39 PSI) PER REF 6 THEREFORE ANCHOR BOLT STRESSES ARE NOT SIGNIFICANT FOR FRAME ANALYSIS FOR DEPRESSURIZATION

CHECK COLUMN F-5 FOR WIND IN OPPOSITE DIRECTION (107 MPH VELOCITY) COMBINATION 1+8×2.93

$P = 93.7 + (2.93)(-8.5) = 68.8^{k}$ C

$M = 270.6 + (2.93)(-3297.0) = 9389.6^{k''}$

$e = \frac{9389.6}{68.8} + 21 = 157.47 \quad e/d = 3.088$

$w/g = .092 \quad i = 1.4243 \quad m \cdot g = 0.0433 \quad k = 0.254 \quad j = 0.915$

$f_s = \frac{(68.8)(3.088)}{(0.915)(5)(1.4243)} = 32.60^{ksi} < 35.2^{ksi}$ OK

$f_c = \frac{(32.60)(0.254)}{(9)(1-0.254)} = 1.233^{ksi}$ OK

WIND COMBINATION 1+8 DOES NOT GOVERN

DETERMINE STATUS OF OTHER ANCHOR BOLTS AT WIND VELOCITY OF 107 MPH AND NO DEPRESSURIZATION (LOADING 1+7)

101 P = 41.0 + (13.06)(2.93) = 79.3^k
M = 81.1 + (1825.4)(2.93) = 5429.5$^{k'}$

201 P = 64.9 + (-20.7)(2.93) = 4.2^k
M = -274.9 + (2612.0)(2.93) = 7378.3$^{k''}$

301 P = 64.7 + (-7.97)(2.93) = 41.3^k
M = -468.5 + (2739.6)(2.93) = 7558.5$^{k''}$

401 P = 71.5 + (-9.7)(2.93) = 43.1^k
M = -552.6 + (2996.9)(2.93) = 8228.3$^{k''}$

601 P = 71.8 + (-10.2)(2.93) = 41.9^k
M = -567.7 + (2999.9)(2.93) = 8222.0$^{k''}$

701 P = 69.4 + (-5.5)(2.93) = 53.3^k
M = -536.4 + (2783.8)(2.93) = 7620.1$^{k''}$

801 P = 70.9 + (-11.6)(2.93) = 36.9^k
M = -481.2 + (2559.8)(2.93) = 7019.0$^{k''}$

901 P = 56.6 + (-8.8)(2.93) = 30.8^k
M = -350.9 + (2110.8)(2.93) = 5833.7$^{k''}$

1001 P = 40.7 + (-4.2)(2.93) = 28.4^k
M = -218.6 + (1799.8)(2.93) = 5054.6$^{k''}$

$b = 26''$ $d = 47''$

107 $e = \frac{5429.5}{79.3} + 21 = 89.46''$ $e/d = 1.903$

$w/g = 0.92$ $i = 1.9355$ $m - g = 0.07127$ $k = 0.313$ $j = 0.896$

$f_s = \frac{(79.3)(1.903)}{(0.896)(.5)(1.9355)} = 17.40^{ksi}$ $f_c = .881^{ksi}$

201 $e = \frac{7378.3}{4.2} + 21 = 1777.7''$ $e/d = 37.82$

$w/g = 0.92$ $i = 1.025$ $m - g = 0.0377$ $k = 0.240$ $j = 0.920$

$f_s = \frac{(4.2)(37.82)}{(0.920)(.5)(1.025)} = 33.69^{ksi}$ $f_c = 1.182^{ksi}$

301 $e = \frac{7558.5}{41.3} + 21 = 204.0''$ $e/d = 4.340$

$w/g = 0.92$ $i = 1.2690$ $m - g = 0.0467$ $k = 0.263$ $j = 0.912$

$f_s = \frac{(41.3)(4.340)}{(0.912)(.5)(1.2690)} = 30.98^{ksi}$ $f_c = 1.228^{ksi}$

401 $e = \frac{8228.3}{43.1} + 21 = 211.9''$ $e/d = 4.5085$

$w/g = 0.92$ $i = 1.2563$ $m - g = 0.0463$ $k = 0.261$ $j = 0.913$

$f_s = \frac{(43.1)(4.5085)}{(0.913)(.5)(1.2563)} = 33.88^{ksi}$ $f_c = 1.330^{ksi}$

601 $e = \frac{8222.0}{41.9} + 21 = 217.2''$ $e/d = 4.621$

$w/g = 0.92$ $i = 1.2486$ $m - g = 0.04598$ $k = 0.261$ $j = 0.913$

$f_s = \frac{(41.9)(4.621)}{(0.913)(.5)(1.2486)} = 33.97^{ksi}$ $f_c = 1.333^{ksi}$

701 $e = \frac{7620.1}{53.3} + 21 = 163.97''$ $e/d = 3.489$

$w/g = 0.92$ $i = 1.358$ $m - g = 0.0500$ $k = 0.270$ $j = 0.910$

$f_s = \frac{(53.3)(3.489)}{(0.910)(.5)(1.358)} = 30.10^{ksi}$ $f_c = 1.237^{ksi}$

80) $e = \frac{7019}{36.9} + 21 = 211.2$ $e/d = 4.494$

$w/d = 0.92$ $L = 1.2574$ $m = q = 0.0963$ $k = 0.2615$ $j = 0.913$

$f_s = \frac{(36.9)(4.494)}{(0.913)(5)(1.2574)} = 28.89^{ksi}$ $f_c = 1.137^{ksi}$

90) $e = \frac{58337}{30.8} + 21 = 210.4$ $e/d = 4.4766$

$w/d = 0.92$ $L = 1.2586$ $m = q = 0.4635$ $k = 0.261$ $j = 0.913$

$f_s = \frac{(30.8)(4.4766)}{(0.913)(5)(1.2586)} = 24.00^{ksi}$ $f_c = 0.942^{ksi}$

100) $e = \frac{5054.6}{28.4} + 21 = 198.98$ $e/d = 4.234$

$w/d = 0.92$ $L = 1.2776$ $m = q = 0.0470$ $k = 0.263$ $j = 0.912$

$f_s = \frac{(28.4)(4.234)}{(0.912)(5)(1.2776)} = 20.64^{ksi}$ $f_c = 0.818^{ksi}$

Nuclear

SUBJECT SEP TOPIC III·2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1332-S-5020-001
SHEET NO. 20 OF 59
DATE 11/3/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

128 P = 50.3 + (8.8)(2.93) = 76.1^k
M = 32.3 + (2099.6)(2.93) = 6184.1$^{k''}$

228 P = 83.6 + (-16.7)(2.93) = 34.7^k
M = 27.7 + (2266.4)(2.93) = 6668.3$^{k''}$

328 P = 81.8 + (-7.8)(2.93) = 58.9^k
M = 212.2 + (2350.2)(2.93) = 7098.3$^{k''}$

428 P = 92.8 + (-9.8)(2.93) = 64.1^k
M = 257.8 + (2460.4)(2.93) = 7466.8$^{k''}$

528 P = 93.7 + (-10.7)(2.93) = 62.3^k
M = 270.6 + (2495.4)(2.93) = 7582.1$^{k''}$

628 P = 95.3 + (-9.0)(2.93) = 68.9^k
M = 266.9 + (2411.2)(2.93) = 7331.7$^{k''}$

728 P = 91.9 + (-10.6)(2.93) = 60.8^k
M = 239.8 + (2256.4)(2.93) = 6851.1$^{k''}$

828 P = 82.2 + (-8.3)(2.93) = 57.9^k
M = 194.2 + (2089.2)(2.93) = 6315.6$^{k''}$

928 P = 72.2 + (-5.9)(2.93) = 54.9^k
M = 118.9 + (1832.4)(2.93) = 5487.8$^{k''}$

1028 P = 50.4 + (-5.6)(2.93) = 34.0^k
M = 285.1 + (1693.6)(2.93) = 5247.3$^{k''}$

TURBINE BLDG TORNADO CAPACITY

$b = 24''$ $d = 51''$ $A_T = 5.00\ \square''$

12" $e = \frac{6184.1}{76.1} + 21 = 102.26$ $e/d = 2.005$

$w/j = 0.92$ $i = 1.848$ $m = g = 0.0562$ $k = 0.284$ $j = 0.905$

$f_s = \frac{(76.1)(2.005)}{(0.905)(5.0)(1.848)} = 16.67^{ksi}$ $f_c = 0.735^{ksi}$

22" $e = \frac{6668.3}{34.7} + 21 = 213.17''$ $e/d = 4.18$

$w/j = 0.92$ $i = 1.2822$ $m = g = 0.0390$ $k = 0.243$ $j = 0.919$

$f_s = \frac{(34.7)(4.18)}{(0.919)(5)(1.2822)} = 24.62^{ksi}$ $f_c = 0.878^{ksi}$

32" $e = \frac{7098.3}{58.9} + 21 = 141.5$ $e/d = 2.774$

$w/j = 0.92$ $i = 1.556$ $m = g = 0.0473$ $k = 0.264$ $j = 0.912$

$f_s = \frac{(58.9)(2.774)}{(0.912)(5)(1.556)} = 23.03^{ksi}$ $f_c = 0.918^{ksi}$

42" $e = \frac{7466.8}{64.1} + 21 = 137.5$ $e/d = 2.696$

$w/j = 0.92$ $i = 1.5181$ $m = g = 0.0462$ $k = 0.261$ $j = 0.913$

$f_s = \frac{(64.1)(2.696)}{(0.913)(5)(1.5181)} = 24.94^{ksi}$ $f_c = 0.979^{ksi}$

52" $e = \frac{7582.1}{62.3} + 21 = 142.70$ $e/d = 2.798$

$w/j = 0.92$ $i = 1.4899$ $m = g = 0.0453$ $k = 0.259$ $j = 0.914$

$f_s = \frac{(62.3)(2.798)}{(0.914)(5)(1.4899)} = 23.60^{ksi}$ $f_c = 0.994^{ksi}$

62" $e = \frac{7331.7}{68.9} + 21 = 127.41$ $e/d = 2.498$

$w/j = 0.92$ $i = 1.5829$ $m = g = 0.048$ $k = 0.266$ $j = 0.911$

$f_s = \frac{(68.9)(2.498)}{(0.911)(5)(1.5829)} = 23.87^{ksi}$ $f_c = 0.961^{ksi}$

728 $e = \frac{6851.1}{60.8} + 21 = 133.68$ $e/d = 2.621$

$w/\gamma = 0.92$ $L = 1.5408$ $m = g = 0.0469$ $k = 0.263$ $\gamma = 0.912$

$f_s = \frac{(60.8)(2.621)}{(0.912)(5)(1.5408)} = 22.68^{ksi}$ $f_c = 0.899^{ksi}$

928 $e = \frac{6315.6}{57.9} + 21 = 130.08$ $e/d = 2.5505$

$w/\gamma = 0.92$ $L = 1.5642$ $m = g = 0.0476$ $k = 0.265$ $\gamma = 0.912$

$f_s = \frac{(57.9)(2.5505)}{(0.912)(5)(1.5642)} = 20.70^{ksi}$ $f_c = 0.829^{ksi}$

928 $e = \frac{5487.8}{54.9} + 21 = 120.96$ $e/d = 2.372$

$w/\gamma = 0.92$ $L = 1.6337$ $m = g = 0.0497$ $k = 0.269$ $\gamma = 0.910$

$f_s = \frac{(54.9)(2.372)}{(0.910)(5)(1.6337)} = 17.52^{ksi}$ $f_c = 0.716^{ksi}$

1028 $e = \frac{5247.3}{34.0} + 21 = 175.33$ $e/d = 3.438$

$w/\gamma = 0.92$ $L = 1.365$ $m = g = 0.0418$ $k = 0.250$ $\gamma = 0.917$

$f_s = \frac{(34.0)(3.438)}{(0.917)(5)(1.365)} = 18.68^{ksi}$ $f_c = 0.692^{ksi}$

130 P = 14.3 + (1.9)(2.93) = 19.9K
M = 325.1 + (857.5)(2.93) = 2890.3K'

230 P = 19.3 + (1.9)(2.93) = 24.9K
M = 443.1 + (853.2)(2.93) = 2943.0K''

330 P = 19.5 + (2.0)(2.93) = 25.4K
M = 486.8 + (887.7)(2.93) = 3087.8K''

430 P = 21.3 + (2.0)(2.93) = 27.2K
M = 536.9 + (914.2)(2.93) = 3215.5K''

530 P = 22.3 + (2.07)(2.93) = 28.4K
M = 559.6 + (923.9)(2.93) = 3266.6K''

630 P = 21.6 + (2.0)(2.93) = 27.5K
M = 547.0 + (896.3)(2.93) = 3173.2K''

730 P = 20.5 + (1.9)(2.93) = 26.1K
M = 514.1 + (836.8)(2.93) = 2963.9K''

830 P = 19.6 + (1.7)(2.93) = 24.6K
M = 478.8 + (769.8)(2.93) = 2734.3K'

930 P = 17.6 + (1.5)(2.93) = 22.0K
M = 425.7 + (686.5)(2.93) = 2437.1K''

1030 P = 12.3 + (1.6)(2.93) = 17.0K
M = 365.3 + (693.7)(2.93) = 2397.8K''

GPU Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 24 OF 59
DATE 11/3/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

$b = 18''$ $d = 45''$ $A_T = 3.80\,\square''$

130 $e = \frac{287.3}{19.9} + 19.5 = 164.7$ $e/d = 3.661$

$w/j = 0.92$ $i = 1.3356$ $m = g = 0.0742$ $k = 0.318$ $j = 0.894$

$f_s = \frac{(19.9)(3.661)}{(0.894)(3.80)(1.3356)} = 16.06^{KSI}$ $f_c = 0.832^{KSI}$

230 $e = \frac{2943.0}{24.9} + 19.5 = 137.69$ $e/d = 3.060$

$w/j = 0.92$ $i = 1.4299$ $m = g = 0.0794$ $k = 0.327$ $j = 0.891$

$f_s = \frac{(24.9)(3.060)}{(0.891)(3.80)(1.4299)} = 15.74^{KSI}$ $f_c = 0.850^{KSI}$

330 $e = \frac{3087.8}{25.4} + 19.5 = 141.07$ $e/d = 3.135$

$w/j = 0.92$ $i = 1.4154$ $m = g = 0.0786$ $k = 0.326$ $j = 0.891$

$f_s = \frac{(25.4)(3.135)}{(0.891)(3.80)(1.4154)} = 16.62^{KSI}$ $f_c = 0.893^{KSI}$

430 $e = \frac{3215.5}{27.2} + 19.5 = 137.7$ $e/d = 3.060$

$w/j = 0.92$ $i = 1.4298$ $m = g = 0.0794$ $k = 0.327$ $j = 0.891$

$f_s = \frac{(27.2)(3.060)}{(0.891)(3.80)(1.4298)} = 17.19^{KSI}$ $f_c = 0.928^{KSI}$

530 $e = \frac{3266.6}{28.4} + 19.5 = 134.5$ $e/d = 2.989$

$w/j = 0.92$ $i = 1.4446$ $m = g = 0.08025$ $k = 0.328$ $j = 0.891$

$f_s = \frac{(28.4)(2.989)}{(0.891)(3.80)(1.4446)} = 17.36^{KSI}$ $f_c = 0.941^{KSI}$

630 $e = \frac{3173.7}{27.5} + 19.5 = 134.9$ $e/d = 2.998$

$w/j = 0.92$ $i = 1.4428$ $m = g = 0.06016$ $k = 0.328$ $j = 0.891$

$f_s = \frac{(27.5)(2.998)}{(0.891)(3.80)(1.4428)} = 16.88^{KSI}$ $f_c = 0.915^{KSI}$

730 $e = \frac{2965.9}{26.1} + 19.5 = 133.13$ $e/d = 2.959$

w/ $j = 0.88$ $i = 1.4233$ $m = q = 0.0791$ $k = 0.326$ $j = 0.891$

$f_s = \frac{(26.1)(2.959)}{(0.891)(3.80)(1.4233)} = 16.03^{KSI}$ $f_c = 0.861^{KSI}$

830 $e = \frac{2734.3}{24.6} + 19.5 = 130.65$ $e/d = 2.903$

w/ $j = 0.88$ $i = 1.4350$ $m = q = 0.0797$ $k = 0.327$ $j = 0.891$

$f_s = \frac{(24.6)(2.903)}{(0.891)(3.80)(1.4350)} = 14.70^{KSI}$ $f_c = 0.794^{KSI}$

930 $e = \frac{2437.1}{22.0} + 19.5 = 130.27$ $e/d = 2.895$

w/ $j = 0.88$ $i = 1.4367$ $m = q = 0.0798$ $k = 0.328$ $j = 0.891$

$f_s = \frac{(22.0)(2.895)}{(0.891)(3.80)(1.4367)} = 13.09^{KSI}$ $f_c = 0.710^{KSI}$

1030 $e = \frac{2397.8}{17} + 19.5 = 160.55$ $e/d = 3.5677$

w/ $j = 0.89$ $i = 1.3324$ $m = q = 0.0740$ $k = 0.318$ $j = 0.894$

$f_s = \frac{(17)(3.5677)}{(0.894)(3.80)(1.3324)} = 13.40^{KSI}$ $f_c = 0.694^{KSI}$

GPU Nuclear

SUBJECT: SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 26 OF 59
DATE 11/3/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

	1	2	3	4	5	6	7	8	9	10	
A	17.40 KSI 0.881 KSI	33.69 KSI 1.182 KSI	30.98 KSI 1.228 KSI	33.88 KSI 1.320 KSI	35.3 KSI 1.386 KSI	33.97 KSI 1.333 KSI	32.10 KSI 1.237 KSI	28.89 KSI 1.137 KSI	24.00 KSI 0.942 KSI	20.64 KSI 0.818 KSI	BOLT CONC
F	16.67 KSI 0.735 KSI	24.62 KSI 0.878 KSI	23.03 KSI 0.918 KSI	21.94 KSI 0.979 KSI	25.60 KSI 0.994 KSI	23.17 KSI 0.961 KSI	22.66 KSI 0.899 KSI	20.78 KSI 0.829 KSI	17.52 KSI 0.716 KSI	18.68 KSI 0.692 KSI	BOLT CONC
J	16.06 KSI 0.832 KSI	15.71 KSI 0.850 KSI	16.62 KSI 0.893 KSI	17.19 KSI 0.928 KSI	17.36 KSI 0.941 KSI	16.88 KSI 0.915 KSI	16.03 KSI 0.861 KSI	14.70 KSI 0.794 KSI	13.09 KSI 0.710 KSI	13.40 KSI 0.694 KSI	BOLT CONC

ANCHOR BOLT STRESS AND CONCRETE BEARING STRESS AT TORNADO VELOCITY OF 107 MPH.

MODEL STRUCTURE WITH BASE PL AND ANCHOR BOLTS. ALLOW ANCHOR BOLTS AT FOLLOWING COLUMNS TO YIELD AND EXAMINE STATE OF REMAINING ANCHOR BOLTS + FRAME DEFLECTION AT THE CONTROL ROOM ROOF

A: 4, 5, 6. USE E = 1375 KSI FOR THESE ANCHOR BOLTS

GPU Nuclear

SUBJECT SEP TOPIC III·2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-B02-151-5320-007
SHEET NO. 27 OF 59
DATE 11/7/83
COMP. BY/DATE 11/28/83
CHK'D. BY/DATE DBT 12/12/83

REVIEW MEMBER FORCES FROM 3-D ANALYSIS VS 2D ANALYSIS TO ENSURE THAT ADDITIONAL MEMBER CHECKS ARE NOT REQ'D

REF CALC C-1302-151-5320-003
PP 27-29 (BASED ON PSP)

	2D M	2D P	3D (LOAD 7) M	3D (LOAD 7) P	
+WL					
501 @ 501	3391 k''	11k T	3114 k''	11k T	OK
551 @ 504	677 k''	11k T	556 k''	11k T	OK
547 @ 528	2860 k''	11k T	2495 k''	11k T	OK
546 @ 526	470 k''	11k T	364 k''	11k T	OK
548 @ 526	917 k''		785 k''		OK
552 @ 529	777 k''		664 k''		OK
549 @ 530	1081 k''	2k T	924 k''	2k T	OK
-WL			(LOAD 8)		
501 @ 501	2357 k''	9k T	2135 k''	9k T	OK
551 @ 504	230 k''	9k T	152 k''	9k T	OK
547 @ 528	3652 k''	9k T	3297 k''	9k T	OK
546 @ 526	964 k''	9k T	844 k''	9k T	OK
548 @ 526	891 k''		773 k''		OK
552 @ 529	850 k''		745 k''		OK
549 @ 530	1231 k''		1083 k''		OK

FRAME MEMBER FORCES FROM 3D ANALYSIS ARE LESS THAN THOSE FROM 2D THEREFORE ADDITIONAL CHECKS OF COLUMNS AND GIRDERS ARE NOT REQUIRED.

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SUBJECT SEP TOPIC III-2 LA2 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 28 OF 59
DATE 11/7/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

REVIEW TRUSS MEMBER LOADINGS 2D VS 3D

REF CALC NO C-1302-151-5320-003 PG 25 (10 PSF)

	2D WL	3D WL	
DIAGONAL T5x3x½	+0	+0	OK
	-16	-15	OK
DIAGONAL TT 5x3x5/16	+2	+0	OK
	-9	-5	OK
VERTICAL TT 5x3x3/8	+11	+10	OK
	0	-0	OK
VERTICAL TT 5x3x5/16	+6	+5	OK
	0	-0	OK
TOP CHORD TT 8x6x9/16	+25	+24	OK
	-1	-0	OK
BOT CHORD TT 8x6x5/8	+15	+13	OK
	-29	-28	OK

TRUSS MEMBER FORCES FOR 3D ANALYSIS ARE LOWER THAN FOR 2D SO NO ADDITIONAL ANALYSIS IS REQUIRED

GPU Nuclear

SUBJECT: SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 29 OF 57
DATE 11/4/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

CHECK STATUS OF ROOF HORIZONTAL TRUSS AT TOP CHORD TO ENSURE CAPACITY TO DISTRIBUTE LOADINGS.

TRUSS DIAGONAL MEMBER.

2001, 2002, 2017 TO 2022, 2037 TO 2040 — WT 8 x 18 — $A = 5.28^{\square''}$
2003 TO 2016, 2023 TO 2036 — L 3½ x 3 x ¼ — $A = 1.56^{\square''}$
2041 TO 2062 — L 6 x 4 x 5/16 — $A = 3.03^{\square''}$

REVIEW AS TENSION ONLY MEMBERS

$F_t = 22^{ksi}$ ON GROSS AREA

$F_t = 29^{ksi}$ ON EFFECTIVE NET AREA

WT 8x18, $t_f = 0.430''$

$P_T = (5.28)(22) = 116.2^k$

$A_e = C_t A_n$ $\quad A_n = 5.28 - (13/16)(0.430)(2) = 4.58^{\square''}$

$C_t = 0.85$ BASED LESS THAN THREE FASTENERS/LINE IN THE DIRECTION OF STRESS.

$A_e = (0.85)(4.58) = 3.893^{\square''}$

$P_T = (3.893)(29) = 112.9^k$ ← governs.

L 3½ x 3 x ¼

$P_T = (1.56)(22) = 34.3^k$

$A_e = C_t A_n$ $\quad A_n = (1.56) - (13/16)(0.25)(1) = 1.357^{\square''}$

$C_t = 0.75$

$A_e = (0.75)(1.357) = 1.018^{\square''}$

$P_T = (1.018)(29) = 29.5^k$ ← governs.

L 6 x 4 x 5/16

$P_T = (3.03)(22) = 66.66^k$

$A_e = C_t A_n$ $\quad A_n = 3.03 - (13/16)(5/16) = 2.776$

$C_t = 0.75$

$A_e = (0.75)(2.776) = 2.082^{\square''}$

$P_T = (2.082)(29) = 60.4^k$ ← governs.

A000 0016 12-80

SUBJECT SEP TOPIC III·2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

TRUSS DIAGONAL CAPACITIES (TENSION)

WT 8x18 112.9K
L 3½x3x4 29.5K
L 6x4x5/16 60.4K
} WORKING STRESS VALUES

REF NUREG 0800 SECT 3.8.4

3C (ii) 2 ALLOWABLE STRESS = 1.6S

TORNADO COMBIN. CAPACITIES

WT x18 P_T = 112.9 x 1.6 = 180.6K
L 3½x3x4 P_T = 29.5 x 1.6 = 47.2K
L 6x4x5/16 P_T = 60.4 x 1.6 = 96.6K

2001 2002 2017 TO 2022 2037 TO 2040 180.6K
2003 TO 2016, 2023 TO 2036 47.2K
2041 TO 2062 96.6K

COMPUTER ANALYSIS ASSUMED THAT TRUSS DIAGONALS ARE CAPABLE OF RESISTING COMPRESSION. IN ORDER TO COMPARE REPORTED FORCES WITH THE ALLOWABLE VALUES, COMPRESSION VALUES MUST BE ADDED TO THE TENSION LOAD OF THE OTHER DIAGONAL IN THE PANEL

GPU Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 31 OF 59
DATE 11/4/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

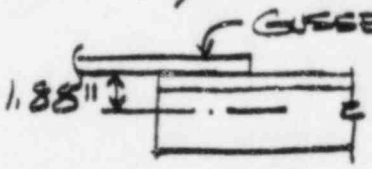
CHECK WT 8x18 AS A COMPRESSION MEMBER FOR 2019, 2020, 2039 AND 2040

LENGTH 2019, 2020 : $(29^2 + 16^2)^{1/2} = 33.12'$
2039, 2040 : $(16.75^2 + 16^2)^{1/2} = 23.16'$

L(EFF) = ½ TOTAL L SINCE WT 8 IS TACK WELDED TO PURLIN @ INTERSECTION

WT 8x18 $A = 5.28^{\square''}$ $b_f = 6.985''$ $r_x = 2.41''$ $y = 1.88''$
$d = 7.930$ $t_f = 0.430''$ $r_y = 1.52''$ $I_y = 12.2\ in^4$

2019 2020 $L/r_y = 12 \times 16.56/1.52 = 130.7$ $F_a = 8.60^{ksi}$



$e = 1.88'' + 3/16 = 2.07''$

$M = Pe = 2.07P$

$S_t = \frac{30.6}{1.88} = 16.28\ in^3$ (COMP'N)
$S_b = 5.05\ in^3$ (TENSION)

DETERMINE F_B

$$r_T = \sqrt{\frac{I_y}{A_f + \frac{1.88 - 0.430}{3}}} = \sqrt{\frac{12.2}{(6.985)(0.430) + \frac{(1.88 - 0.430)}{3}}} = 1.871$$

$$L/r_T = 16.56 \times 12/1.871 = 106.2 < \sqrt{\frac{510 \times 10^3 C_b}{F_y}} = 119$$

$$F_b = \left[\frac{2}{3} - \frac{(36)(106.2)^2}{1530 \times 10^3}\right] 36 = 14.45^{ksi}$$

OR $F_B = \frac{12000}{Ld/A_f} = \frac{(12000)(6.985)(0.430)}{(12)(16.56)(7.930)} = 22.87^{ksi}$

$F_B = 22^{ksi}$

$$\frac{P/5.28}{8.60} + \frac{2.07P/16.28}{22} \leq 1.0$$

$$\frac{P}{(5.28)(8.60)} + \frac{2.07P}{(16.28)(22)} = 1.0$$

$P = 35.97^{k}$ COMP'N CAPACITY

$$f_a/F_a = \frac{35.97/5.28}{8.60} = 0.79 > 0.15 \therefore \text{MUST CHECK } 1.6\text{-}1a \text{ \& } b$$

AQDO 0016 12-80

$L/r_x = (16.36)(12)/2.41 = 82.5 \quad F'_{ex} = 21.95$

$$\frac{P/5.28}{8.60} + \frac{(1.0)(2.07P/16.28)}{\left(1-\frac{P/5.28}{21.95}\right)(22)} = 1.0$$

$$\frac{P}{(5.28)(8.60)}\left(1-\frac{P}{(5.28)(21.95)}\right) + \frac{2.07P}{(16.28)(22)} = 1-\frac{P}{(5.28)(21.95)}$$

$$\frac{P}{5.28(8.60)} + \frac{P}{(5.28)(21.95)} + \frac{2.07P}{(16.28)(22)} - \frac{P^2}{(5.28)^2(8.60)(21.95)} - 1 = 0$$

$$0.03643P - 0.00019P^2 - 1 = 0$$

$$P^2 - 191.7P + 5262.6 = 0$$

$$P = \frac{191.7 \pm (191.7^2 - (4)(5262.6))^{1/2}}{2} =$$

$$= \frac{191.7 \pm 125.4}{2} = 158.6^k \quad 33.2^k \leftarrow$$

CK 1.6-1b $\frac{33.2}{(5.28)(22)} + \frac{(2.07)(33.2)}{(16.28)(22.0)} = 0.304 < 1.0$ OK

FOR TORNADO COMBINATIONS USE $P_c = 33.2 \times 1.6 = 53.1^k$

CHECK 2039 AND 2070

$L/r_y = 12 \times 23.16 \times 12/1.52 = 91.42 \quad F_a = 14.04$

$L/r_T = 12 \times 23.16 \times 12/1.871 = 74.27$

$F_b = \left[\frac{2}{3} - \frac{(36)(74.27)^2}{(1530)(1000)(1.0)}\right]36 = 19.33^{ksi}$ $\quad F_b = 22^{ksi}$ PER ABOVE

$L/r_x = 12 \times 23.16 \times 12/2.41 = 57.7 \quad F'_{ex} = 44.86^{ksi}$

$$\frac{P/5.28}{14.04} + \frac{(1.0)(2.07P/16.28)}{\left(1-\frac{P/5.28}{44.86}\right)(22)} = 1.0$$

$$\frac{P}{(5.28)(14.04)}\left(1-\frac{P}{(5.28)(44.86)}\right) + \frac{2.07P}{(16.28)(22)} = 1-\frac{P}{(5.28)(44.86)}$$

$$P\left[\frac{1}{(5.28)(14.04)} + \frac{2.07}{(16.28)(22)} + \frac{1}{(5.28)(44.86)}\right] - \frac{P^2}{(5.28)^2(14.04)(44.86)} - 1.0 = 0$$

$$0.02349P - 0.000057P^2 - 17558.7 = 0$$

$$P^2 - 412.1P + 17558.7 = 0$$

$$P = \frac{412.1 \pm (412.1^2 - (4 \times 17558.7))^{1/2}}{2}$$

$$P = \frac{412.1 \pm 315.6}{2} = \begin{matrix} 363.9 \\ 48.3 \end{matrix} \leftarrow$$

$$\frac{48.3}{(5.28)(22)} + \frac{(2.07)(48.3)}{(16.28)(22)} = 0.695 < 1.00$$

FOR TORNADO COMBINATION: $P = (1.0)(48.3) = 77.3$

SINCE DEPRESSURIZATION CAPACITY AND WIND LOAD CAPACITIES DO NOT MEET 1.75 PSI AND 250 MPH, DO NOT CONSIDER LOAD CASES 179 AND 189 FOR ROOF TRUSS ANALYSIS.

SINCE SIDING DEPRESSURIZATION CAPACITY IS LESS THAN FRAME DEPRESSURIZATION CAPACITY, DO NOT CONSIDER LOAD CASE 19 FOR ROOF TRUSS ANALYSIS.

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SUBJECT: SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 34 OF 59
DATE 11/4/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

WT 8x18

2001 + 2002	17	40.6 + 4.5 =	45.1	< 180.6* OK
	18	44.4 + 64.0 =	108.4	

2017 + 2018	17	105.0 + 89.3 =	194.3	> 180.6 NG
	18	106.0 + 57.5 =	163.5	

CHECK ACTUAL CAPACITY

P_{DL}: 5.2^k P_{WL} = -6.0^k @ 10 PSF
P_{DL}: 3.5^k P_{WL} = 5.4^k @ 10 PSF
Δ = 1.7

$$p = \frac{180.6 - 1.7}{6.9 + 5.4} \times 10 = 144.3 \text{ PSF} \qquad V = \sqrt{\frac{144.3}{0.00256}} = 237 \text{ MPH}$$

2019 2020	17	59.5 C	0.6 C	> P_C = 53.1^k
	18	16.7 C	40.3 C	

CHECK ACTUAL CAPACITY

P_{DL} = 1.8 P_{WL} = 3.6 @ 10 PSF

$$p = \frac{53.1 - 1.8}{3.6} \times 10 = 142.5 \text{ PSF} \qquad V = \sqrt{\frac{142.5}{0.00256}} = 236 \text{ PSF}$$

2021 + 2022	17	58.6 + 37.1 =	95.7	< 180.6 OK
	18	11.7 - 36.5 =	-24.8	

2037 + 2038	17	57.2 + 4.5 =	61.7	< 180.6 OK
	18	15.5 + 6.0 =	21.5	

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SUBJECT SEP TOPIC III·2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5360-001
SHEET NO. 35 OF 59
DATE 11/4/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

2039, 2040	17	17.4 T	28.4 T	
	18	73.6 C	27.2 C	< P_c = 77.3" OK

L 3½ x 3 x 4

2003 + 2004	17	14.4 T	0.9 T	
	18	2.0 C	28.9 T = 27.9	< 47.2" OK
2005 / 2006	17	21.1 T	3.2 T	
	18	2.3 T	30.3 T	< 47.2" OK
2007 + 2008	17	20.9 T	7.4 T	
	18	11.7 T	24.6 T	< 47.2" OK
2009 + 2010	17	14.7 T	13.8 T	
	18	22.5 T	14.5 T	< 47.2" OK
2011 + 2012	17	9.7 T	16.9 T	
	18	30.5 T	3.7 T	< 47.2 OK

GPU Nuclear

SUBJECT: SEP TOPIC III-2 LAI #2251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5370-007
SHEET NO. 36 OF 59
DATE 11/4/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

2013 + 2014 17 57T 14.7T
18 56.2T 7.9C = 44.1K < 47.2K OK

2015 + 2016 17 6.0C 17.3T
18 40.7T 20.1C = 60.8K > 47.2K

CHECK ACTUAL CAPACITY

$P_{DL} = 1.2$ $P_{WL} = -2.6$ @ 10 PSF
$P_{DL} = 0.9$ $P_{WL} = 1.2$ @ 10 PSF
$\Delta = 0.3$

$P = \frac{47.2 \cdot 0.3}{2.6 + 1.2} \times 10 = 123.4$ PSF $V = \sqrt{\frac{123.4}{0.00256}} = 220$ MPH

2023 + 2024 17 28.8T 6.4C = 35.2K
18 2.6C 10.9T = 13.5K
< 47.2K OK

2025 + 2026 17 34.8T 3.5C 38.3K
18 3.6T 13.6T
< 47.2K OK

2027 + 2028 17 27.7T 5.8T
18 8.8T 12.6T
< 47.2K OK

2029 + 2030 17 15.9T 19.3T
18 14.5T 7.2T
< 47.2K OK

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SUBJECT SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 37 OF 59
DATE 11/4/83
COMP. BY/DATE RT 11/28/83
CHK'D. BY/DATE DBT 12/12/83

2031 + 2032	17	1.6 T	27.5 T	
	18	13.5 T	1.5 T	
				<47.2 OK

2033 + 2034	17	8.0 C	36.6 T = 44.6*	
	18	10.3 T	0	

L 6x4x5/8 P_T = 96.6

2041 + 2042	17	33.8 T	24.7 C = 58.5*	
	18	6.3 C	17.9 T = 24.2*	<96.6 OK
2043 + 2044	17	0.7* C	0	
	18	21.2 C	22.3 T = 43.5	<96.6 OK
2045 + 2046	17	19.7 T	17.6 C = 37.3	<96.6
	18	10.3 C	11.8 T = 22.1	
2047 + 2048	17	14.2 T	12.4 C = 26.6	<96.6
	18	10.8 C	12.1 T = 22.9	
2049 + 2050	17	8.6 T	7.2 C = 15.8	<96.6
	18	5.9 C	7.2 T = 13.1	
2051 + 2052	17	1.7 C	2.3 T = 4.0	<96.6
	18	3.8 T	1.9 C = 5.7	
2053 + 2054	17	9.8 C	10.6 T = 20.4	<96.6
	18	10.4 T	8.7 C = 19.1	
2055 + 2056	17	15.2 C	16.6 T = 31.8	<96.6
	18	13.8 T	12.2 C = 26.0	
2057 + 2058	17	23.0 C	26.7 T = 49.7	<96.6
	18	21.7 T	21.4 C = 43.1	
2059 + 2060	17	18.3 T	20.6 C = 38.9	<96.6
	18	6.6 T	3.8 C = 10.4	

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SUBJECT SEP TOPIC III·2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5360-001
SHEET NO. 38 OF 59
DATE 11/7/83
COMP. BY/DATE PH 11/26/83
CHK'D. BY/DATE DBT 12/12/83

2060 + 2061 17 20.6C 35.4C : 4.8 <96.6
18 3.8C 21.7T : 25.5

ALL ROOF TRUSS DIAGONALS ARE CAPABLE OF RESISTING THE 107 MPH TORNADO WIND DISTRIBUTION AND MOST CAN RESIST THE FULL 250 MPH TORNADO VELOCITY WITHOUT OVERSTRESS.

DETERMINE VELOCITY AT WHICH FRAME COLUMNS WILL CONTACT CONTROL ROOM ROOF

GAP @ NO LOADING = 2 1/8"

COL LINE	COL LINE 8	COL LINE 9	COL LINE 10
+37.25 27 DL	= 0.05527	0.04439	0.0446
9.75' WL	(2.93)(0.1923) = 0.56344	(2.93)(0.17054) = 0.49968	(2.93)(0.17247) = 0.505
Δ_T	0.61871"	0.54407"	0.5521
+27.50 ROOF			
12.50'			
+15' 31 DL	0.00663	= 0.00461	= 0.0078
TO ELEVATION 46'-8" WL	(2.93)(0.04840) = 0.14181	(2.93)(0.4263) = 0.12491	(2.93)(0.04065) = 0.1191
	0.14844"	0.12952"	0.1269

$$\Delta @ C.R\ Roof = \Delta_{31} + \left(\frac{12.50}{22.25}\right)(\Delta_{27} - \Delta_{31})$$ (ASSUMING STRAIGHT LINE BETWEEN POINTS)

$$\Delta @ 8 = 0.14844 + \left(\frac{12.50}{22.25}\right)(0.61871 - 0.14844) = 0.41263"$$

$$\Delta @ 9 = 0.12952 + \left(\frac{12.50}{22.25}\right)(0.54407 - 0.12952) = 0.36822"$$

$$\Delta @ 10 = 0.12693 + \left(\frac{12.50}{22.25}\right)(0.55217 - 0.12693) = 0.36583"$$

GAP CLOSURE @ 107 MPH = 0.413" @ COL. LINE 8
ASSUME SIMULTANEOUS YIELDING OF ANCHOR BOLTS AT A = 2, 3, 4, 5, 6 & 7 AND CHECK ALLOWABLE LOAD INCREASE TO YIELDING OF NEXT SETS OF BOLTS.

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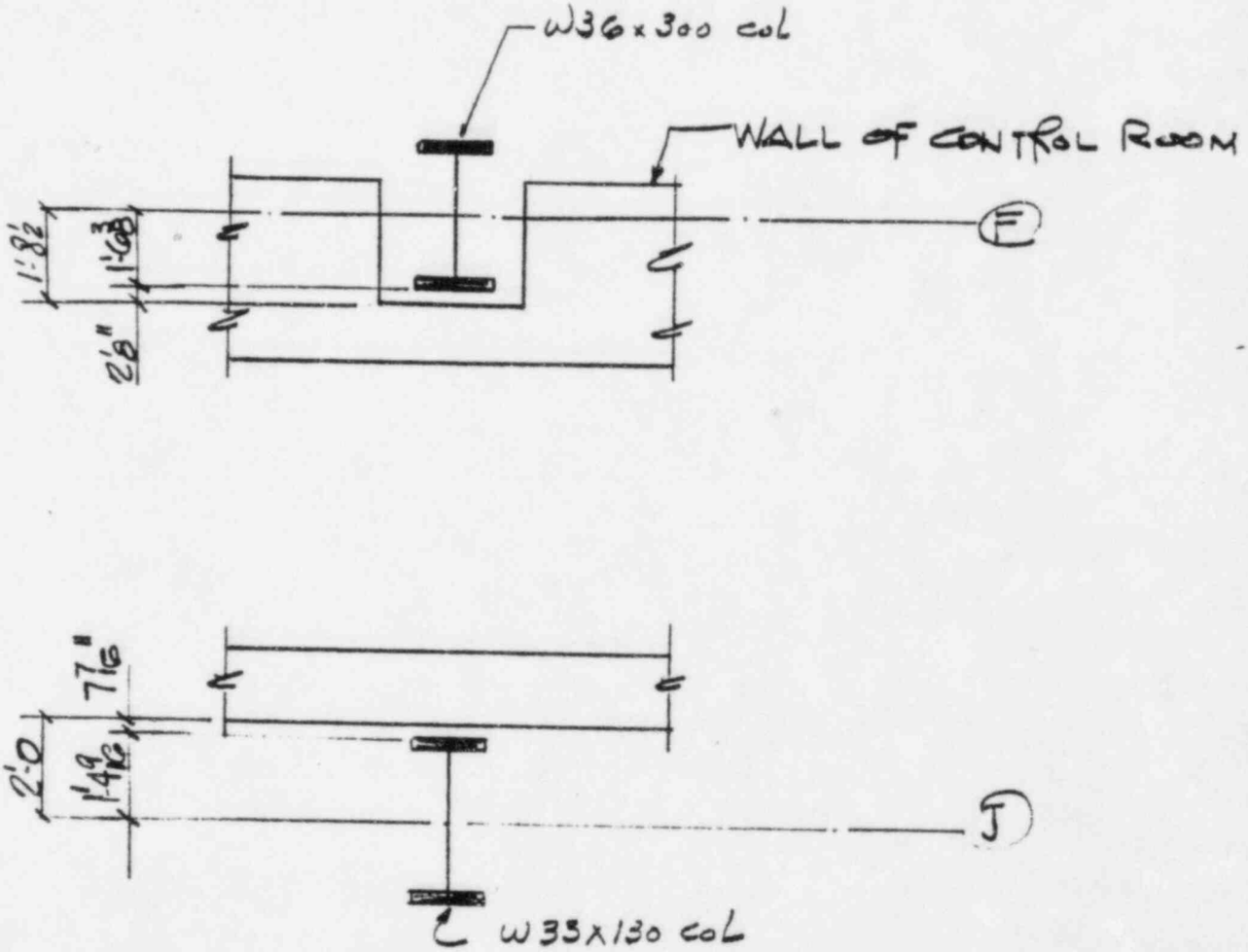
SUBJECT SEP TOPIC III-2 LAI 82251-07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 40 OF 59
DATE 9-7-83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DJT 12/12/83

REF DWG 4099



CLEARANCE BETWEEN BUILDING COLUMNS AND CONTROL ROOM WALLS.

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SUBJECT SEP Topic III-2 LAI 82251.07

TORNADO BUILDING TORNADO CAPACITY

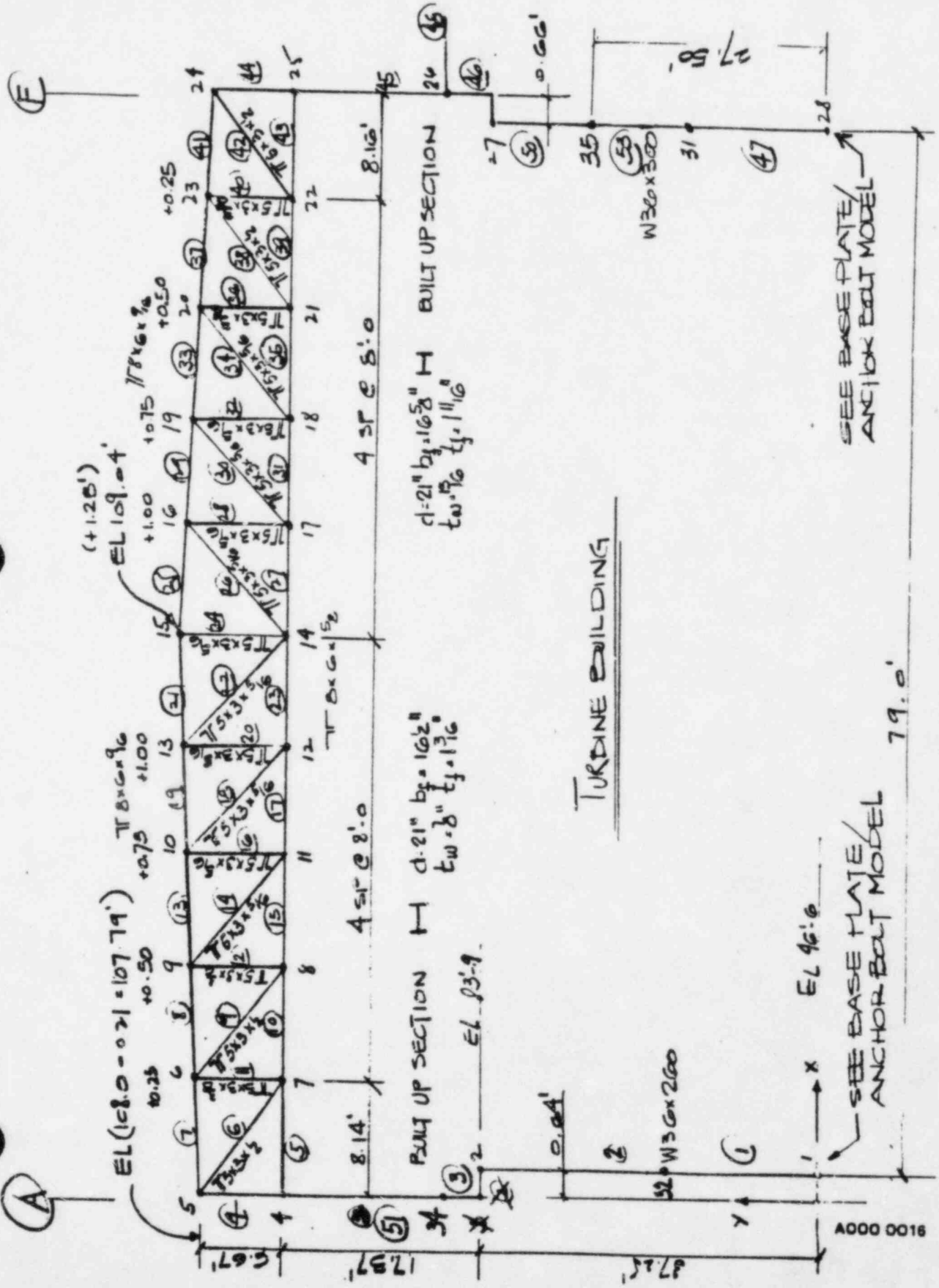
CALC. NO. C-1302-151-5360-007

SHEET NO. 41 OF 59

DATE 9-8-83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE DBT 12/1/83



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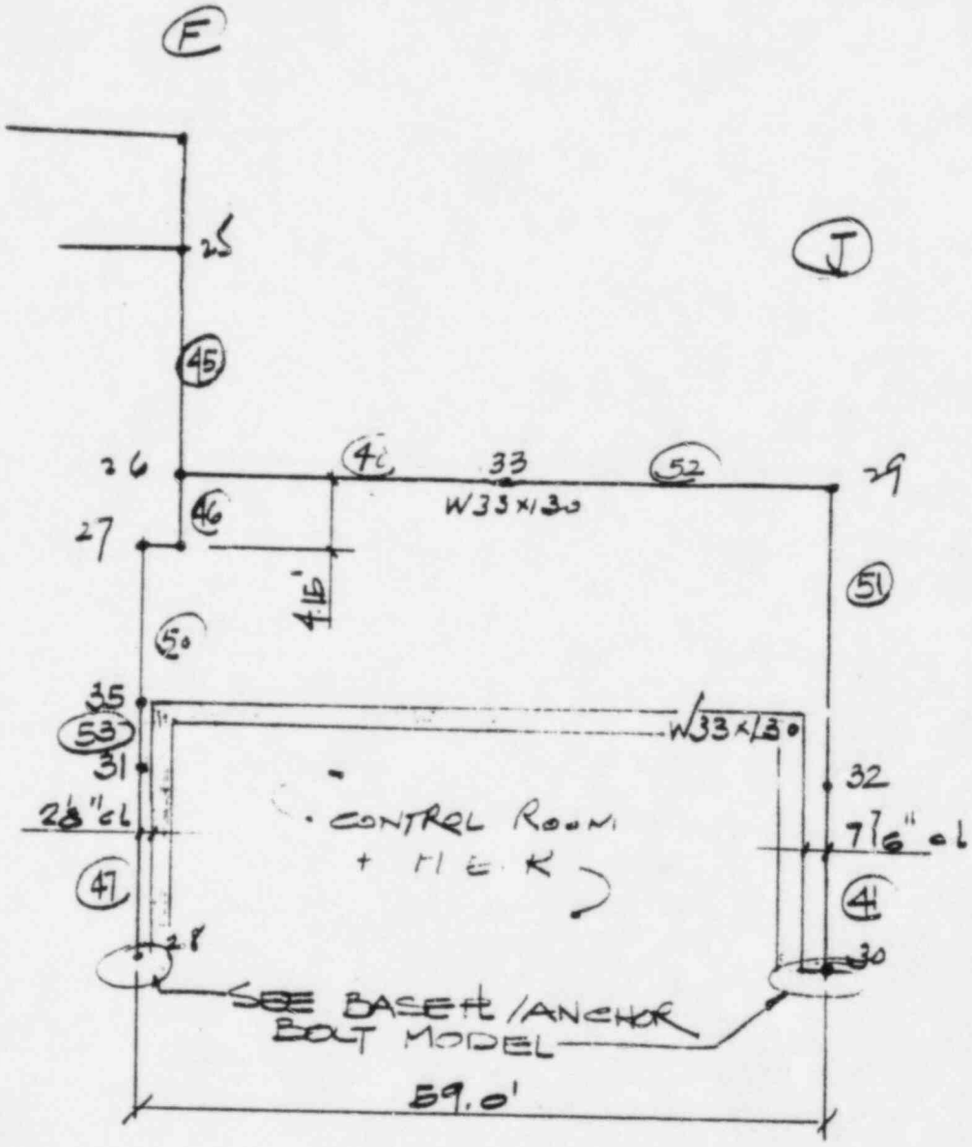
SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C:1302.151.5320.007
SHEET NO. 42 OF 59
DATE 9-8-83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83



TURBINE BUILDING

A000 0016 12-80

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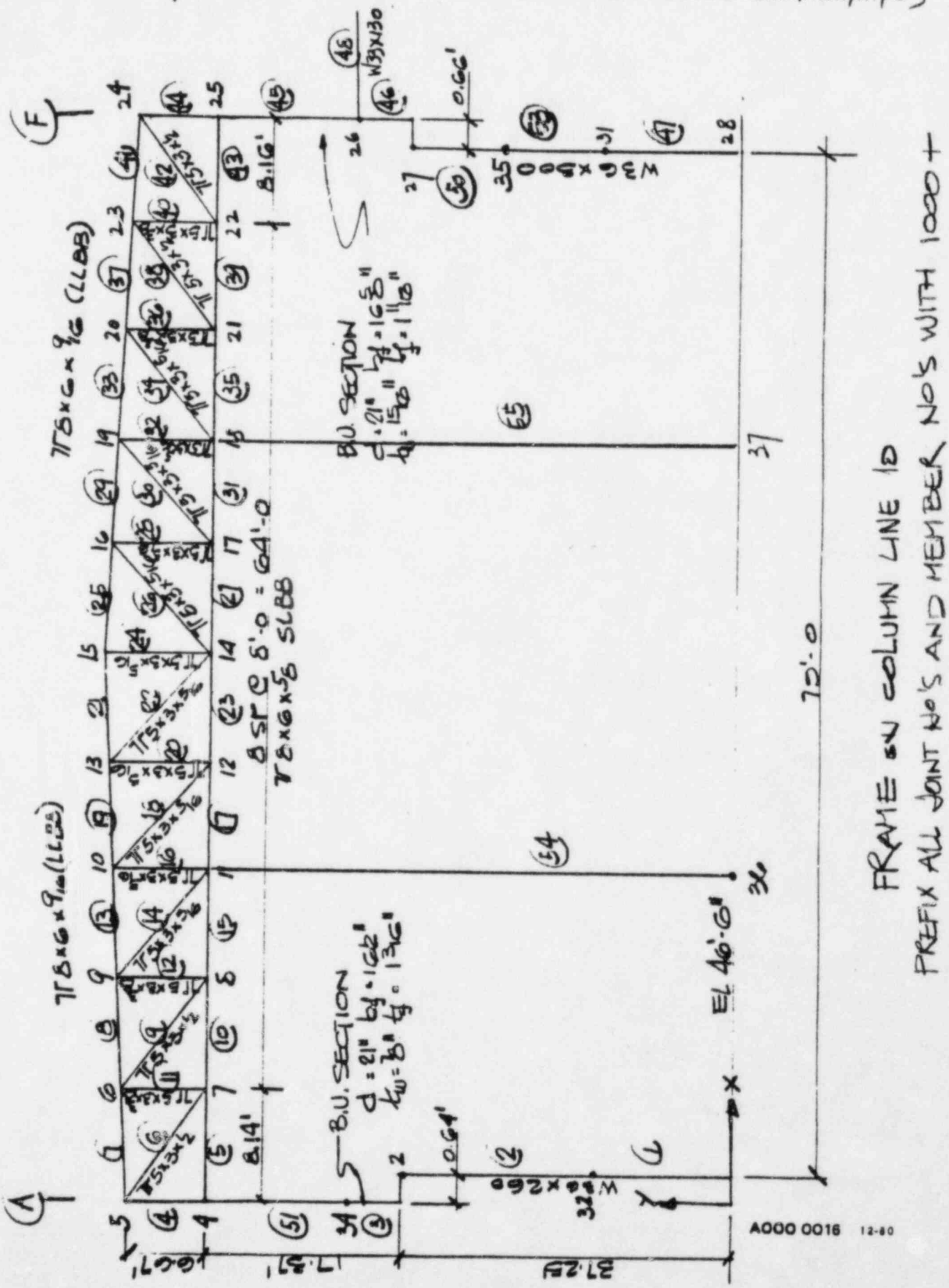
SUBJECT ~~SEP~~ TOPIC III-2 LAI PL251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1306-151-5320-001
SHEET NO. 43 OF 59
DATE 11/8/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83



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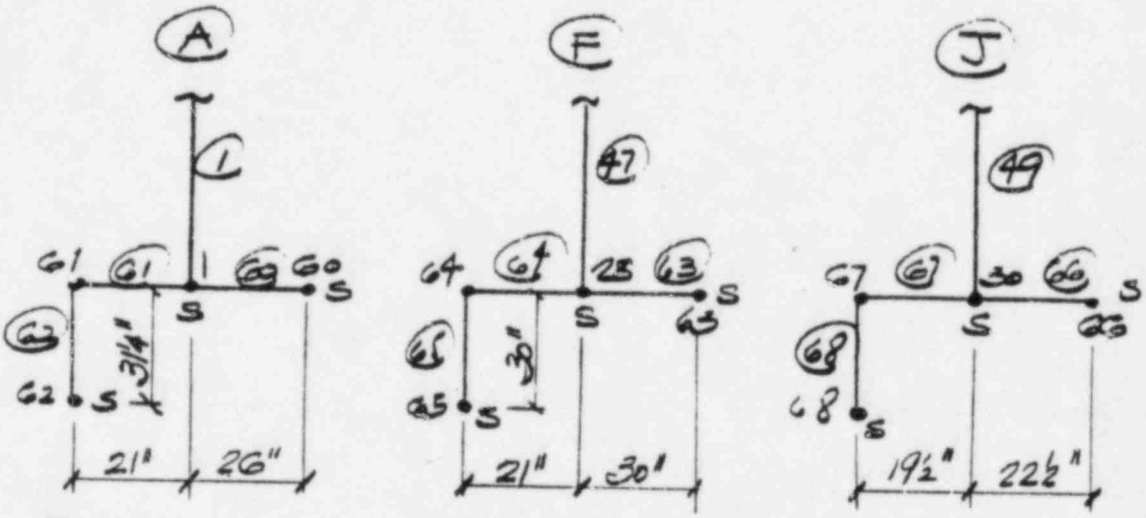

BASE/ANCHOR BOLT MODEL FOR CHECKING FRAME DEFLECTION WITH ANCHOR BOLTS PAST YIELD STRESS.

ASSUME THAT BASE PL W/26 OR W30 AND ANCHOR BOLT CHAIRS FORMS A RIGID ASSEMBLY WHICH WILL ROTATE AS A RIGID BODY ABOUT THE EDGE OF THE BASE PLATE.

SHEAR IS TAKEN OUT BY THE SHEAR LUGS AT THE ℄ OF THE COLUMN; ONLY VERTICAL LOAD IS RESISTED BY THE ANCHOR BOLTS AND THE EDGE OF THE BASE PLATE.

BASE PLATE MODEL USED ONLY FOR YIELDED ANCHOR BOLTS.

procedures. The behavior of steels in these tests is closely related to the behavior of structural-steel members under static loads. Because, for structural steels, the yield points and moduli of elasticity determined in tension and compression are nearly the same, compression tests are seldom necessary.

Typical tensile stress-strain curves for structural steels are shown in Fig. 1-4. The initial portion of these curves is shown at a magnified scale in Fig. 1-4. Both sets of curves may be referred to for the following discussion.

Strain Ranges. When a steel specimen is subjected to load, an initial "elastic range" is observed in which there is no permanent deformation. Thus, if the load is removed, the specimen returns to its original dimensions. The ratio of stress to strain within the elastic range is the modulus of elasticity, or Young's modulus E.

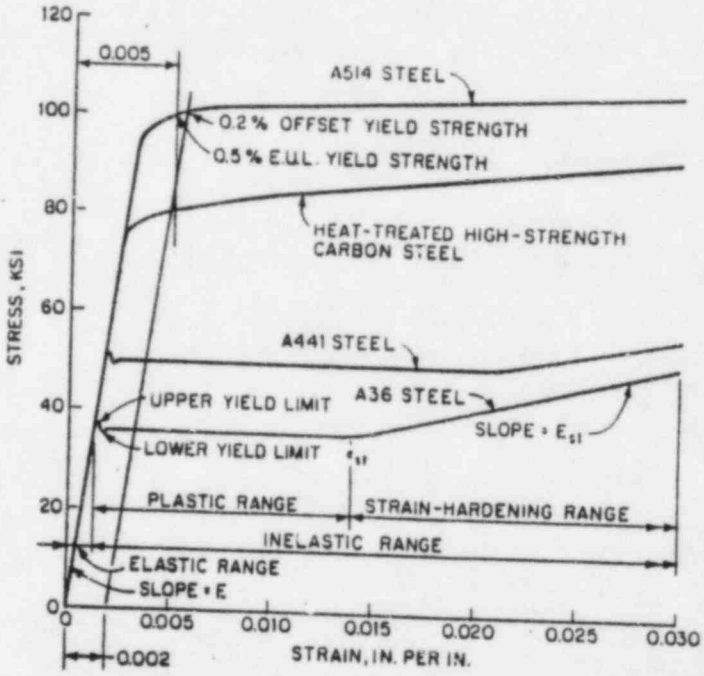

Fig. 1-4 Partial stress-strain curves for structural steels strained through the plastic and into the strain-hardening range. (*From R. L. Brockenbrough and B. G. Johnston, "USS Steel Design Manual," U.S. Steel Corporation, with permission.*)

Since this modulus is consistently about 29×10^3 ksi for all the structural steels, its value is not usually determined in tension tests, except in special instances.

The strains beyond the elastic range in the tension test are termed the "inelastic range." For carbon steel and high-strength, low-alloy steel, this range has two parts. First comes a "plastic range," in which strain increases with no appreciable increase in stress. This is followed by a "strain-hardening range," in which strain increase is accompanied by a significant increase in stress. The curves for heat-treated steels, however, indicate that these steels do not generally exhibit a distinct plastic range or a large amount of strain hardening.

The strain at which strain hardening begins (ϵ_{st}) and the rate at which stress increases with strain in the strain-hardening range (the strain-hardening modulus E_{st}) have

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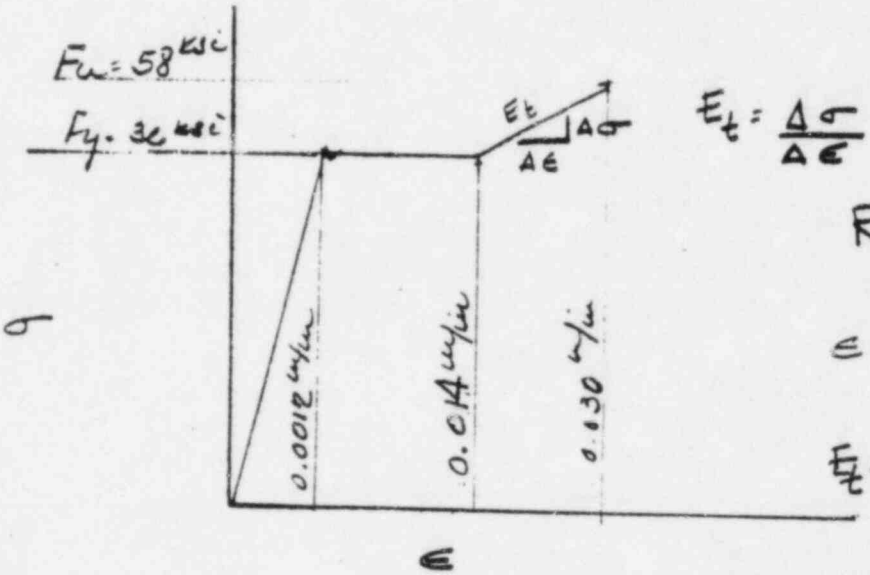
SUBJECT SEP TOPIC III-2 LAI 92251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 46 OF 59
DATE 9-13-83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83



$E_t = \frac{\Delta\sigma}{\Delta\epsilon}$

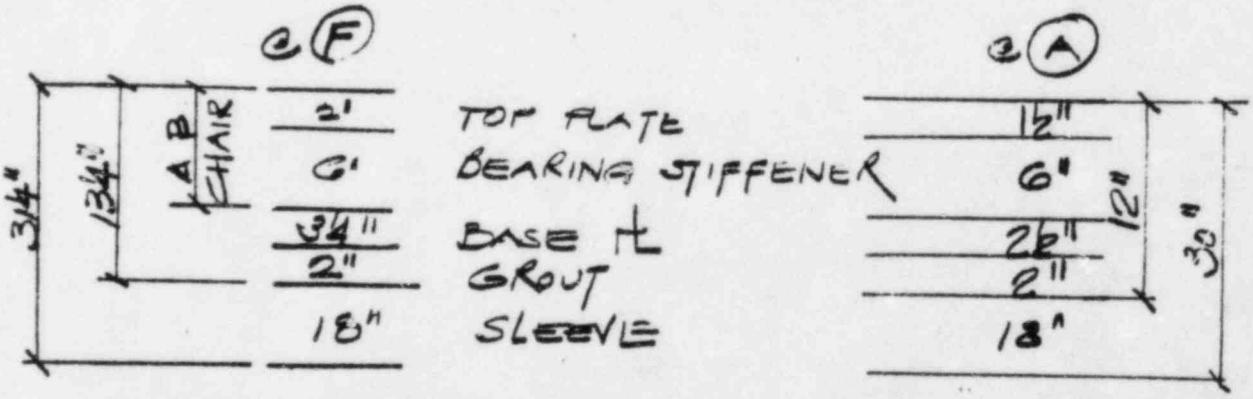
REF "STRUCTURAL STEEL DESIGNERS HANDBOOK" MERRIT PG 1-11

$\epsilon = \frac{\sigma}{E} = \frac{36}{29000} = 0.0012$

$E_t = \frac{58-36}{0.030 - 0.014} = 1375$

STRUCTURAL STEEL STRESS STRAIN CURVE FOR ANCHOR BOLTS

LENGTH OF ANCHOR BOLT



ASSUME L = 31'4" FOR STRAIN LENGTH FOR BOTH COL'S

@ Fu ΔL = (31.25)(0.030) = 0.9375" EXTENSION.

@ Fy ΔL = (31.25)(0.0012) = 0.0375" EXTENSION

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SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-1320-007
SHEET NO. 47 OF 59
DATE 11/10/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

DETERMINE INCREMENTAL PRESSURE TO REACH YIELD OF NEXT SET OF ANCHOR BOLTS.

REF COMPUTER OUTPUT "PHSTROJ" (ANCHOR BOLTS MODELED PER SHEET NO. 44)

	1	2	3	4	5	6	7	8	9	10	
	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	CAPACIT
A	87.0	166.5	154.9	169.4	176.5	169.9	150.5	144.5	120.0	103.2	10% MPH
	93.0	11.5	25.1	10.6	3.5	10.1	29.5	35.5	60.0	76.8	RESERV
	32.1	64.8	61.8	Y	Y	Y	57.3	59.4	46.5	40.5	T/10PSF
	2.897	0.177	0.406				0.515	0.598	1.290	1.896	RATIO
	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	CAPACI
F	83.4	123.1	115.2	124.7	128.0	119.4	113.4	103.5	87.6	98.4	10% MP
	96.6	56.9	64.8	55.3	57.0	60.6	66.6	76.5	92.4	86.6	RESER
	34.5	55.9	49.7	52.9	59.0	46.7	52.2	43.0	37.1	36.3	T/10F
	2.800	1.018	1.304	1.045	0.963	1.278	1.276	1.779	2.491	2.386	RATIO
	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	CAPACIT
J	61.0	59.8	63.2	65.3	66.0	64.1	60.9	55.9	49.7	50.9	10% MPH
	75.8	77.0	73.6	71.5	70.8	72.7	75.9	80.9	87.1	85.9	RESERV
	19.8	19.9	21.0	22.1	22.5	21.5	19.4	17.5	15.6	15.9	T/10F
	3.828	3.869	3.505	3.235	3.147	3.381	3.912	4.623	5.513	5.403	RATIO

ANCHOR BOLT CAPACITY

2" ϕ (5.0)(36) = 180.K COL LINES A & F

1¾" ϕ (3.8)(36) = 136.8K COL LINE J

CHECK ANCHOR BOLT EXTENSION ON A-4.5 & 6 TO BE SURE THAT ULTIMATE STRAIN HAS NOT BEEN REACHED

JOINT	Δ_y		
461	0.06017"/10PSF <	0.9375"	OK
561	0.06323"/10PSF <	0.9375"	OK
661	0.06000"/10PSF <	0.9375"	OK

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SUBJECT SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-1320-001
SHEET NO. 46 OF 59
DATE 11/11/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

ADDL PRESS.	BOLT YIELD	WIND PRESS.	VELOCITY
1.77 PSF	A-2	31.08	110 MPH
4.06 PSF	A-3	33.37	114 MPH
5.16 PSF	A-7	34.46	116 MPH
5.08 PSF	A-8	35.29	117 MPH

Δ OF JOINT 835 DUE TO 1.77 PSF = $\frac{1.77}{10} \times 0.177'' = 0.031''$
(WITH A-4, 5 & 6 BOLTS YIELDED)

PROVIDE COMPUTER ANALYSIS FOR BASES YIELDED AT A-2, 3, 4, 5, 6, 7 & 8.

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SUBJECT: SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 44 OF 59
DATE 11/15/83
COMP. BY/DATE FA 11/28/83
CHK'D. BY/DATE DBT 12/12/83

BOLTS YIELDED AT A-2,3,4,5,6,7,8
DETERMINE INCREMENTAL PRESSURE TO REACH YIELD OF NEXT SET OF ANCHOR BOLTS AFTER 110 MPH
REF COMPUTER OUTPUT "PHSTRL9"

	1	2	3	4	5	6	7	8	9	10	
A	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	CAPACIT
	87.0	168.5	154.9	169.4	176.5	169.9	150.5	144.5	120.0	103.2	107 MPH
	5.7	11.5	6.9				10.1	10.5	8.2	7.2	Δ TO 110
	92.7	180.0	165.8				160.6	155.0	128.2	110.4	110 MPH
	87.3	Y	Y	Y	Y	Y	Y	Y	51.8	69.6	RESERVE
	43.2								52.1	45.2	T/10PSF
	2.02								0.994	1.540	RATIO
F	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	CAPACIT
	83.4	123.1	115.2	124.7	128.0	119.4	113.4	103.5	87.6	93.4	107 MPH
	6.1	9.9	8.8	9.4	9.6	8.3	9.2	7.6	6.6	6.4	Δ TO 110
	89.5	133.0	124.0	134.1	137.6	127.7	122.6	111.1	94.2	99.8	110 MPH
	90.5	47.0	56.0	45.9	42.4	52.3	57.4	68.9	85.8	80.2	RESERVE
	45.1	68.5	62.3	65.2	65.8	57.8	63.5	53.1	45.6	43.2	T/10PSF
	2.01	0.686	0.899	0.704	0.644	0.905	0.904	1.298	1.882	1.852	RATIO
J	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	CAPACITY
	61.0	59.8	63.2	65.3	66.0	64.1	60.9	55.9	49.7	56.9	107 MPH
	3.5	3.5	3.7	3.9	4.0	3.8	3.4	3.1	2.8	2.8	Δ TO 110
	64.5	63.3	66.9	69.2	70.0	67.9	64.3	59.0	52.5	53.7	110 MPH
	72.3	73.5	69.9	67.6	66.8	68.9	72.5	77.8	84.3	83.1	RESERVE
	25.1	25.1	26.0	26.7	26.7	25.6	23.5	21.3	18.7	18.7	T/10PSF
	2.88	2.928	2.688	2.532	2.502	2.691	3.085	3.652	4.588	4.444	RATIO

ALLOWABLE ADD'L PRESS TO NEXT A.B YIELD = 6.44 PSF
V = 121 MPH

CHECK ANCHOR BOLT EXTENSION TO INSURE THAT ULTIMATE STRAIN HAS NOT BEEN EXCEEDED

JOINT	261	361	461	561	661	761	861
Δ 107 MPH	0	0	0	0	0	0	0
Δ TO 110 MPH	0	0	0.0107"	0.0112"	0.0106"	0	0
Δ TO 121 MPH	0.0404	0.0400	0.0433	0.0446	0.0427"	0.0353"	0.0040"
TOTAL Δ	0.0404	0.0400	0.0540	0.0558	0.0533	0.0353	0.0040

Δ ALLOW = 0.9375" ∴ OK

CONSIDER A-9 F-2,3,4,5,6 & 7 TO YIELD.

A000 0016 12-80

GPU Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 50 OF 59
DATE 11/16/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

	1	2	3	4	5	6	7	8	9	10	
A	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	
	93.7									110.4	110 MF
	27.8									29.1	Δ TO 12
	120.5									139.5	121 MF
	59.5									40.5	RESER
	55.5									55.0	T/10PS
	1.072									0.736	RATI
E	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	
	89.5	133.0	124.0	134.1	137.6	127.7	127.6	111.1	94.2	99.8	110 M
	29.0	44.1	40.1	42.0	42.4	37.2	40.9	34.2	29.4	27.8	Δ TO 1:
	118.5	177.1	164.1	176.1	180.0	164.9	163.5	145.3	123.6	127.6	121 MF
	61.5	2.9	15.9	13.9	0	25.1	36.5	54.7	76.4	72.4	RESERV
	71.7	Y	Y	Y	Y	Y	Y	68.9	56.3	54.4	T/10PS
	0.858							0.794	1.357	1.331	RATIO
J	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	
	64.5	63.3	66.9	69.2	70.0	67.9	64.3	59.0	52.5	53.7	110 MP
	16.2	16.2	16.7	17.2	17.2	16.5	15.1	13.7	12.0	12.0	Δ TO 12
	80.7	79.5	83.6	86.4	87.2	84.4	79.4	72.7	64.5	65.7	121 MF
	56.1	57.3	53.2	50.4	49.6	52.4	57.4	64.1	72.3	71.1	RESERV
	34.2	35.8	37.5	38.7	38.5	36.3	32.4	28.2	24.0	24.0	T/10 PS
	1.670	1.623	1.419	1.302	1.288	1.444	1.772	2.273	3.012	2.963	RATIO

ALLOWABLE ADDITIONAL PRESSURE TO NEXT A.B. YIELD = 7.36 PSF
V = 132.3 MPH

CHECK ANCHOR BOLT EXTENSION TO INSURE THAT ULTIMATE STRAIN HAS NOT BEEN EXCEEDED.

JOINT	361	361	461	561	661	761	861
Δ 121 MPH	0.0404	0.0400	0.0540	0.0558	0.0533	0.1353	0.0540
Δ TO 132 MPH	0.0072	0.0557	0.0601	0.0613	0.0583	0.0469	0.0531
Δ @ 132 MPH	0.0476"	0.0957"	0.1141"	0.1171"	0.1115"	0.0822"	0.0571"

Δ ALLOW = 0.9375" ∴ OK

CONSIDER A-1, 10
F-1, 8, 9, 10 } YIELDED

A000 0016 12-80

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SUBJECT: SEP TOPIC III-2 LAI 82251-07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 51 OF 59
DATE 11/17/83
COMP. BY/DATE MH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

ALL BOLTS ON (A) & (E) COL LINES ARE AT YIELD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(a)	
	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	CAPAC
(J)	80.7	79.5	83.6	86.4	87.2	84.4	79.4	72.7	64.5	65.7	121 MP
	25.2	26.0	27.6	28.5	28.3	26.7	23.8	20.8	17.7	17.7	Δ TO 13
	105.9	105.5	111.2	114.9	115.5	111.1	103.2	93.5	82.2	83.4	132 M
	30.9	31.3	25.6	21.9	21.3	25.7	33.6	43.3	54.6	53.4	RESER
	42.4	42.8	43.9	44.5	44.6	43.5	41.6	39.7	37.5	37.8	710 PSF
	0.729	0.731	0.583	0.492	0.478	0.591	0.808	1.091	1.456	1.413	RATIO

ALLOWABLE ADD'L PRESSURE TO NEXT A.B. YIELD = 4.78 PSF
VELOCITY = 139.2 MPH

CHECK ANCHOR BOLT EXTENSION TO INSURE THAT ULTIMATE STRAIN HAS NOT BEEN EXCEEDED.

JOINT	261	361	461	561	661	761	861
Δ 132 MPH	0.0476"	0.0957"	0.1141"	0.1171"	0.1115"	0.0822"	0.0571"
Δ TO 139.2	0.0417	0.0405	0.0429	0.0439	0.0426	0.0379	0.0399
Δ @ 139.2 MPH	0.0893"	0.1362"	0.1570	0.1610	0.1541	0.1201	0.0970

↑ < 0.9375" ∴ OK

CONSIDER ALL BOLTS YIELDED

+ ANALYZE CASE WITH RIGID SUPPORT AT 835 935 1035

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SUBJECT SEP TOPIC III-2 LAI 82251.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. 6:1301:151:5320-001
SHEET NO. 52 OF 59
DATE 11/21/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

ALL ANCHOR BOLTS YIELDED

JOINT DISPLACEMENT - 835 @ CONTROL ROOM ROOF

Δ FOR 10 PSF = 0.64868"

Δ CLEAR = 0.945"

ADDL WIND LOAD CAPACITY = $\frac{0.945}{0.64868}$ = 14568 x 10
= 14.57 PSF

$p = (0.00256)(139)^2 + 14.57 = 64.03$ PSF

$V = \sqrt{\frac{64.03}{0.00256}} = 158$ MPH

VELOCITY AT WHICH FRAME COL CONTACTS CONTROL ROOM/MER ROOF = 158 MPH

CHECK EXTENSION OF A.B @ COL A-5 TO VERIFY THAT IT HAS NOT REACHED ULTIMATE

$\Delta = 0.1610"$ (@ 139 MPH)

$\Delta = \frac{0.1608}{0.3218"}$ (1.457)(0.11039)
< 0.9375" ∴ ANCHOR BOLTS ARE BELOW ULTIMATE CAPACITY

CHECK COLUMN A-5 FOR COMBINED LOADING
501 @ 501

	DL	WL VELOCITY (MPH) 107	110	121	132	139	158	
P	74.2	-10.6	-10.2	-10.6	-10.7	-11.1	-11.5	10 PSF WIN PRESS
M	-584.1	+3114.3	+537.6	+604.6	+780.9	+879.9	+1104.9	
		2.93	0.177	0.644	0.736	0.478	1.457	WL FACTORS
P	74.2	-31.1	-1.8	-6.8	-7.9	-5.3	-16.7	INCREMENTAL LOADING
M	-584.1	+9124.9	+95.2	+389.4	+574.7	+420.6	+1609.8	
P	74.2	43.1	41.3	34.5	26.6	21.3	4.6	SUMMARY LOADINGS
M	-584.1	8540.8	8636.0	9025.4	9600.1	10020.7	11630.5	

$F_a = 18.05^{ksi}$ $F_B = 24^{ksi}$

@ 139 MPH

$f_a = \frac{21.3}{76.5} = 0.28^{ksi}$ $f_a/F_a = 0.016 < 0.150$

$f_b = \frac{10020.7}{953} = 10.51^{ksi}$ $f_b/F_b = 0.438$

$0.454 < 1.00$ OK

WITHOUT CONSIDERING 1.6 FACTOR

@ 158 MPH

$f_a = \frac{4.6}{76.5} = 0.06^{ksi}$ $f_a/F_a = 0.003$

$f_b = \frac{11630.5}{953} = 12.20^{ksi}$ $f_b/F_B = 0.508$

$0.511 < 1.00$ OK

W/O CONSIDERING 1.6 FACTOR

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SUBJECT SEP Topic III-2 LAS 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5360-001
SHEET NO. 54 OF 59
DATE 11/21/83
COMP. BY/DATE PH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

CHECK STRESSES IN COL A-5 @ 212 MPH (501 @ 501)

	155 MPH	TO 212 MPH		
P =	4.6	+ (-11.6)(5.153) =	-55.2^k	(TENSION)
M =	11620.5	+ (1218.6)(5.153) =	17909.9$^{k''}$	

f_a = 55.2/76.5 = 0.72^{ksi} f_a/F_a = 0.72/22 = 0.032

f_b = 17909.9/953 = 18.79^{ksi} f_b/F_b = 18.79/24 = 0.783

0.815

< 1.600

OK

COLUMN A-5 STRESS @ BASE - OK

ANALYSIS DEFLECTION SUMMARY

CLOSURE OF GAP BETWEEN STEEL COLUMN AND CONTROL ROOM ROOF (2.5" ORIGINAL CLEARANCE)

STRESS STATE	VELOCITY	Δ 83	AVAIL CLEAR
FIRST ANCHOR BOLT REACHES ALLOWABLE STRESS (Δ DL+WL)	107 MPH (29.3 PSF)	0.413"	1.712"
COL'S A-4,5 & 6 YIELDED → COL A-2 REACHES YIELD	110 MPH (31.0 PSF)	0.031"	1.681"
COL'S A-2,3,4,5,6,7, & 8 YIELDED → COL F-5 REACHES YIELD	121 MPH (37.5 PSF)	0.141"	1.540"
COL'S A-2 to 9 + F-2 to 7 YIELDED → COL A-10 REACHES YIELD	132 MPH (44.6 PSF)	0.213"	1.327"
COL'S A-1 to 10 + F-1 TO 10 YIELDED → COL J-5 REACHES YIELD	139 MPH (49.6 PSF)	0.382"	0.945"
ALL COLUMNS YIELDED	158 MPH (64.03 PSF)	0.945"	0"

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SUBJECT SEP TOPIC III-2 LAI 82257.07
TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 56 OF 57
DATE 11/21/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE D.B.T. 12/12/83

AFTER CONTACT WITH CONTROL ROOM/MER ROOF, CONSIDER CONTACT POINT AS A SUPPORT

JOINT 835	JOINT 935	JOINT 1035
P: 12.7K / 10 PSF	6.7K / 10 PSF	10.0K / 10 PSF

REF CALCULATION C-1302-151-5320-003
SIDING ULTIMATE CAPACITY = 165 MPH

DETERMINE ROOF REACTION AT POINT OF SIDING FAILURE

V = 165 PSF p = 69.7 PSF
V = 158 PSF p = 64 PSF
5.7 PSF

835 R = 12.7 x 5.7/10 = 7.2K
935 R = 6.7 x 5.7/10 = 3.8K
1035 R = 10.0 x 5.7/10 = 5.7K
16.7K ROOF SHEAR AT POINT OF SIDING FAILURE.

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SUBJECT SEP TOPIC III-2 LAT 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C1204-151-0520-007
SHEET NO. 57 OF 59
DATE 11/21/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

ESTIMATE FAILURE VELOCITY BASED ON NO SIDING FAILURE

ASSUME THAT FAILURE IS CAUSED BY ANCHOR BOLT AT COL A-2 REACHING ULTIMATE STRESS

Δ @ 158 MPH = 0.3218"

Δ/10 PSF W/ STEEL CONTACT @ ROOF = 0.11949"

Δ @ ULTIMATE = 0.9375"

$$P\ (\text{add'l}) = \frac{(0.9375 - 0.3218)}{0.11949} = 5.153 \times 10 = 51.53\ \text{psi}$$

$$P\ (\text{TOTAL}) = 64 + 51.5 = 115.5\ \text{psf} = 212\ \text{MPH}$$

REACTION AT CONTROL ROOM/MER ROOF @ ULTIMATE

$$P = 16.7 + (5.153)(12.7 + 6.7 + 10.0) = 168.2^{k}$$

COMPARE SHEAR TO DESIGN CAPACITY AS VERIFIED BY CALCULATION FOR ADDITION OF CABLE

STONE & WEBSTER CALC PG 20 (REF 12)
V_{EW} (SEISMIC OBE) = $198^{k} > 168.2^{k}$
TORNADO REACTION

CHECK SHEAR ON CRITICAL WALL AND COMPARE WITH STONE & WEBSTER CALC. INCLUDE AFFECT OF CENTER OF FORCE ECCENTRICITY TO CENTER OF RIGIDITY

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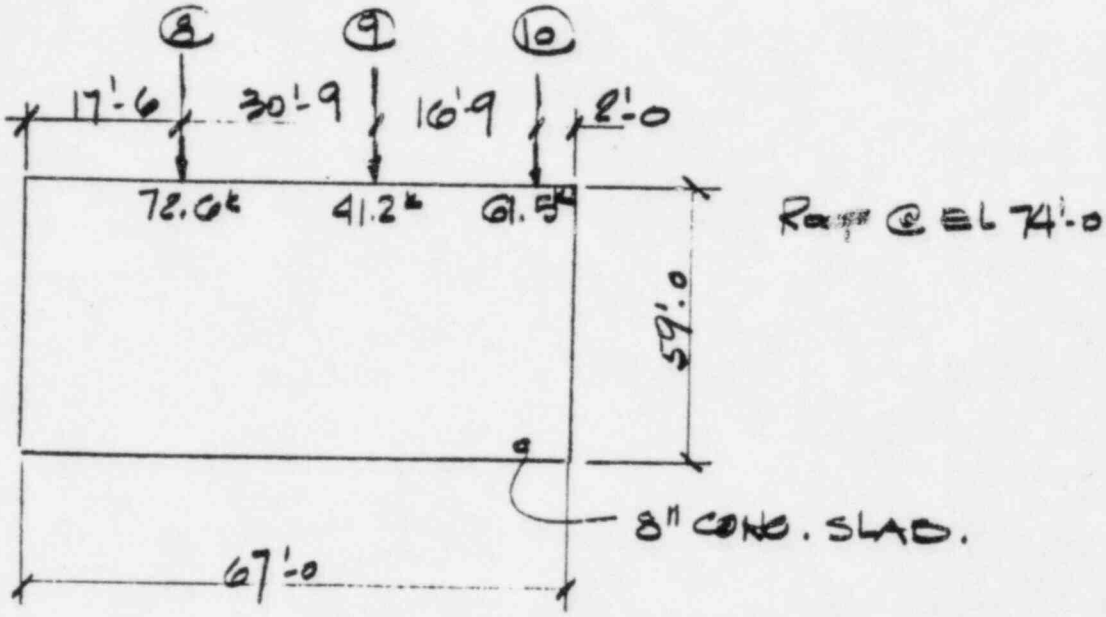
SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-751-5320-007
SHEET NO. 58 OF 59
DATE 11/21/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

CENTER OF SHEAR



$$\frac{(72.6)(17.5) + (41.2)(48.25) + (61.5)(65)}{(72.6 + 41.2 + 61.5)} = 41.39'$$

CTR OF FORCE IS @ 41.39' FROM LEFT SIDE

CTR OF RIGIDITY @ 14.96' FROM LEFT EDGE (REF 12 PG27)

$M_T = (72.6 + 41.2 + 61.5)(41.39 - 14.96) = 4633^{k'}$

DUE TO FRAME REACTIONS

$V_{NORTH} = (0.0059728)(4633) = 27.7^k$

$V_{SOUTH} = (0.0059753)(4633) = 27.7^k$

$V_{EAST} = (0.236)(168) + (0.0111084)(4633) = 39.6^k$

$V_{WEST} = (0.764)(168) + (0.0111046)(4633) = 179.8^k$

FROM REF 12 $V_{NORTH} = 162^k > 27.7^k$ OK
$V_{SOUTH} = 426^k > 27.7^k$ OK
$V_{EAST} = 170^k > 39.6^k$ OK
$V_{WEST} = 414^k > 179.8^k$ OK

NOTE - COMPARISON IS OBE VS TORNADO SO F.S. IS GREATER THAN THAT SHOWN

A000 0016 12-80

SUMMARY

INITIAL ANCHOR BOLT YIELDING OCCURS AT APPROXIMATELY 107 MPH.

PROGRESSIVE ANCHOR BOLT YIELDING OCCURS UNTIL ALL COLUMN ANCHOR BOLTS HAVE YIELDED WHEN THE TORNADO VELOCITY REACHES 139 MPH. THE STEEL FRAME REMAINS STABLE WITH ALL BASES AT YIELD.

LATERAL DEFLECTION CLOSES THE GAP BETWEEN THE STEEL COLUMN F-8 AND THE CONTROL ROOM ROOF AT 158 MPH

AT A TORNADO VELOCITY OF 166 MPH, THE SIDING FAILS AND BARE STEEL FRAME LOADING IS PRESENT. IMMEDIATELY PRIOR TO SIDING FAILURE, THE FRAME REACTION AT THE CONTROL ROOM/MER ROOF IS APPROXIMATELY 17 K.

BASED ON CAPACITY SIMILARITIES DETERMINED IN CALCULATION C-1302-151-5320-003, ASSUME BARE FRAME VELOCITY CAPACITY WILL MATCH CAPACITY WITH FULL SIDING. FRAME FAILURE VELOCITY = 212 MPH.

CONTACT BETWEEN FRAME AND MER ROOF CAUSES REACTION ON ROOF WHICH IS OF A LESSER MAGNITUDE THAN OBE EARTHQUAKE AND THEREFORE NEED NOT BE ANALYZED.

ATTACHMENT II

TURBINE BUILDING: WIND LOAD COMBINATIONS

Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO G1302-151-5320-006
SHEET NO. 1 OF 57
DATE 10/19/83
COMP. BY/DATE P.H. 11/18/83
CHK'D. BY/DATE D.B.T. 11/22/83

PROBLEM

REVIEW SEISMIC CATEGORY ONE STRUCTURES FOR LOAD COMBINATIONS INCLUDING WIND LOAD, SNOW LOAD AND OPERATING PIPE REACTION LOADS AND THERMAL LOADS (INTEGRATED ASSESSMENT SUMMARY 4.3.8)

RESULTS

- STRUCTURAL STEEL - ALL FRAME MEMBERS, GIRTS, PURLINS AND DECKING ARE STRESSED BELOW THE ALLOWABLE LIMITS OF NUREG 0800 SECT 3.8.4

- ANCHOR BOLTS AND CONCRETE BEARING - FOR LOAD COMBINATIONS OF DEAD, SNOW AND WIND, ALL CONCRETE BEARING MEETS THE ORIGINAL DESIGN CRITERIA WHICH ALLOWED A ONE-THIRD INCREASE IN ALLOWABLE STRESS. ONE SET OF ANCHOR BOLTS SHOWS MINOR OVERSTRESS (30.1 KSI VS 29.5 KSI) FOR ONE WIND DIRECTION BASED ON ORIGINAL DESIGN CRITERIA. USING CURRENT SRP ALLOWABLES, 9 SETS OF ANCHOR BOLTS AND 8 BASE PLATE CONCRETE BEARING STRESSES EXCEED THE ALLOWABLE VALUES. BASED ON SATISFACTORY RESULTS USING ORIGINAL DESIGN CRITERIA, THE STEEL STRUCTURE IS JUDGED TO SAFELY RESIST THE APPLIED LOADING.

- FOR LOAD COMBINATIONS OF DEAD AND WIND, IT HAS BEEN DETERMINED THAT ANCHOR BOLT AND CONCRETE BEARING STRESSES EXCEED THE ORIGINAL DESIGN CRITERIA AT SEVERAL COLUMNS. HOWEVER, THREE DIMENSIONAL FRAME ANALYSIS HAS DEMONSTRATED THAT EVEN IF THREE SETS OF COLUMN ANCHOR BOLTS WERE TO YIELD, THE STRUCTURE CONTAINS SUFFICIENT REDUNDANCY TO RETAIN STRUCTURAL STABILITY.
- WHEN USING CURRENT SRP ALLOWABLES, 17 SETS OF ANCHOR BOLTS AND 9 BASE PLATE CONCRETE BEARING STRESSES EXCEED THE ALLOWABLE VALUES.
- BASED ON SATISFACTORY STABILITY UNDER

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ECT SEP TOPIC III-2 LAS 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 2 OF 57
DATE 10/19/83
COMP. BY/DATE PH 11/16/83
CHK'D. BY/DATE DBT 11/22/83

COMBINED LOADINGS, THE STRUCTURE IS JUDGED TO SAFELY RESIST THE APPLIED FORCES.

CONCRETE PORTIONS OF TURBINE BUILDING IT IS CONCLUDED THAT FOR CONCRETE PORTIONS OF THE TURBINE BUILDING, EARTHQUAKE IS MORE CRITICAL THAN WIND LOADING AND WIND LOAD ANALYSIS IS NOT REQUIRED TO ESTABLISH STRUCTURAL ADEQUACY

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SUBJECT SEP TOPIC III.2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BUILDING

CALC. NO. C-1302-151-5320-006
SHEET NO. 3 OF 57
DATE 8/24/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

REFERENCES

1. NUREG 0800, 3.8.4 "OTHER SEISMIC CATEGORY I STRUCTURES"
2. ANSI A58.1-1982 "MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES"
3. LAI 82251.09
4. AISC "SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS" EFFECTIVE NOV 1, 1978
5. ROBERTSON PRODUCT CATALOG
6. CALCULATION Nº C-1302-151-5320-003
7. COMPUTER OUTPUT "BC3Q006"
8. COMPUTER OUTPUT "BCAIJVT" (TURBINE BUILDING)
9. COMPUTER OUTPUT "BC3QDCJ" (TURBINE BLDG BASE PL.)
10. SEP TOPIC II-2.A SEVERE WEATHER PHENOMENA
11. ACI 349-79 "NUCLEAR SAFETY STRUCTURES CODE"
12. NUREG CR-1981 SEISMIC REVIEW OF THE OYSTER CREEK NUCLEAR POWER PLANT AS PART OF THE SEP
13. COMPUTER OUTPUT "MAREKEZ"
14. "PCI DESIGN HANDBOOK PRECAST PRESTRESSED CONCRETE" 2ND ED
15. AISC ENG. JOURNAL 3RD QTR 1981 PG 86

ASSUMPTIONS & BASIC DATA

- ALL STRUCTURAL STEEL ASTM A-36
- TRUSS MEMBERS ARE CONSIDERED TO ACT AS PINNED END MEMBERS WHICH CARRY ONLY AXIAL LOAD. MOMENTS GENERATED BY PARTIAL END FIXITY ARE CONSIDERED TO BE SECONDARY MOMENTS AND ARE NOT CONSIDERED IN MEMBER CAPACITY CALCULATIONS.
- DESIGN WIND LOAD = 80 MPH

TURBINE BUILDING

LOAD COMBINATIONS - STEEL - TURBINE BLDG
REF NUREG 0800 - SECT 3.8.4

COMB	LIMIT
(3) D+L+W	S
(6) D+L+T_o+R_o+W	1.5S

D = STRUCTURE DEAD LOAD. NO EQUIPMENT LOADS ARE APPLICABLE

L = SNOW LOAD P_g = 20 PSF (REF ANSI A58.1-82)

T_o = OPERATING THERMAL EFFECTS - NONE PRESENT

R_o = PIPE REACTIONS DURING OPERATION OR SHUTDOWN - NONE PRESENT

THEREFORE DESIGN CONDITION FOR STEEL STRUCTURES IS D+L+W WITH REQUIRED SECTION STRENGTH BASED ON ALLOWABLE STRESSES WITHOUT A ONE-THIRD INCREASE

TURBINE BUILDING STEEL FRAME

LOADING CONDITION
D+L+W

WHERE "L" INCLUDES SNOW LOADING

SNOW $P_g = 20$ PSF (REF (11))
REF ANSI A58.1-1982, SECTION 7

$P_f = 0.7\, C_e\, C_t\, I\, P_g$

$C_e = 1.0$ TABLE 18 *
$C_t = 1.0$ TABLE 19
$I = 1.2$ TABLE 20 CATEGORY III

$P_f = (0.7)(1.0)(1.0)(1.2)(20) = 16.8$ psf

* USE $C_e = 1.0$ TO CONSERVATIVELY ACCOUNT FOR POTENTIAL SHIELDING OF TURBINE BUILDING ROOF BY REACTOR BUILDING.

- CHECK ALSO SECTION 7.3.4 FOR MINIMUM ALLOWABLE VALUES OF P_f

$P_f \geq P_g I = (20)(1.2) = 24$ psf ← GOVERNS

$\therefore P_f = 24$ psf FOR TURBINE BLDG.
PANEL POINT LOADS. (24)(8)(35.125) = 6744# INTERIOR
(24)(4)(35.125) = 3372# EXTERIOR

WIND LOADING – DESIGN VELOCITY = 80 MPH FASTEST-MILE AT 30 FEET ABOVE GRADE, EXPOSURE C

ANSI A58.1-1982

$q_z = 0.00256\, K_z\, (IV)^2$

$V = 80$ MPH
$I = 1.11$ TABLE 5 CATEGORY III AT OCEANLINE

K_z FROM TABLE 6

$q_z = (0.00256)(1.11 \times 80)^2 K_z = 20.19\, K_z$

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SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. G-1302-151-5320-006
SHEET NO. 6 OF 57
DATE 7/5/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

FOR MAIN FRAME ANALYSIS

$P = q_z G_H C_p$ FOR WINDWARD WALL

$G_H = G_{86.5} = 1.174$

$C_p = 0.80$

$P = (20.19) K_z (1.174)(0.80) = 18.96 K_z$

$P = q_h G_H C_p$ FOR LEEWARD WALL

$G_H = G_{86.5} = 1.174$

$C_p = -0.50$

$q_h = q_{86.5} = (20.19) K_{86.5} = (20.19)(1.3225) = 26.70$ psf

$P = (26.70)(1.174)(-0.50) = -15.67$ psf

HGT ABOVE GRADE	K_z	WINDWARD $P = 18.96 K_z$	LEEWARD	ACTUAL ELEV.	
0-15	.80	15.2	-15.7	23.5	38.5
20	.87	16.5	↑	43.5	
25	.93	17.6		48.5	46
30	.98	18.6		53.5	51
40	1.06	20.1		63.5	58.5
50	1.13	21.4		73.5	68.5
60	1.19	22.6		83.5	78.5
70	1.24	23.5		93.5	88.5
80	1.29	24.5		103.5	98.5
90	1.34	25.4	-15.7	113.5	108.5

ROOF SUCTION

$P = q_h G_H C_p = (26.70)(1.174)(-0.7) = -21.9$ psf

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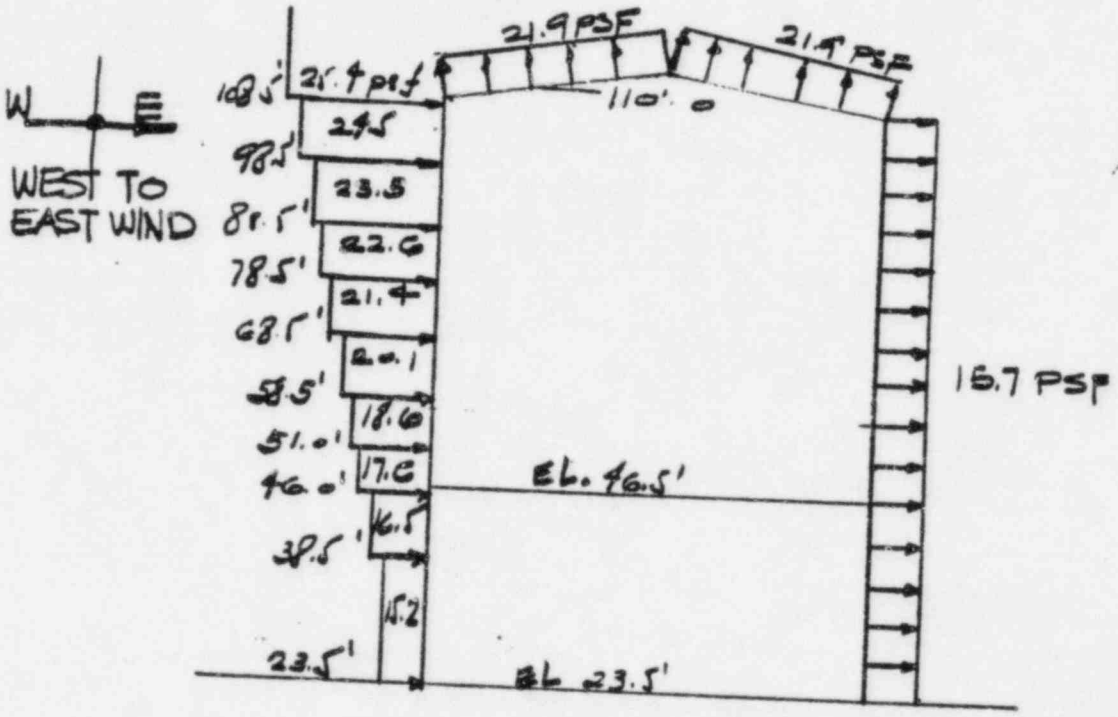

TURBINE BLDG WIND LOADING (80 MPH)

LOADING FOR COMPUTER MODEL

ROOF SUCTION

P = (21.9)(35.125)(8) = 6154# @ EACH INTERIOR PANEL POINT (JOINTS 6, 9, 10, 13, 15, 16, 19, 20, 23)

P = 2 × 6154 = 3077# @ EACH EXTERIOR PANEL POINT (JOINTS 3 & 24)

WINDWARD WALL LATERAL FORCE

APPLY CONCENTRATED LOADS AT GIRT ELEV.

ELEV
109'-3½
100'-7
93'-2½
85'-10
78'-3
70'-6
62'-8
54'-10
CONC. 46'-6

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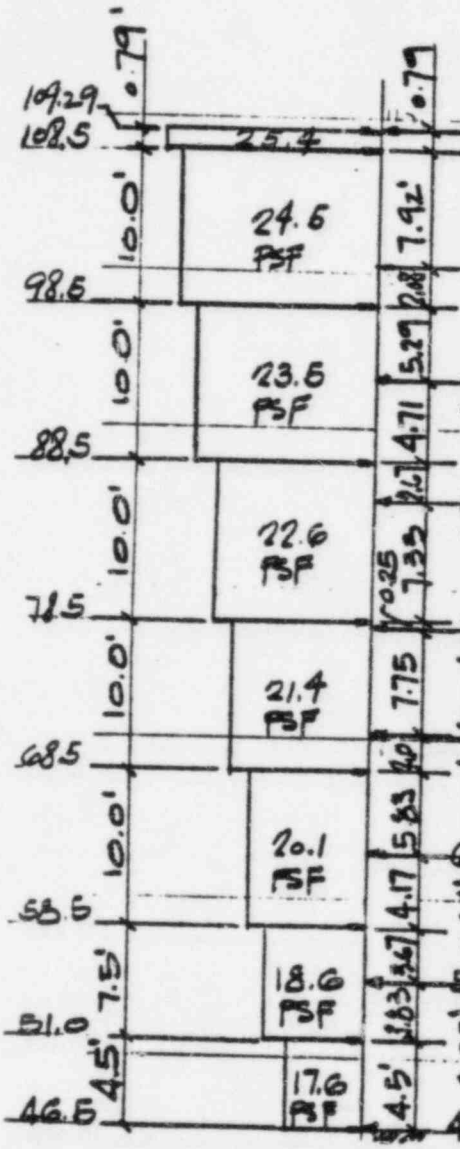
CALC. NO. 6-1302-151-5320-006
SHEET NO. 8 OF 57
DATE 7/6/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG



[(24.5)(7.92)(3.96) + (25.4)(0.79)(8.315)] / 8.71 = 107.38 #/ft

[(24.5)(7.92)(4.75) + (25.4)(0.79)(0.395)] / 8.71 = 106.73

[(23.5)(5.29)(2.645) + (24.5)(2.08)(6.33)] / 7.37 = 88.38

175.11 #/ft

[(23.5)(5.29)(4.725) + (24.5)(2.08)(1.04)] / 7.37 = 86.89

[(22.6)(2.67)(1.335) + (23.5)(4.71)(5.025)] / 7.38 = 86.28

173.17 #/ft

[(22.6)(2.67)(6.045) + (23.5)(4.71)(2.355)] / 7.38 = 84.76

[(21.4)(0.25)(0.125) + (22.6)(7.33)(3.915)] / 7.58 = 85.65

170.40 #/ft

[(21.4)(0.25)(7.455) + (22.6)(7.33)(3.665)] / 7.58 = 85.36

[(21.4)(7.75)(½)] = 82.93

168.29 #/ft

[(21.4)(7.75)(½)] = 82.93

[(20.1)(5.83)(2.915) + (21.4)(2)(6.83)] / 7.83 = 80.96

163.89 #/ft

[(20.1)(5.83)(4.915) + (21.4)(2)(1)] / 7.83 = 79.02

[(18.6)(3.67)(1.835) + (20.1)(4.17)(5.755)] / 7.84 = 77.50

156.52 #/ft

[(18.6)(3.67)(6.005) + (20.1)(4.17)(2.085)] / 7.84 = 74.58

[(17.6)(4.5)(2.25) + (18.6)(3.83)(6.415)] / 8.33 = 76.25

150.83 #/ft

[(17.6)(4.5)(6.08) + (18.6)(3.83)(1.915)] / 8.33 = 74.18 #/ft

ΣP = 1359.77 #/ft ΣR = 1359.77 K CHECK

109.29	107.38	× 35.125 =	3772*	GIRT REACTIONS AT FRAME COL. ON WINDWARD SIDE
100.58	105.11	=	6853	
93.21	173.17	=	6083	
85.83	170.40	=	5985	
78.25	168.29	=	5911	
70.50	163.89	=	5757	
62.67	156.52	=	5498	
54.83	150.83	=	5298	
46.50	74.18	=	2606	

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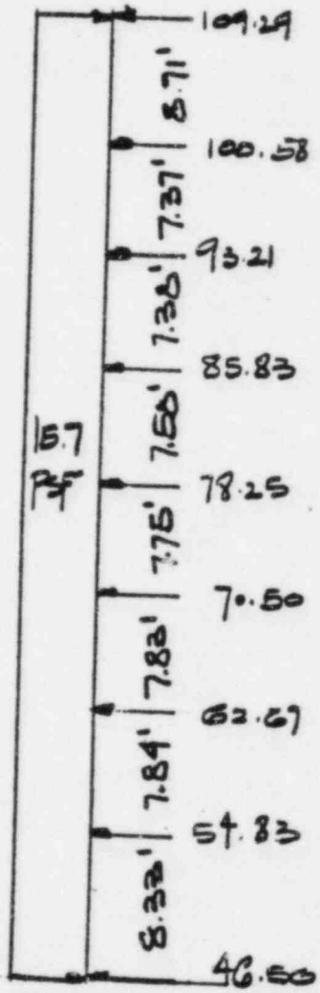
SECT. SEP TOPIC III-2 LAI 82257.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 9 OF 57
DATE 7/6/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83



109.29	(8.71)(½)(15.7)	=	68.37 #/ft
100.58	(7.37+8.71)(½)(15.7)	=	126.23 #/ft
93.21	(7.38+7.37)(½)(15.7)	=	115.79 #/ft
85.83	(7.58+7.38)(½)(15.7)	=	117.44 #/ft
78.25	(7.75+7.58)(½)(15.7)	=	120.34 #/ft
70.50	(7.83+7.75)(½)(15.7)	=	122.30 #/ft
62.67	(7.84+7.83)(½)(15.7)	=	123.01 #/ft
54.83	(8.33+7.84)(½)(15.7)	=	126.93 #/ft
46.50	(8.33)(½)(15.7)	=	65.39 #/ft.

109.29	68.37	×35.125	=	2401 #	GIRT REACTIONS AT FRAME COL. ON LEEWARD SIDE.
100.58	126.23		=	4434	
93.21	115.79		=	4067	
85.83	117.44		=	4125	
78.25	120.34		=	4227	
70.50	122.30		=	4296	
62.67	123.01		=	4321	
54.83	126.93		=	4458	
46.50	65.39		=	2297	

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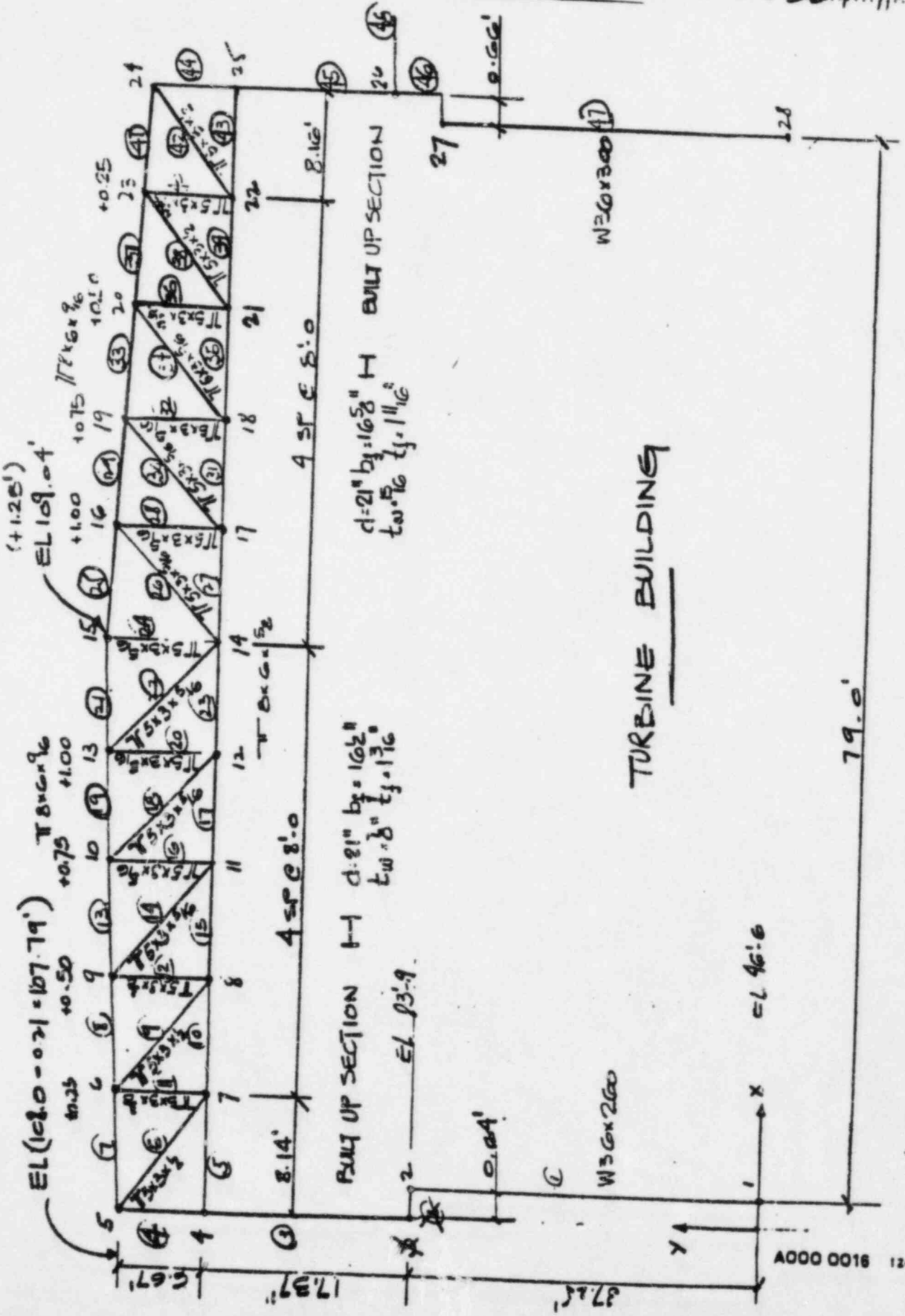
SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 10 OF 57
DATE 7/6/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11-22-83



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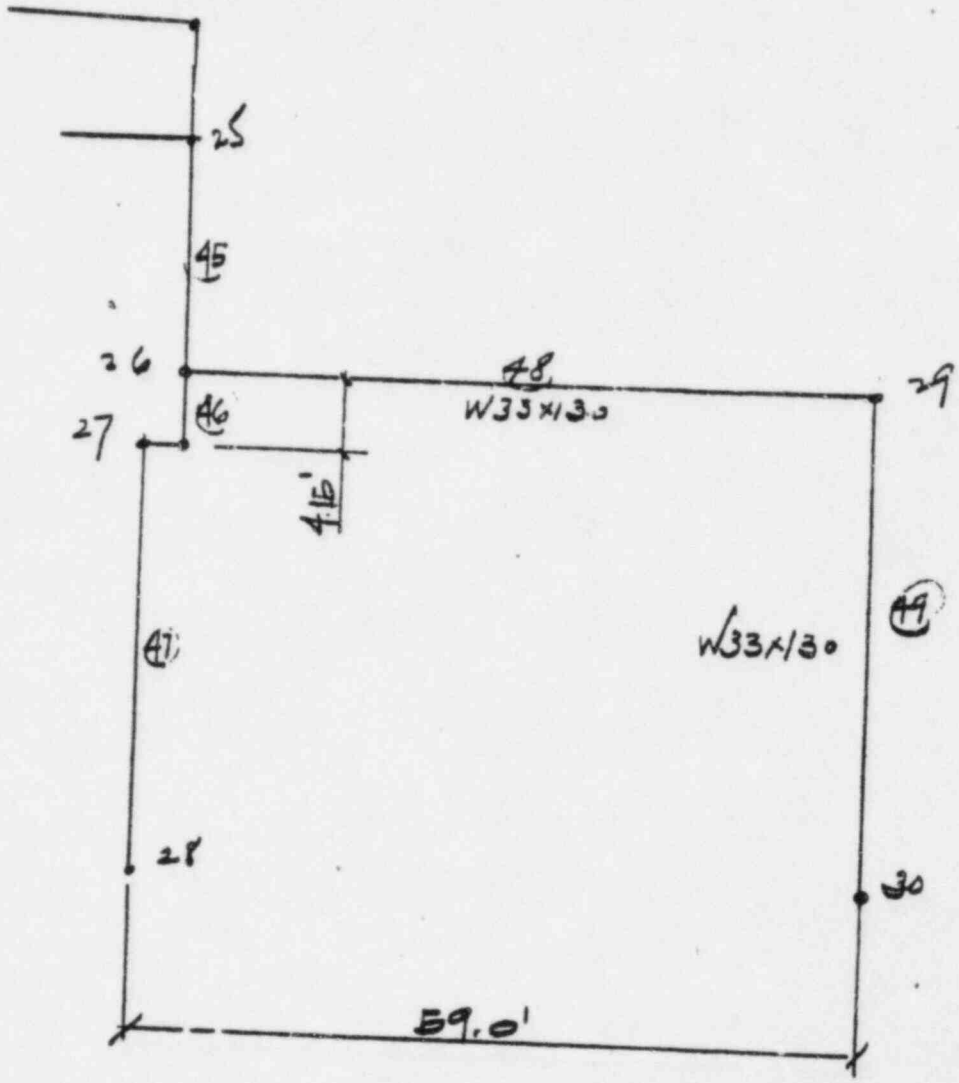
SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

CALC. NO C-1302-151-5320-006
SHEET NO. 11 OF 57
DATE 7/6/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11-22-83

TURBINE BLDG



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SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-026
SHEET NO. 12 OF 57
DATE 7/19/83
COMP. BY/DATE RH 11/16/83
CHK'D. BY/DATE DBT 11-22-83

ROOF DECK & PURLINS

SNOW LOADING + 24 PSF
WIND SUCTION − 21.9 PSF

DEAD LOAD

ROOFING (4 PLY WITH GRAVEL)	6.5 PSF
DECK (ROBERTSON SECT 3-18GA)	2.9 PSF
INSULATON (CELLULAR GLASS)	0.7 PSF
	9.1 PSF

DECK LOADING COMBINATION
DEAD + SNOW + WIND
9.1 + 24.0 − 21.9 = 11.2 PSF

DECK SECTION PROPERTIES - REF ROBERTSON CATALOG
$+S = 0.398 \text{ in}^3$
$-S = 0.380 \text{ in}^3$
MATERIAL = ASTM A446 $F_y = 33^{ksi}$

CONSIDER SIMPLE SPAN - CRITICAL CASE

$+M_{ALLOW} = fS = \frac{(20)(0.398)}{12} = 0.663^{k'}$
663 ft-lb

$+M = \frac{wl^2}{8}$ $l = 8'$ SPAN

$w_{ALLOW} = \frac{8M}{l^2} = \frac{(8)(663)}{8^2} = 82.9 \text{ PSF} > 11.2 \text{ PSF}$
OK

CHECK PURLIN
16 B 31 w/ MAX SPAN OF 36'-9½" @ 8' o/c
$S = 47.2 \text{ in}^3$
CONSIDER TOP FLANGE FULLY SUPPORTED BY ROOF DECK ∴ $F_B = 24^{ksi}$

$w = (8)(11.2) = 89.6 \text{ \#/FT} + 31.0 \text{ (BM WGT)} = 120.6 \text{ \#/ft}$

$M = \frac{(0.1206)(36.79)^2}{8} = 20.40^{k'}$

$f_b = \frac{2040 \times 12}{47.2} = 519^{psi} < 24^{ksi} = OK$

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SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 13 OF 57
DATE 7/19/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11-27-83

TRUSS MEMBER RESULTS

MEMBER SIZE	CAPACITY (REF 6)	ACTUAL MAX LD REF 6	MEMBER Nº'S	
DIAGONAL 7Γ5x3x1/2	T 161.7 C 97.0	T 46.8 C 51.2	6 9 38 42	OK
DIAGONAL 7Γ5x3x5/16	T 103.7 C 59.3	T 25.3 C 27.5	14 18 22 26 30 34	OK
VERTICAL 7Γ5x3x3/8	T 123.7 C 94.0	T 32.3 C 29.6	11 12 36 40	OK
VERTICAL 7Γ5x3x5/16	T 103.7 C 74.7	T 18.4 C 16.4	16 20 24 28 32	OK
TOP CHORD 7Γ8x6x9/16	T 320.6 C 290.2	T -77.3 C 74.9	7 8 13 19 21 25 29 33 37 41	OK
BOT CHORD 7Γ8x6x5/8	T 354.4 C 292.6	T 71.2 C 87.3	5 10 15 17 23 27 31 35 39 43	OK

ALL TRUSS MEMBER STRESSES ARE LESS THAN THE MAX ALLOWABLE LIMIT

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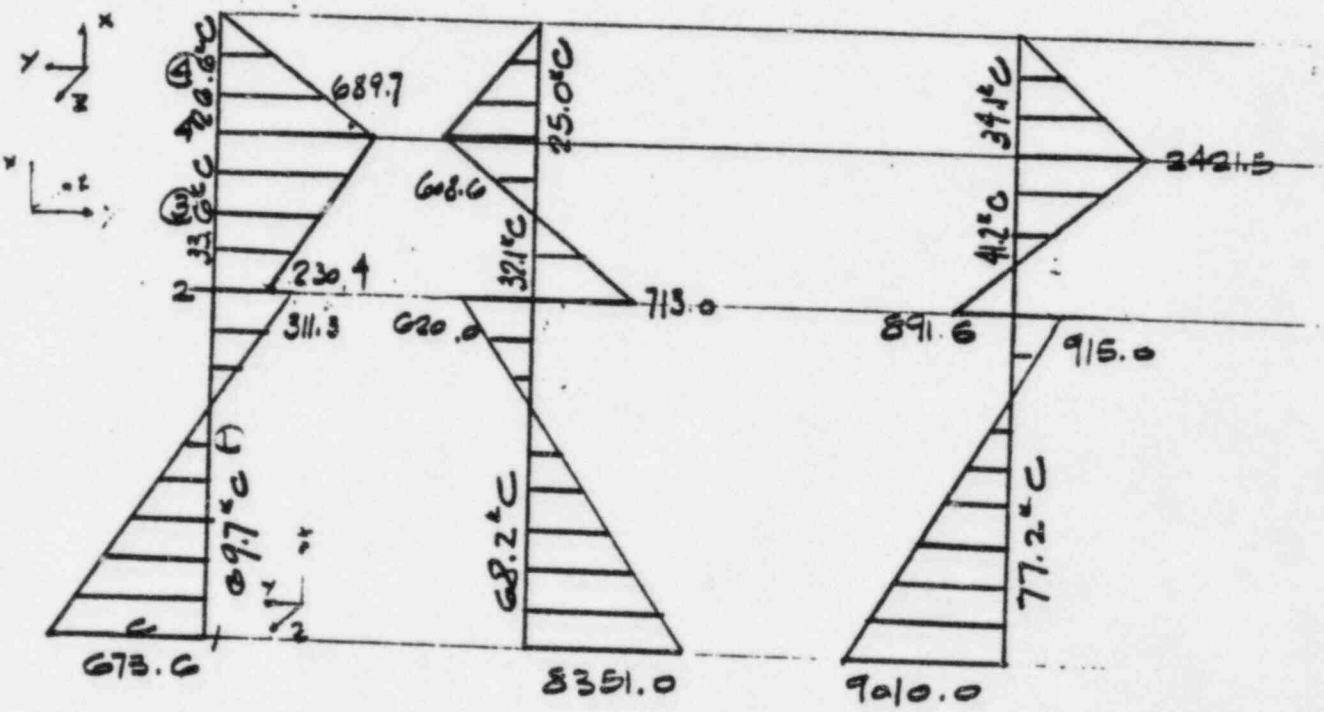
SUBJECT: SEP Topic III-2 tAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 14 OF 57
DATE 7/26/83
COMP. BY/DATE FT 11/18/83
CHK'D. BY/DATE DBT 11-22-83

CHECK COLUMN STRESSES
MEMBERS 1-3-4



DEAD LOAD

DL+SNOW +WL W/E

DL+SNOW +WL E/W

MOMENT PLOT ON COMP'N SIDE (K")

REF CALC N° C-1302-151-5320-003
PG 30 $K_x = 1.22$

W36×260 $A = 76.5\ in^2$ REF PG 31 ABOVE CALC.
$S_x = 953\ in^3$ $F_a = 18.05^{KSI}$ $F_B = 24^{KSI}$
$r_x = 15.0\ in$

D+L+WL E/W $f_a = 77.2/76.5 = 1.01^{KSI}$
$f_b = 9010/953 = 9.45^{KSI}$

$f_a/F_a = 1.01/18.05 = 0.06 < 0.15$

$0.06 + \frac{9.45}{24} = 0.06 + 0.39 = 0.45 < 1.00$ OK

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CHECK B.U. SECTION @ BOTTOM CHORD OF TRUSS.

REF CALC. NO C-1302-151-5320-003 (SHEETS 18 + 21)

$A = 55.5 in^2$ $F_a = 14.12^{ksi}$
$S_x = 411.4 in^3$ $F_b = 22^{ksi}$

$f_a = 34.1/55.5 = 0.61^{ksi}$ $f_a/F_a = 0.61/14.12 = 0.04 < 0.15$

$$0.04 + \frac{24.21.5}{\frac{411.4}{22}} = 0.04 + 0.27 = 0.31 < 1.00 \text{ OK.}$$

CHECK ANCHOR BOLT CAPACITY

REF CALC NO C-1302-150-5320-003 PAGE 40

$b = 26''$ $A_s = 2@2''\phi$ A.B $A_T(2''\phi) = 2.50^{\square''}$
$d = 47''$ $A_s = (2)(2.50) = 5.00^{\square''}$
$d'' = 21''$ $f'_c = 3000 psi$ $n = 9$

$M = 9010^{k''}$ $P = 77.2^k$

$$e = \frac{M}{N} = \frac{9010}{77.2} + 21 = 137.7''$$

$e/d = 137.7/47 = 2.93$

TRY $\gamma = 0.91$

$$L = \frac{1}{(1-\gamma\frac{d}{e})} = \frac{1}{(1-0.\frac{91}{2.93})} = 1.45$$

$$m = \gamma = \frac{n A_s L}{b d} = \frac{(9)(5.0)(1.45)}{(26)(47)} = 0.053$$

$$k = \sqrt{m^2 + 2\gamma} - m = 0.278$$

$$\gamma = 1 - k/3 = 0.907 \sim 0.91 \text{ OK}$$

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JECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 16 OF 57
DATE 7/27/83
COMP. BY/DATE FH 11/16/83
CHK'D. BY/DATE D.BT 11-22-83

$$f_s = \frac{N}{\gamma A_{si}} \frac{e}{d} = \frac{(77.2)(2.93)}{(0.907)(5.00)(1.45)} = \underline{34.4^{KSI}} > 22^{KSI}$$

NG

$$f_c = \frac{f_s}{n} \frac{k}{(1-k)} = \frac{(34.4)(0.278)}{9\ (1-0.278)} = \underline{1.47^{KSI}} > 1.125^{KSI}$$

NG

ANCHOR BOLT STRESSES EXCEED ALLOWABLE
CONCRETE BEARING EXCEEDS ALLOWABLE

USE NPS STIFFPLATE PROGRAM FOR MORE EXACT ANALYSIS. REF (9) P = 94,761 LB TENSION

$$f_s = \frac{94.761}{2.6} = 37.0^{ksi}$$ BOLT STRESS

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SUBJECT SEP TOPIC III-2 LAI 82251.09

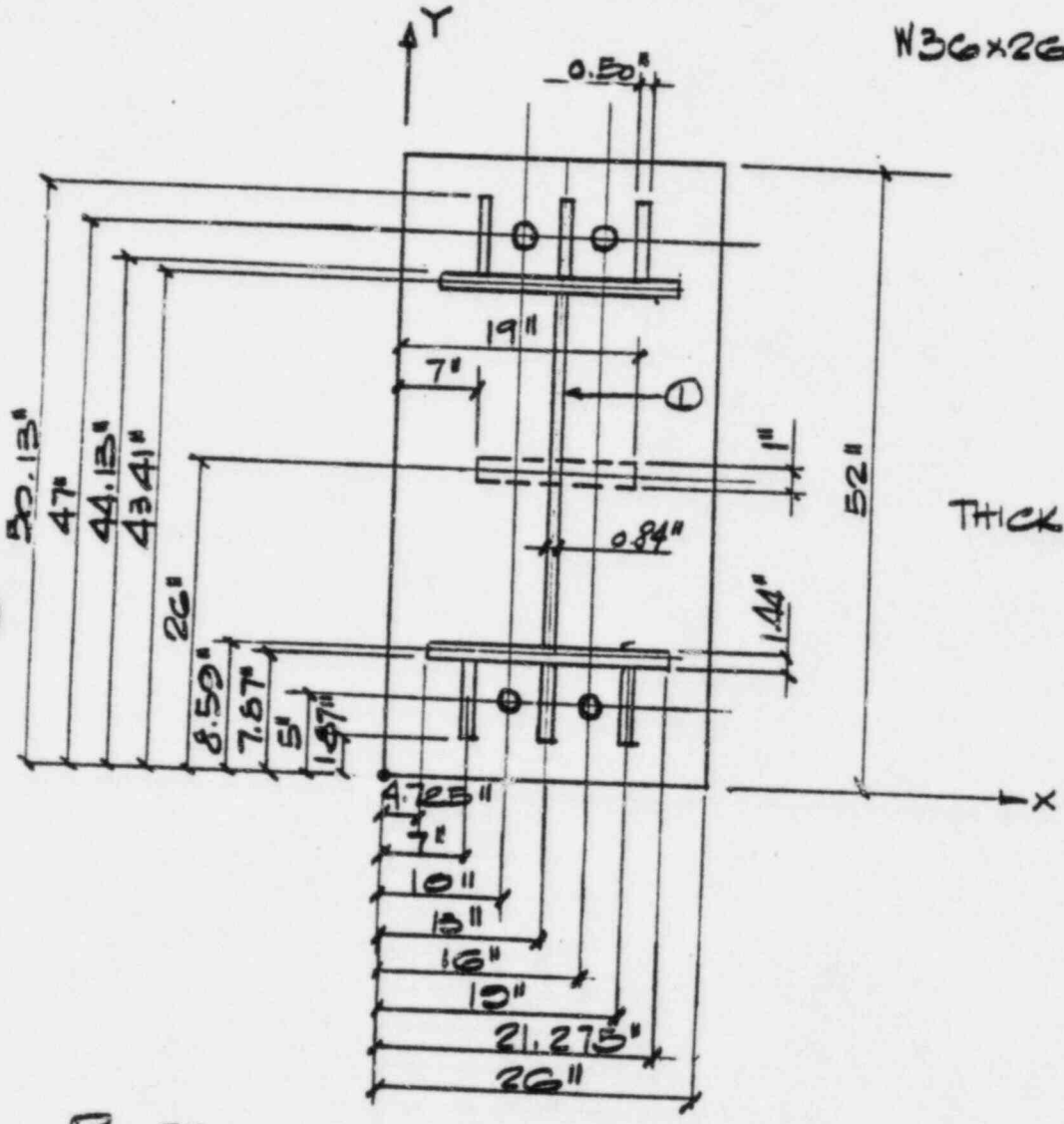
WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-181-5320-006
SHEET NO. 17 OF 57
DATE 8/1/83
COMP. BY/DATE TH 11/18/83
CHK'D. BY/DATE DBT 11-22-83

ANALYZE BASE PL USING NPS STIFFPLATE PROGRAM

W36x260 @ COL LINE A



THICKNESS = 2.5"

P = 77.2 M = 9010 K-IN

INPUT DATA BASE-H

TITLE O.C. TURBINE BLDG COL LINE A DEAD LOAD + 80 MPH WIND LOAD

BOLT	10	5	1	0			
BOLT	16	5	1	0			
BOLT	10	47	1	0			
BOLT	16	47	1	0			
LOAD	1	0	0	-77200	9010000	0	0

PLATE	26	52	2.5				
PROP	1	2.	12.5				
REGION	1	13.	26.	16.55	35.06	0	2

STIFF		7	1.87	7	11.47	6	0.5
↕		7	40.53	7	50.13	6	0.5
		13	1.87	13	11.47	6	0.5
		13	40.53	13	50.13	6	0.5
		19	1.87	19	11.47	6	0.5
		19	40.53	19	50.13	6	0.5
STIFF		7	26	19	26	4	1.0
OPTION	20	10	10				

NOTE: BASED ON PROGRAM DATA GENERATION ALGORITHM, IT IS REQUIRED THAT THERE BE A SPACE BETWEEN THE EDGE OF THE STIFFENERS AND THE COLUMN FLGE. THE PROGRAM CANNOT GENERATE THE FINITE ELEMENT GRID WHEN THE EDGE OF THE STIFFENER IS COINCIDENT WITH THE EDGE OF THE PLATE. IN ORDER TO ACCOMMODATE THIS REQUIREMENT, THE STIFFENERS WILL BE CARRIED 1.5 IN. BEYOND THE COL FLANGE.

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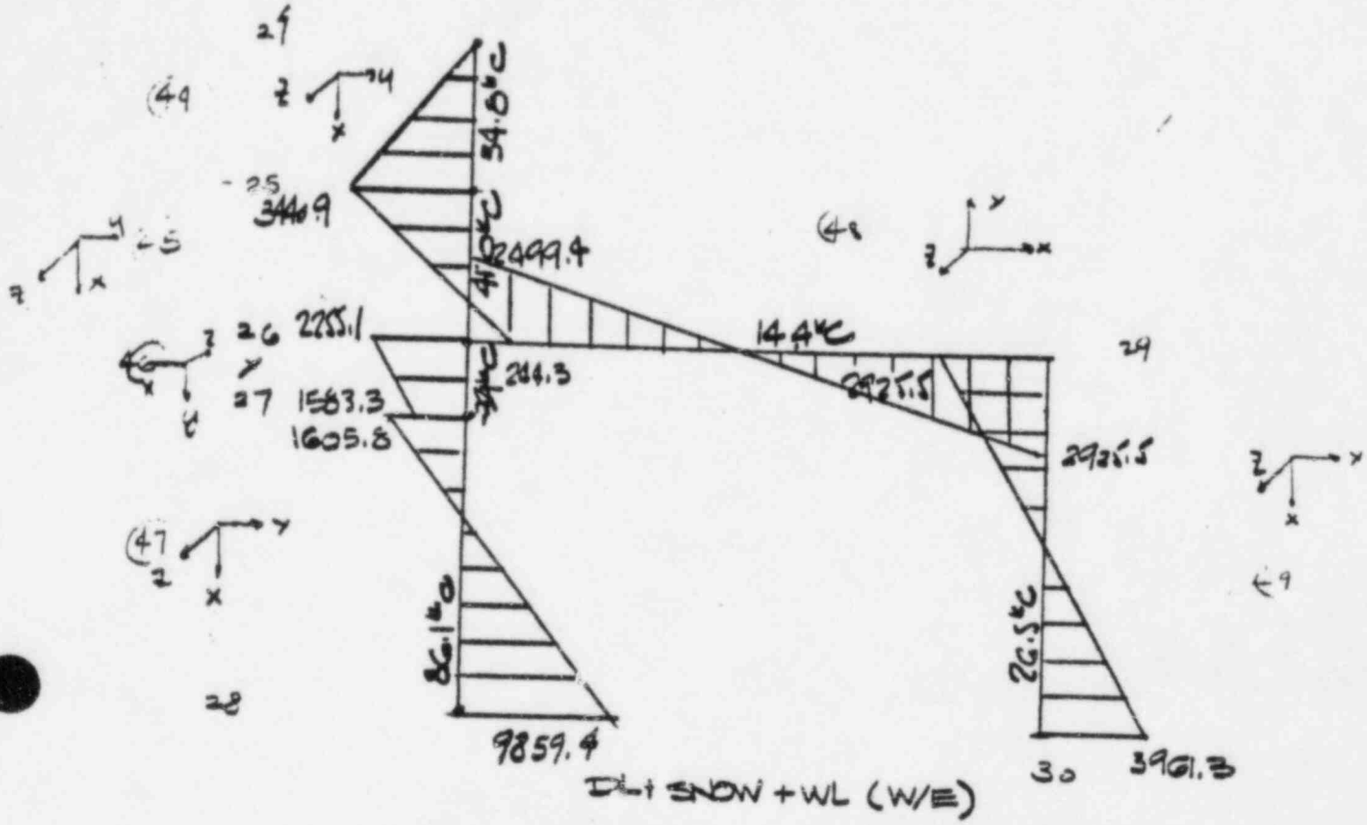
SUBJECT SEP TOPIC III-2 LAI 82251.09

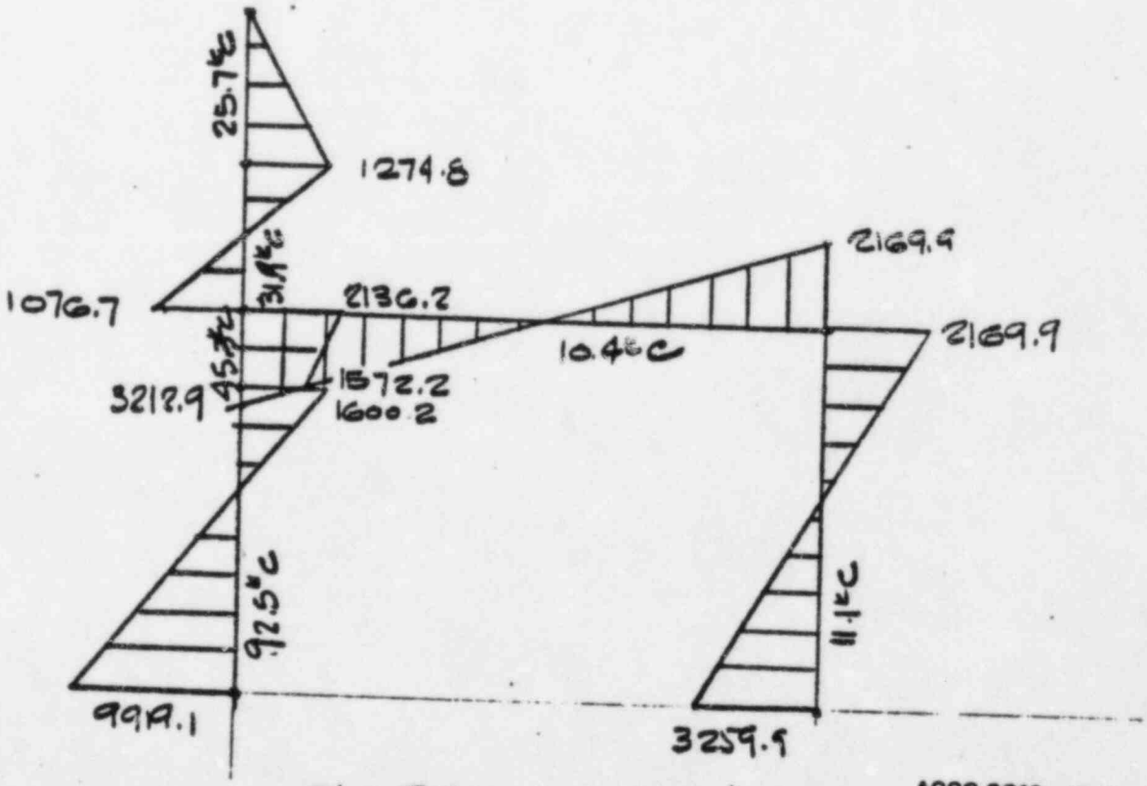
WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 19 OF 57
DATE 7/28/83
COMP. BY/DATE FH 11/16/83
CHK'D. BY/DATE D.B.T. 11-22-83



DL + SNOW + WL (W/E)



DL + SNOW + WL (E/W)

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SUBJECT: SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 20 OF 57
DATE 7/28/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11-22-83

CK W36x300 COL

K_x = SAME AS W36x260 = 1.22

$A = 88.3\ IN^2$ $F_A = 18.79^{KSI}$ } CALC NO C-1302-151-5320-003
$S_x = 1110\ IN^3$ $F_B = 24^{KSI}$ } PAGE 32

$f_a = 92.3/88.3 = 1.05^{KSI}$ $f_a/F_a = 1.05/18.79 = 0.06 < 0.15$

$f_b = 9919.1/1110 = 8.94^{KSI}$

$0.06 + \frac{8.94}{24} = 0.06 + 0.37 = 0.43 < 1.0$ OK

CK B.U. SECTION AT BOTTOM OF TRUSS

$A = 72.6\ IN^2$
$S_x = 539.0\ IN^3$ } CALC NO C-1302-151-5320-003
$F_A = 14.13^{KSI}$ PAGE 33
$F_B = 22^{KSI}$

$f_a = 34.8/72.6 = 0.48^{KSI}$ $f_a/F_a = 0.48/14.13 = 0.03 < 0.15$

$f_b = 3440.9/539 = 6.38^{KSI}$

$0.03 + \frac{6.38}{22} = 0.03 + 0.29 = 0.32 < 1.00$ OK

CK W33x130 GIRDER

$A = 38.3\ IN^2$ $r_x = 13.2\ in$
$S_x = 406\ IN^3$

CALCULATE C_B FOR WL (W/E)

$M_1 = 2499.4$ $M_2 = 2925.5$ $M_1/M_2 = +0.854$

$C_B = 1.75 + 1.05(0.854) + 0.3(0.854)^2 = 2.68 > 2.3$

$C_B = 2.3$

$F_B = \frac{(12\,000)(2.3)(9.89)}{(29)(12)(3309)} = 23.57^{KSI}$ $F_B = 22^{KSI}$

DETERMINE ALLOWABLE AXIAL LOAD

$L_x = 58'$ $r_x = 13.2$ IN
$L_y = 29'$ $r_y = 2.39$ IN

$\frac{KL}{r_x} = \frac{(58)(12)}{13.2} = 52.7$

$\frac{KL}{r_y} = \frac{(29)(12)}{2.39} = 145.6$ $F_a = 7.04$ KSI

$f_a = 144/38.3 = 0.38$ KSI $f_a/F_a = 0.38/7.04 = 0.05 < 0.15$

$f_b = 2925.5/406 = 7.20$ KSI $f_b/F_B = 7.20/22 = 0.33$

$0.05 + 0.33 = 0.38 < 1.00$ OK

CK W33X130 COL

$A = 38.3$ IN^2 $K_x = 1.35$
$S_x = 406$ IN^3 $F_A = 18.07$ KSI
$F_B = 19.75$ KSI

REF CALC N° C-1302-151-5320-003 PAGE N° 35

$f_a = 26.5/38.3 = 0.69$ KSI $0.69/18.07 = 0.04 < 0.15$

$f_b = 3961.3/406 = 9.76$ KSI $9.76/19.75 = 0.49$

$0.04 + 0.49 = 0.53 < 1.00$ OK

CK BASE PL W36 x 300

$P = 86.1^k$ $M = 9850.4^{k''}$

$b = 29''$ $A_s = 2 \cdot 2''\phi$ A.B. $A_T (2''\phi) = 2.50^{\square''}$
$d = 51''$ $A_s = 2 \times 2.50 = 5.00 \text{ IN}^2$
$d' = 21''$ $f'_c = 3000$ PSI

$e = \frac{9859.4}{86.1} + 21 = 132.4''$ $e/d = 132.4/51 = 2.60$

TRY $j = 0.91$ $c = \frac{1}{1 - \frac{jd}{e}} = 1.538$

$m = q = \frac{nA_s c}{bd} = \frac{(9)(5)(1.538)}{(29)(51)} = 0.047$

$k = \sqrt{m^2 + 2q} - m = 0.263$ $j = 1 - \frac{k}{3} = 0.912 \approx 0.91$ ok

$f_s = \frac{N}{jA_s c} \frac{e}{d} = \frac{(86.1)(2.60)}{(0.912)(5)(1.538)} = \underline{31.9^{ksi}} > 22^{ksi}$ NG.

$f_c = \frac{f_s}{n} \frac{k}{(1-k)} = \frac{(31.9)(0.263)}{(9)(1-0.263)} = \underline{1.265^{ksi}} > 1.125^{ksi}$ NG.

ANCHOR BOLT STRESSES EXCEED ALLOWABLE
CONCRETE BEARING STRESS EXCEEDS ALLOWABLE

CHK BASE PL W36x130

$P = 26.5^k$
$M = 3961.3^{k''}$

$b = 18''$
$d = 45''$
$d' = 19.5''$

$A_s = 2 \cdot 1\tfrac{3}{4}''\phi \; A.B \quad A_T (1\tfrac{3}{4}''\phi) = 1.90^{\square''}$
$A_s = (2)(1.90) = 3.80^{\square''}$
$f'_c = 3000$ PSI

$e = \frac{3961.3}{26.5} + 10.5 = 160.98 \quad e/d = 3.76$

TRY $j = 0.91 \quad i = \frac{1}{(1 - \frac{0.91}{3.76})} = 1.319$

$m = q = \frac{(9)(3.76)(1.319)}{(18)(45)} = 0.055$

$k = 0.281 \quad j = 1 - \frac{k}{3} = 0.906 \approx 0.91$ OK

$f_s = \frac{(26.5)(3.76)}{(0.906)(3.80)(1.319)} = 21.04^{ksi} < 22^{ksi}$ OK

$f_c = \frac{(21.04)(0.281)}{(9)(1 - 0.281)} = 0.952^{ksi} < 1.125^{ksi}$ OK

Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

CALC. NO. 6-1302-151-5320-006

SHEET NO. 24 OF 57

DATE 10/14/83

COMP. BY/DATE PH 11/18/83

CHK'D. BY/DATE DBT 11-22-83

REVIEW THE INTERACTION OF ADJACENT FRAMES BY USING THREE DIMENSIONAL MODEL

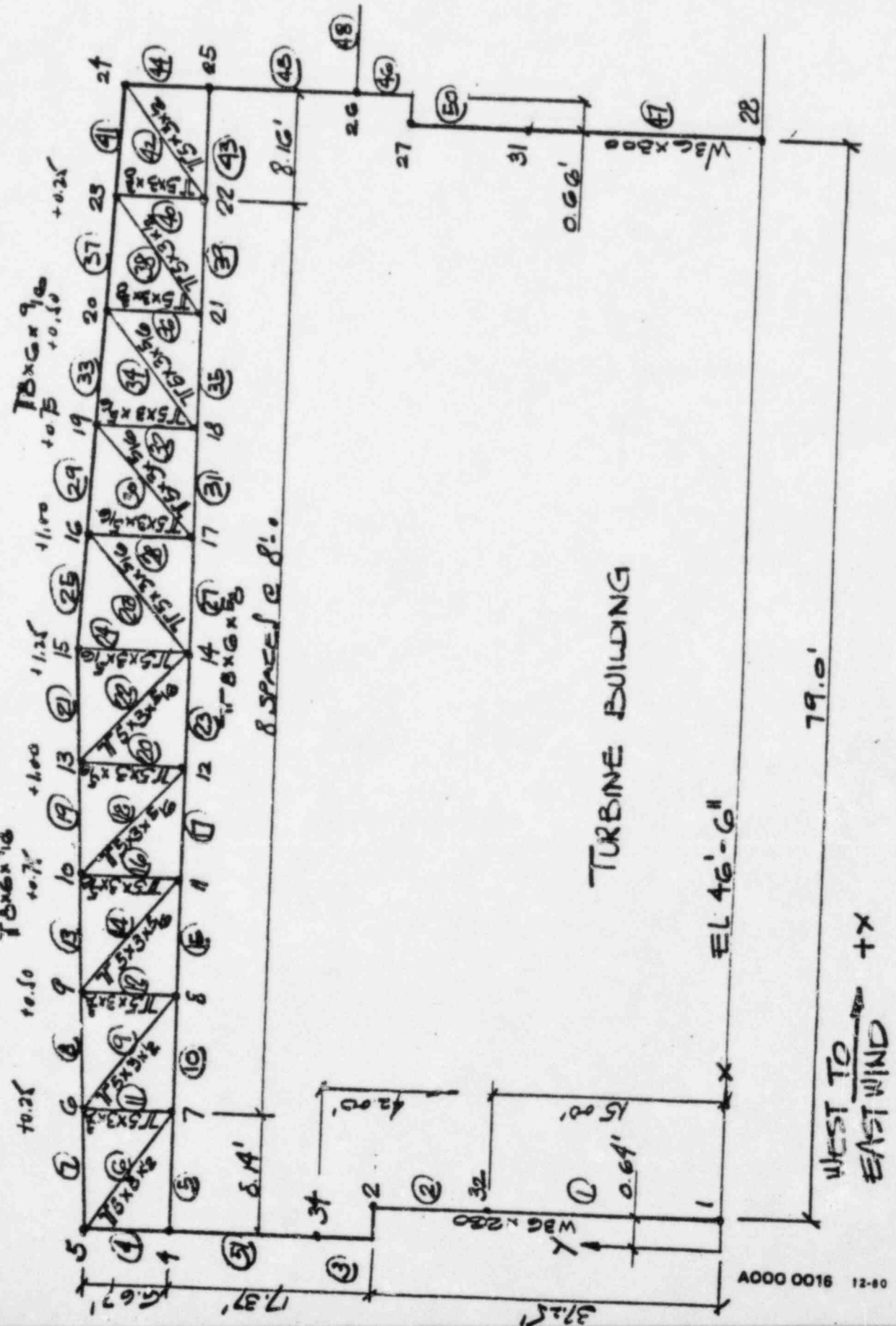
ROOF TOP CHORD TRUSS AND VERTICAL BRACING BETWEEN ROOF TRUSSES WILL ALLOW LOAD SHARING AND REDUCE STRESS ON COLUMN LINE B

PU Nuclear

SUBJECT SEP TOPIC III:2 LAS 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. G-1302-151-5320-006
SHEET NO. 25 OF 57
DATE 10/2/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE D.B.T. 11-22-83

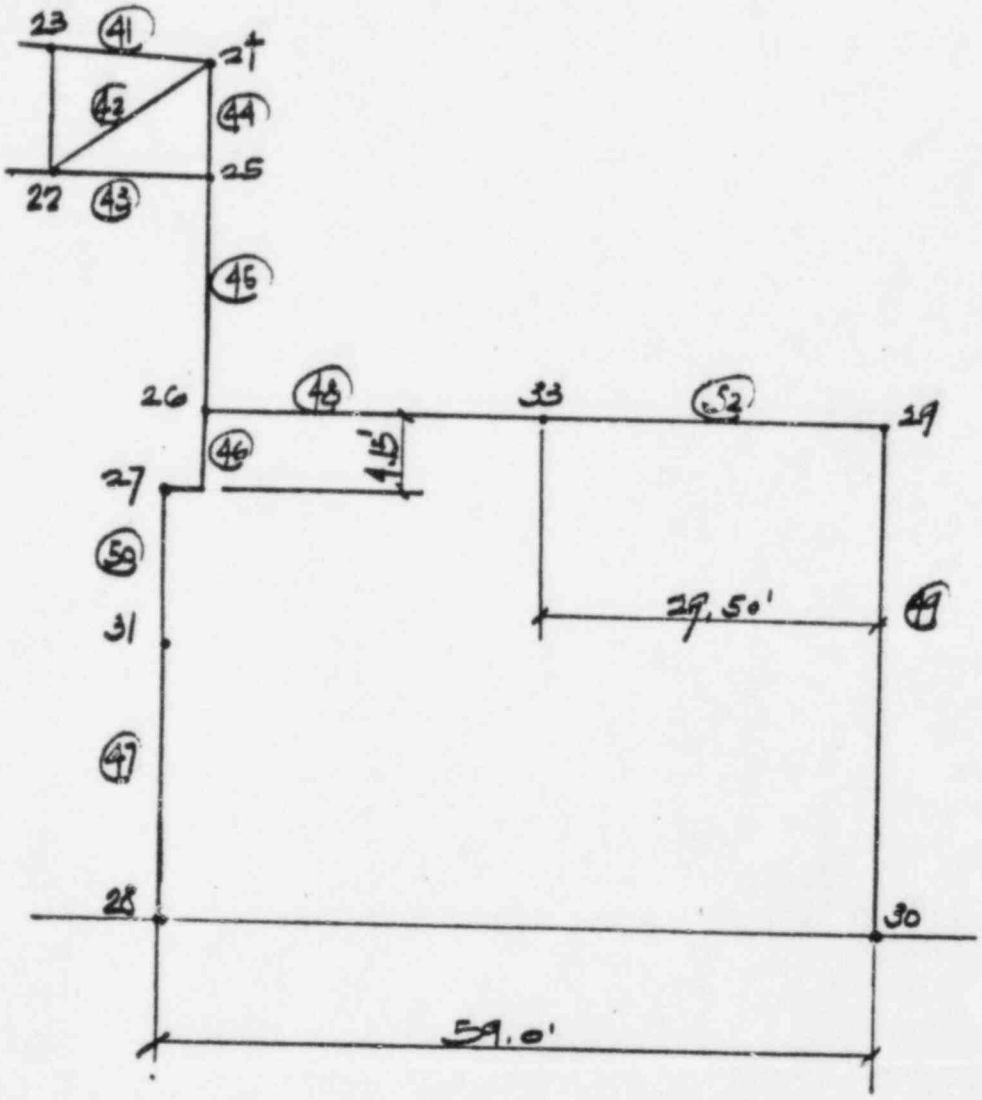


GPU Nuclear

CALC. NO. C-1302-651-5320-006
SHEET NO. 26 OF 57
DATE 10/3/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

CT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG



Nuclear

SUBJECT SEP Topic III-2 LAI 82251.09

WINE LOAD COMBINATIONS TURBINE BLDG

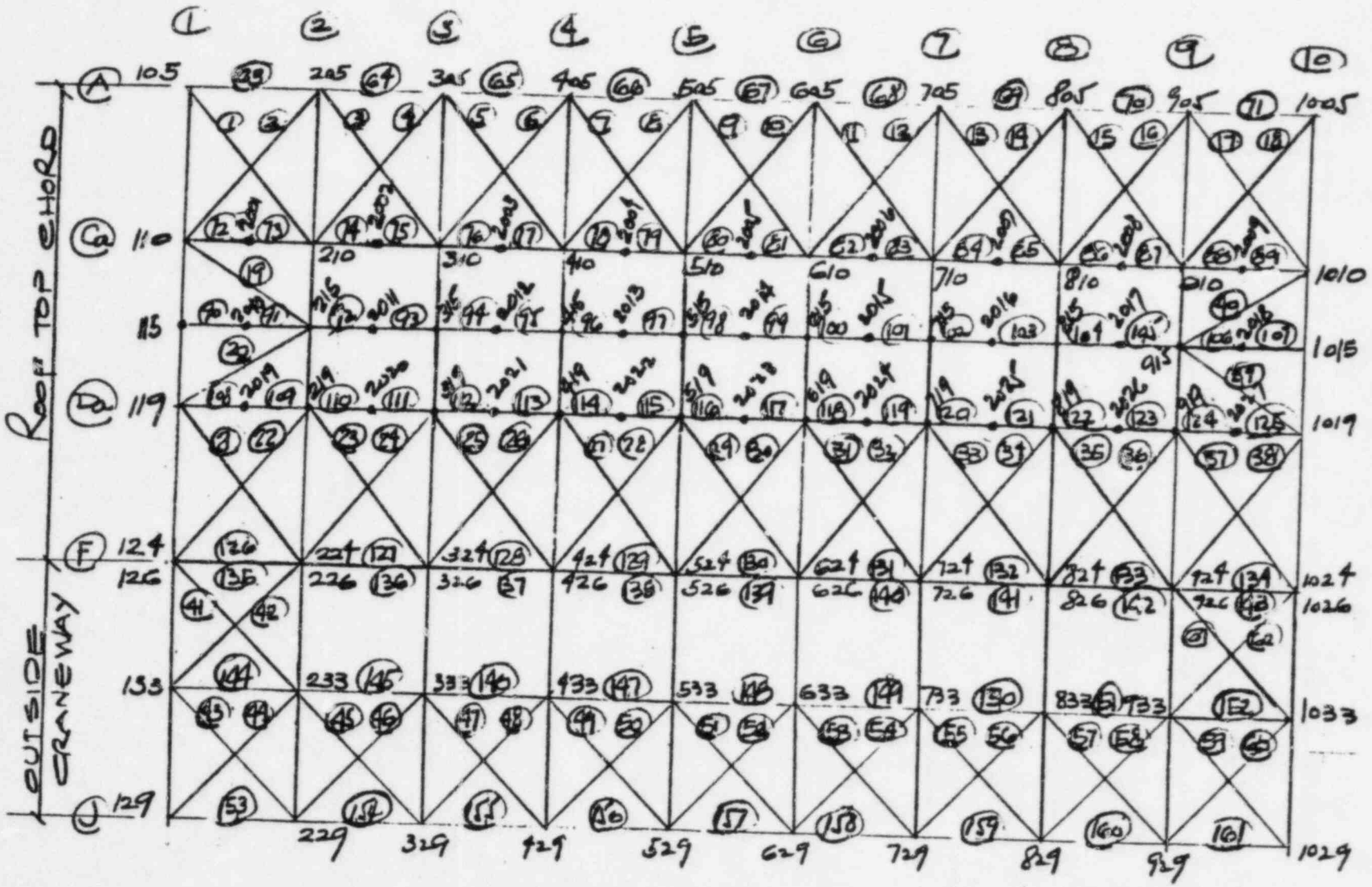
CALC. NO. C-1300-151-5320-000

SHEET NO. 27 OF 57

DATE 10/3/83

COMP. BY/DATE PH 11/18/83

CHK'D. BY/DATE DBT 11/22/83



PREFIX ALL MEMBER NUMBERS 2000+

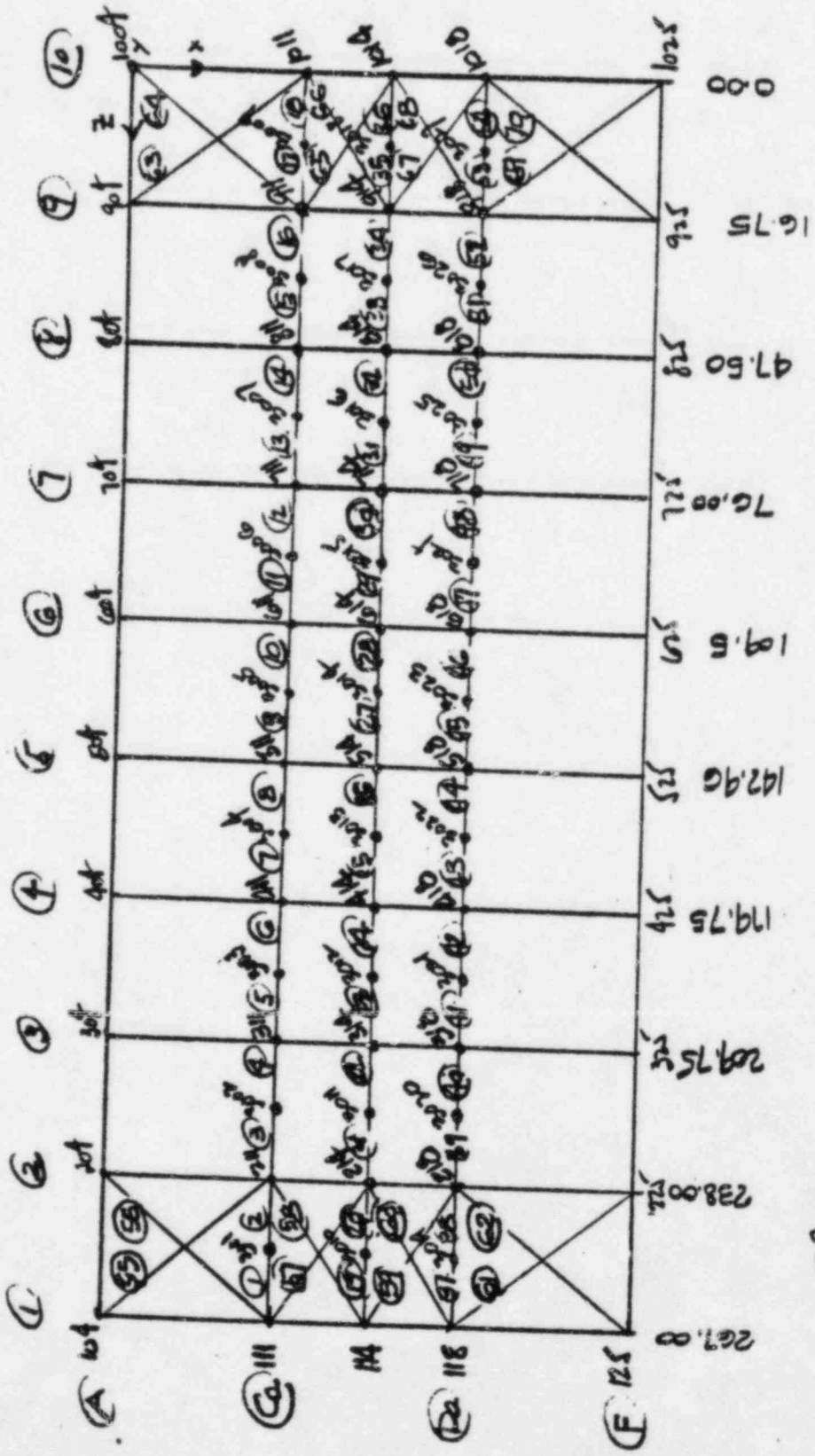
ROOF TOP CHORD HORIZONTAL TRUSS
AND OUTSIDE CRANEWAY HORIZONTAL TRUSS

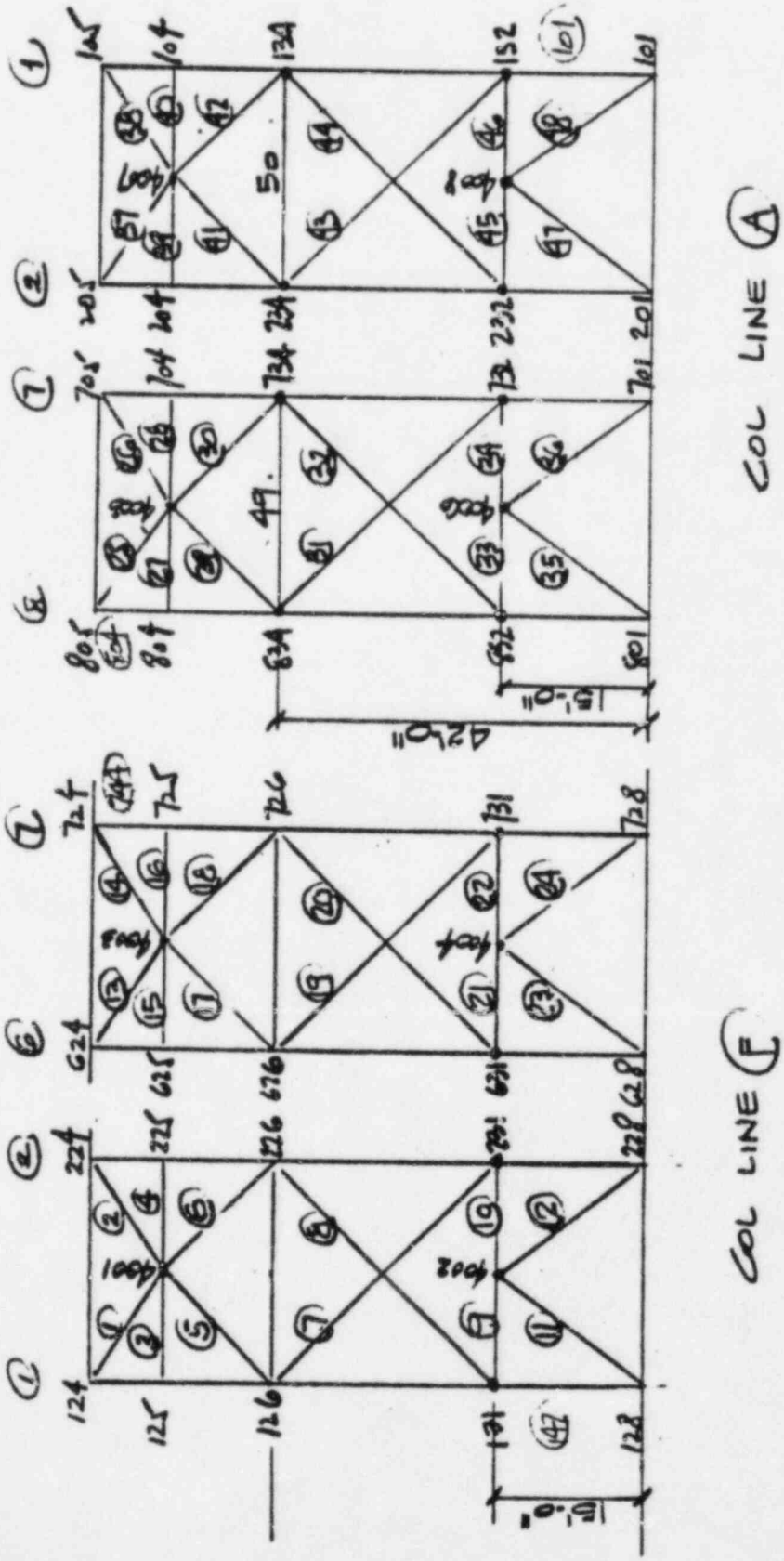
GPU Nuclear

SUBJECT: SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-1302-151-E320-006
SHEET NO. 28 OF 57
DATE 10/3/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83





VERTICAL FRAMES @ COL LINES A & F

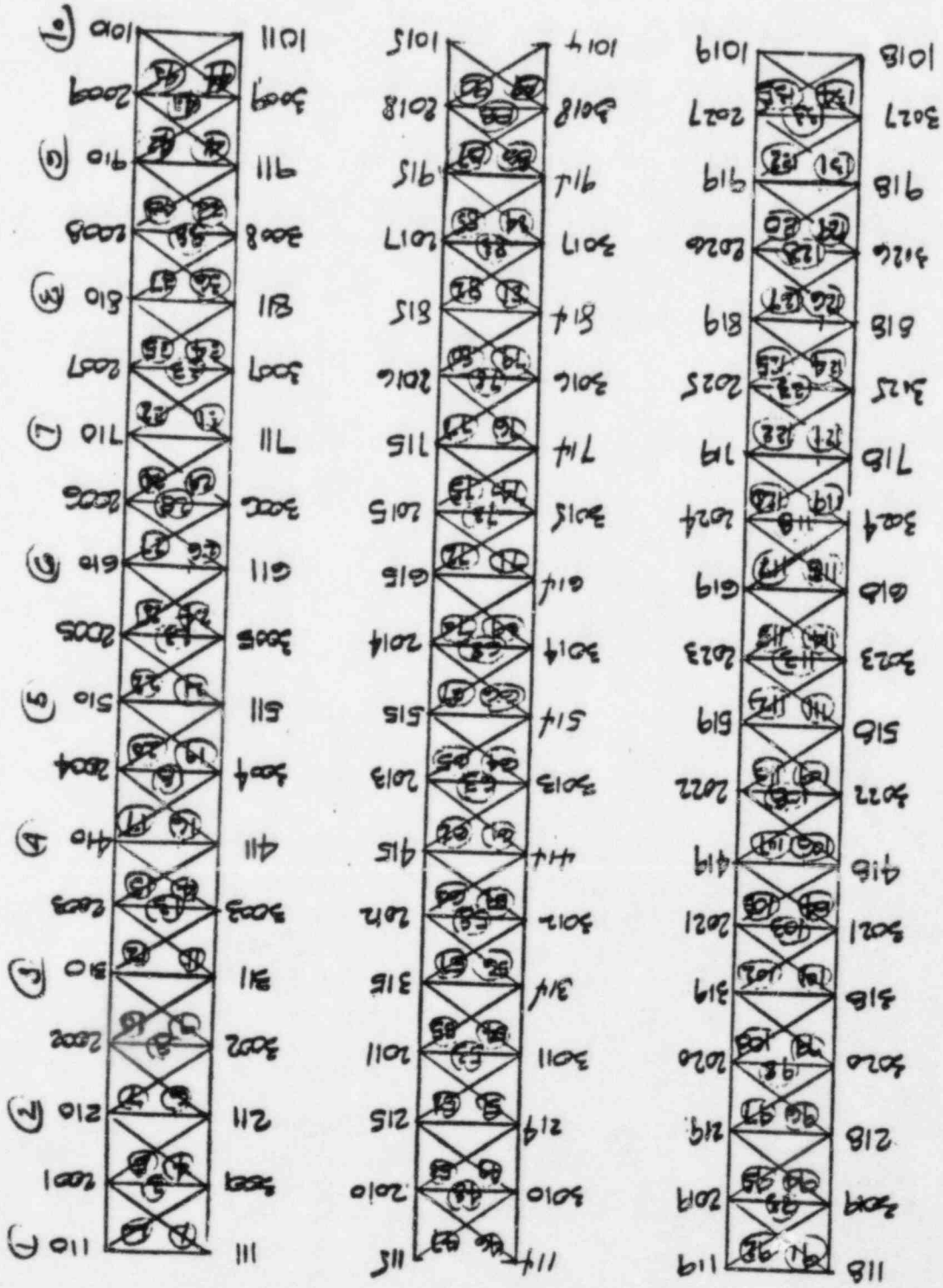
PREFIX ALL MEMBER NUMBERS 5000+

GPU Nuclear

CALC. NO. C-1302-151-5320-006
SHEET NO. 30 OF 57
DATE 10/3/83
COMP. BY/DATE PH 11/15/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT: DEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATION: TURBINE BLDG



PPL Nuclear

PROJECT SEP TOPIC III.2 LAT 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

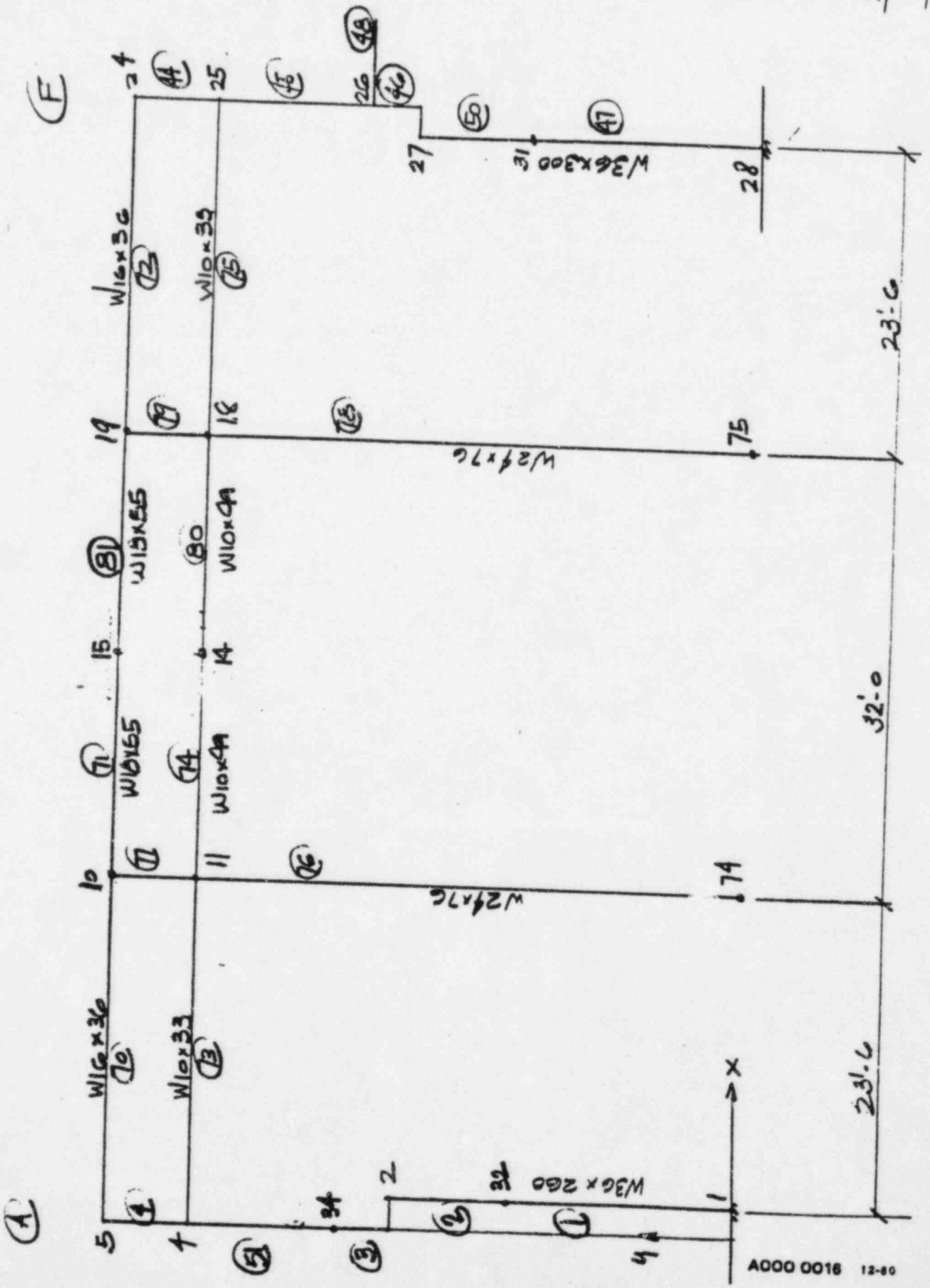
CALC. NO. C-B02-151-S320-006

SHEET NO. 31 OF 57

DATE 10/3/83

COMP. BY/DATE RT 11/10/83

CHK'D. BY/DATE DBT 11/22/83



A000 0016 12-80

WIND LOAD COMBINATIONS TURBINE BLDG

BASED ON 3-D FRAME ANALYSIS
W36 x 260 COL. DL + SNOW + WL COMBINATIONS
CHECK ANCHOR BOLTS - FIND CRITICAL COLUMN

MEMBER	101	201	301	401	501	601	701	801	901	1001
LOADING	134	135	135	135	135	135	135	135	135	
P	34.9	75.3	70.9	77.8	80.6	78.2	66.5	83.8	61.6	45.3
M	447.3	573.0	611.6	657.9	678.2	652.1	614.7	565.8	476.9	375.4

LOADING | 3 4 DL + SNOW + WL (E/W)
| 3 5 DL + SNOW + WL (W/E)

COLUMN LINE 5

$P = 80.6^k \quad M = 678.2^{k'}$

$e = \frac{678.2 \times 12}{80.6} + 21 = 122.0''$

$e/d = 122.0/47 = 2.60$

Try $j = 0.01$

$L = \frac{1}{(1 - j\frac{d}{e})} = \frac{1}{(1 - \frac{0.01}{2.60})} = 1.538$

$m = g = \frac{n A_{si}}{bd} = \frac{(9)(5.00)(1.538)}{(26)(47)} = 0.057$

$k = \sqrt{m^2 + 2g} - m = \sqrt{(0.071)^2 + (2)(0.071)} - 0.071 = 0.285$

$j = 1 - \frac{k}{3} = 1 - \frac{0.285}{3} = 0.905 \quad \approx 0.01$ OK

$f_s = \frac{N}{j A_{si}} \frac{e}{d} = \frac{(20.6)(2.60)}{(.905)(5.00)(1.538)} = \underline{30.11}^{ksi} > 22^{ksi}$ NG

$f_c = \frac{f_s}{n} \frac{k}{(1-k)} = \frac{(30.11)(0.285)}{(9)(1-0.285)} = \underline{1.334} > 1.125^{ksi}$ NG

CHECK COL LINE 4

$P = 77.8^k \quad M = 657.9^{k'}$

$e = \frac{657.9 \times 12}{77.8} + 21 = 122.5'' \quad e/d = 122.5/47 = 2.61$

TRY $j = 0.91 \quad L = 1.535 \quad m = q = 0.0565 \quad k = 0.284 \quad j = 0.905$

$f_s = \frac{(77.8)(2.61)}{(0.905)(5.00)(1.535)} = 29.23^{ksi} > 22^{ksi}$

$f_c = \frac{(29.23)(0.284)}{9(1-0.284)} = 1.288^{ksi} > 1.125^{ksi}$

CHECK COL LINE 6

$P = 78.2^k \quad M = 652.1^{k'}$ SAY SAME AS 4

CHECK COL LINE 7

$P = 66.5^k \quad M = 614.7^{k'}$

$e = 131.9 \quad e/d = 2.81$

TRY $j = 0.90 \quad L = 1.471 \quad m = q = 0.054 \quad k = 0.279 \quad j = 0.907$

$f_s = \frac{(66.5)(2.81)}{(0.907)(5.00)(1.471)} = 27.98^{ksi} > 22^{ksi}$

$f_c = \frac{(27.98)(0.279)}{(9)(1-0.279)} = 1.209^{ksi} > 1.125^{ksi}$

CHECK COL LINE 3

$P = 70.9^k \quad M = 611.6^{k'}$ SAY SAME AS 7

CHECK COL LINE 2

$P = 75.3^k \quad M = 573.0^{k'}$

$e = 112.3'' \quad e/d = 2.389$

TRY $j = 0.90 \quad L = 1.604 \quad m = q = 0.059 \quad k = 0.290 \quad j = 0.903$

$f_s = \frac{(75.3)(2.389)}{(0.903)(5.00)(1.604)} = 24.83^{ksi} > 22^{ksi}$ OK

$f_c = \frac{(24.83)(0.290)}{(9)(1-0.290)} = 1.127^{ksi} < 1.125^{ksi}$ OK

CHECK COL LINE 9

$P = 61.6^k$ $M = 476.9^{k'}$

$e = 113.9$ $e/d = 2.423$

TRY $j = 0.91$ $i = 1.601$ $m = g = 0.0590$ $k = 0.289$ $j = 0.904$

$$f_s = \frac{(61.6)(2.423)}{(0.904)(5.00)(1.601)} = 20.62^{ksi} < 22^{ksi}$$

$$f_c = \frac{(20.62)(0.289)}{(9)(1-0.289)} = 0.932^{ksi} < 1.125^{ksi} \text{ OK}$$

GPU Nuclear

CALC. NO. C-1302-151-5320-006
SHEET NO. 35 OF 57
DATE 10/14/83
COMP. BY/DATE PH 11/15/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS
TURBINE BLDG

BASED ON 3D FRAME ANALYSIS
W36X300 COL DL + SNOW + WL COMBINATIONS
CHECK ANCHOR BOLTS - FIND CRITICAL COLUMN

MEMBER	147	247	347	447	547	647	747	847	947	1047
LOADING	135	135	135	135	135	135	135	135	135	134
P	58.0	82.7	87.0	98.5	99.7	106.7	90.0	87.2	75.0	49.8
M	560.2	647.0	678.8	720.2	736.4	715.0	666.3	610.4	537.8	484.9

↑ CRITICAL CONDITION

COLUMN LINE 5

$P = 99.7 \quad M = 736.4 \quad e = 109.6 \quad e/d = 2.150$

TRY $j = 0.91 \quad L = 1.734 \quad m = g = 0.0528 \quad k = 0.329 \quad j = 0.890$

$$f_s = \frac{(99.7)(2.150)}{(0.890)(5.00)(1.734)} = 27.78^{ksi} > 22^{ksi}$$

$$f_c = \frac{(27.78)(0.329)}{(9)(1-0.329)} = 1.513^{ksi} > 1.125^{ksi}$$

COLUMN LINE 4

$P = 98.5^k \quad M = 720.2^{k'}$ SAY SAME AS COL LINE 5

COLUMN LINE 6

$P = 106.7^k \quad M = 715.0^{k'}$ SAY SAME AS COL LINE 5

COLUMN LINE 3

$P = 25.7^k \quad M = 282.2^{k'} \quad e = 152.8 \quad e/d = 2.995$

TRY $j = 0.91 \quad L = 1.436 \quad m = g = 0.0437 \quad k = 0.255 \quad j = 0.915$

$$f_s = \frac{(25.7)(2.995)}{(0.915)(5.00)(1.436)} = 11.72^{ksi} < 22^{ksi} \text{ OK}$$

$$f_c = \frac{(11.72)(0.255)}{(9)(1-0.255)} = 0.446^{ksi} < 1.125^{ksi} \text{ OK}$$

GPU Nuclear

CALC. NO. C-1302-151-5320-006
SHEET NO. 36 OF 57
DATE 10-2-83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG.

BASED ON 3-D FRAME ANALYSIS
W33x130 COL DL + SNOW + WL COMBINATIONS
CHECK ANCHOR BOLTS - FIND CRITICAL COL

MEMBER LOADING	149 134	249 134	349 134	449 134	549 134	649 134	749 134	849 134	949 134	1049 134
P	20.1	25.3	25.7	27.8	29.0	28.1	26.6	25.2	22.6	17.2
M	242.3	264.9	282.2	297.6	304.7	297.1	278.7	256.7	226.8	217.1

$e = \frac{304.7 \times 12}{29.0} + 19.5 = 145.6''$

$e/d = 145.6/45 = 3.24$

TRY $j = 0.91$ $\quad i = \frac{1}{\left(1 - \frac{0.91}{3.24}\right)} = 1.391$

$m = \frac{f}{f_b} = \frac{(9)(3.76)(1.391)}{(18)(45)} = 0.0581$

$k = \sqrt{(0.0581)^2 + (2)(0.0581)} - 0.0581 = 0.288$

$j = 1 - \frac{0.288}{3} = 0.904 \sim 0.91$ ok

$f_s = \frac{(29.0)(3.24)}{(0.904)(3.76)(1.391)} = 19.87^{ksi} < 22^{ksi}$ OK

$f_c = \frac{(19.87)(0.288)}{(9)(1 - 0.288)} = 0.893^{ksi} < 1.125^{ksi}$ OK.

A000 0016 12-80

GPU Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.09

CALC. NO. 6-1302-A1-5370-006
SHEET NO. 37 OF 57
DATE 10/14/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS

TURBINE BLDG

SUMMARY MAXIMUM ANCHOR BOLT AND CONCRETE BEARING OVERSTRESS BASED ON DL + SNOW + WL AND CURRENT ALLOWABLE STRESS CRITERIA

	1	2	3	4	5	6	7	8	9	10	
A	OK / OK	24.83 / OK	27.93 / 1.269	29.23 / 1.281	30.11 / 1.324	29.23 / 1.285	27.93 / 1.269	OK / OK	OK / OK	OK / OK	BOLT / CONC.
E	OK / OK	OK / OK	OK / OK	27.78 / 1.513	27.78 / 1.513	27.78 / 1.513	OK / OK	OK / OK	OK / OK	OK / OK	BOLT / CONC.
I	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	OK / OK	BOLT / CONC.

WITH THE EXCEPTION OF COLUMN A-5, ALL ANCHOR BOLT AND CONCRETE BEARING STRESSES ARE WITHIN THE ALLOWABLES AS PER THE ORIGINAL DESIGN CRITERIA.

BOLT = 22 x 4/3 = 29.33 KSI
CONC = 1.125 x 4/3 = 1.50 KSI

STRESSES AS NOTED ABOVE EXCEED THE CURRENT ALLOWABLE STRESS CRITERIA

BOLT = 22 KSI
CONC = 1.125 KSI

GPU Nuclear

SUBJECT SEP TOPIC III-2 LAI 82251.-9

CALC. NO. C-1302-151-5320-006
SHEET NO. 38 OF 57
DATE 10/12/83
COMP. BY/DATE FT 11/18/83
CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS TURBINE BLDG

BASED ON 3D FRAME ANALYSIS
W36x260 COL- DL+WL COMBINATIONS
CHECK ANCHOR BOLTS · FIND CRITICAL COLUMN
LOADING 14 = DL + WL (W/E)

MEMBER LOADING	101 14	201 14	301 14	401 14	501 14	601 14	701 14	801 14	901 14	1001 14
P	36.3	37.4	36.1	39.0	40.0	39.7	49.0	31.6	34.7	27.1
M	454.8	603.4 ✓	642.4 ✓	694.0 ✓	717.1 ✓	692.9 ✓	647.3 ✓	596.9 ✓	500.6 ✓	361.3

DESIGN CASE

COLUMN LINE (3)

$P = 40.0^k$

$M = 717.1 \times 12 = 8605^{k''}$

$e = \frac{M}{N} = \frac{8605}{40} + 21 = 236.1''$

$e/d = 236.1/47 = 5.76$

TRY $j = 0.91$

$L = \frac{1}{(1 - \frac{j d}{e})} = \frac{1}{(1 - \frac{0.91}{5.76})} = 1.188$

$m = \rho = \frac{n A_{si}}{bd} = \frac{(9)(5.00)(1.188)}{(26)(47)} = 0.0437$

$k = \sqrt{m^2 + 2\rho} - m = [0.0437^2 + (2)(0.0437)]^{\frac{1}{2}} - 0.0437 = 0.255$

$j = 1 - \frac{k}{3} = 1 - \frac{0.255}{3} = 0.915 \sim 0.91$ OK

$f_s = \frac{N}{j A_{si}} \frac{e}{d} = \frac{(40.0)(5.76)}{(0.915)(5.00)(1.188)} = \underline{42.39^{ksi}} > 22^{ksi}$ NG

$f_c = \frac{f_s}{n} \frac{k}{(1-k)} = \frac{(42.39)(0.255)}{9\ (1-0.255)} = \underline{1.612^{ksi}} > 1.125^{ksi}$ NG

WIND LOAD COMBINATION / TURBINE BLDG

COL LINE 4

$P = 39.0^k$ $M = 694^{k'}$ $e = \frac{694 \times 12}{39.0} + 21 = 234.5'$ $e/d = \frac{234.5}{47} = 4.990$

TRY $j = 0.91$ $i = \frac{1}{(1 - \frac{0.91}{4.990})} = 1.223$

$m = q = \frac{(9)(5.00)(1.223)}{(26)(47)} = 0.0456$

$k = 0.258$ $j = 0.914$

$f_s = \frac{(39.0)(4.990)}{(0.914)(5.00)(1.223)} = 34.84^{ksi} > 22^{ksi}$

$f_c = \frac{(34.84)(0.258)}{(9)(1-0.258)} = 1.346^{ksi} > 1.125^{ksi}$

COL LINE 6

$P = 38.7^k$ $M = 692.9^{k'}$ SAY SAME AS COL LINE 4

COL LINE 3

$P = 36.1^k$ $M = 692.4^{k'}$ $e = \frac{692.4 \times 12}{36.1} + 21 = 213.5$ $e/d = 4.543$

TRY $j = 0.910$ $i = 1.250$ $m = q = 0.046$ $k = 0.261$

$j = 0.913$ OK

$f_s = \frac{(36.1)(4.543)}{(0.913)(5.00)(1.250)} = 28.74^{ksi} > 22^{ksi}$

$f_c = \frac{(28.74)(0.261)}{(9)(1-0.261)} = 1.128^{ksi} \sim 1.125^{ksi}$ OK

COL LINE 7

$P = 49.0^k$ $M = 647.3^{k'}$ $e = 179.5'$ $e/d = 3.820$

TRY $j = 0.910$ $i = 1.313$ $m = q = 0.0435$ $k = 0.266$

$j = 0.912$ OK

$f_s = \frac{(49.0)(3.820)}{(0.912)(5.00)(1.313)} = \underline{31.29^{ksi}} > 22^{ksi}$ NG

$f_c = \frac{(31.29)(0.266)}{(9)(1-0.266)} = \underline{1.260} > 1.125^{ksi}$ NG.

SUBJECT: SEP TOPIC III:2 LAS 82251.07

WIND LOAD COMBINATION TURBINE BLDG

COL LINE 2

$P = 37.4^k$ $M = 613.4^{k'}$ $e = 217.8''$ $e/d = 4.634$

TRY $j = 0.01$ $i = 1.244$ $m = q = 0.0458$ $k = 6.260$

$j = 1 - \frac{0.260}{3} = 0.913$ OK

$$f_s = \frac{(37.4)(4.634)}{(0.913)(5.00)(1.244)} = 30.52^{ksi} > 22^{ksi} \text{ N.G.}$$

$$f_c = \frac{(30.52)(0.260)}{(9)(1-0.260)} = 1.191^{ksi} > 1.125^{ksi} \text{ N.G.}$$

COL LINE 8

$P = 31.6^k$ $M = 596.9^{k'}$ $e = 247.7''$ $e/d = 5.270$

TRY $j = 0.90$ $i = 1.206$ $m = q = 0.0444$ $k = 0.257$

$j = 0.914$ OK

$$f_s = \frac{(31.6)(5.270)}{(0.914)(5.00)(1.206)} = 30.22^{ksi} > 22^{ksi} \text{ N.G.}$$

$$f_c = \frac{(30.22)(0.257)}{(9)(1-0.257)} = 1.161^{ksi} > 1.125^{ksi} \text{ N.G.}$$

COL LINE 9

$P = 34.7^k$ $M = 500.6^{k'}$ $e = 104.1''$ $e/d = 4.130$

TRY $j = 0.91$ $i = 1.283$ $m = q = 0.0472$ $k = 0.264$

$j = 0.912$ OK

$$f_s = \frac{(34.7)(4.130)}{(0.912)(5.00)(1.283)} = 24.50^{ksi} < 22^{ksi} \text{ OK}$$

$$f_c = \frac{(24.50)(0.264)}{(9)(1-0.264)} = 0.976^{ksi} < 1.125^{ksi} \text{ OK}$$

COL LINE 1

$P = 36.3^k$ $M = 454.8^{k'}$ $e = 171.3$ $e/d = 3.646$

TRY $j = 0.91$ $i = 1.332$ $m = q = 0.0491$ $k = 0.268$ $j = 0.911$

$$f_s = \frac{(36.3)(3.646)}{(0.911)(5.00)(1.332)} = 21.81^{ksi} < 22^{ksi} \text{ OK}$$

$$f_c = \frac{(21.81)(0.268)}{(9)(1-0.268)} = 0.887^{ksi} < 1.125^{ksi} \text{ OK}$$

CHECK col A-5 FOR COMBINATION 15 TO DETERMINE ANCHOR BOLT STATUS FOR WIND LOAD IN OPPOSITE DIRECTION

$P = 47.1^{k}$ $M = 598.4^{k'}$ $e = 173.5$ $e/d = 3.691$

TRY $j = 0.910$ $c = 1.327$ $m = q = 0.0489$ $k = 0.268$ $j = 0.911$

$$f_s = \frac{(47.1)(3.691)}{(0.911)(5.00)(1.327)} = 28.76^{ksi} > 22^{ksi}$$

$$f_c = \frac{(28.76)(0.268)}{(9)(1-0.268)} = 1.170^{ksi} < 1.125^{ksi} \text{ OK}$$

GPU Nuclear

SUBJECT: SEP Topic III-2 LAI 82251.09

WIND LOAD COMBINATION & TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 42 OF 57
DATE 10/12/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

BASED ON 3-D FRAME ANALYSIS
W36x300 COL DL + WL COMBINATIONS
CHECK ANCHOR BOLTS - FIND CRITICAL COL
LOADING IS = DL + WL (E/W)

MEMBER LOADING	147 lb	247 lb	347 lb	447 lb	547 lb	647 lb	747 lb	847 lb	947 lb	1047 135
P	54.6	58.3	59.2	66.6	66.1	74.6	59.6	59.9	54.3	49.8
M	574.4	668.0	714.3	764.8	785.7	763.9	710.7	656.4	562.6	484.9
		✓	✓	✓	✓	✓	✓	✓		

COLUMN LINE 5

$P = 66.1^k \quad M = 785.7^{k'}$

$e = \frac{785.7 \times 12}{66.1} + 21 = 163.6'$

$e/d = 163.6/51 = 3.209$

Try $j = 0.91 \quad i = \frac{1}{(1 - \frac{0.91}{3.209})} = 1.396$

$m = z \cdot \frac{(9)(5.00)(1.396)}{(29)(51)} = 0.0425$

$k = \sqrt{(0.0425)^2 + (2)(0.0425)} - 0.0425 = 0.252$

$j = 1 - \frac{.252}{3} = 0.916 \sim 0.91$ OK

$f_s = \frac{(66.1)(3.209)}{(0.916)(5.00)(1.396)} = 33.18^{ksi} > 22^{ksi}$

$f_c = \frac{(33.18)(0.252)}{(29)(1 - 0.252)} = 1.241^{ksi} > 1.125^{ksi}$

GPU Nuclear

CALC. NO. C-1302-151-5320-006
SHEET NO. 43 OF 57
DATE 10/12/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP TOPIC III-2 LAS 82251.09
WIND LOAD COMBINATION
TURBINE BLDG

CHECK COL LINE 4

$P = 66.6^k \quad M = 764.8^{k'}$

$e = \frac{764.8 \times 12}{66.6} + 21 = 158.8''$

$e/d = 158.8/51 = 3.114$

TRY $j = 0.91 \quad i = \frac{1}{(1 - \frac{0.91}{3.114})} = 1.413$

$m = \gamma = \frac{(9)(5.00)(1.413)}{(29)(51)} = 0.043$

$k = \sqrt{(0.043)^2 + (2)(0.043)} - 0.043 = 0.253$

$j = 1 - \frac{0.253}{3} = 0.916 \sim 0.91$ OK

$f_s = \frac{(66.6)(3.114)}{(0.916)(5.00)(1.413)} = 32.05^{ksi} > 22^{ksi}$

$f_c = \frac{(32.05)(0.253)}{(9)(1-0.253)} = 1.206^{ksi} < 1.125^{ksi}$ OK

CHECK COL LINE 6

$P = 74.6^k \quad M = 763.9^{k'} \quad e = \frac{763.9 \times 12}{74.6} + 21 = 143.9'$

$e/d = 143.9/51 = 2.821$

TRY $j = 0.91 \quad i = \frac{1}{(1 - \frac{0.91}{2.821})} = 1.476$

$m = \gamma = \frac{(9)(5.00)(1.476)}{(29)(51)} = 0.0449$

$k = 0.258 \quad j = 0.914 \sim 0.91$ ok

$f_s = \frac{(74.6)(2.821)}{(0.914)(5.00)(1.476)} = 31.20^{ksi} > 22^{ksi}$ N.G.

$f_c = \frac{(31.20)(0.258)}{(9)(1-0.258)} = 1.205^{ksi} > 1.125^{ksi}$ N.G.

SUBJECT SEP TOPIC III-2 LAT. 82251.09

WIND LOAD COMBINATION TURBINE BLDG

CHECK COL LINE 3

$P = 59.2^k$ $M = 714.3^{k'}$ $e = \frac{714.3 \times 12}{59.2} + 21 = 165.8$

$e/d = 165.8/51 = 3.25'$

$\omega_j = 0.90$ $i = \frac{1}{(1 - \frac{0.90}{3.25})} = 1.383$

$m = q = \frac{(9)(0.20)(1.383)}{(29)(51)} = 0.053$

$k = 0.277$ $j = 0.908$ ok

$f_s = \frac{(59.2)(3.25)}{(0.908)(6.28)(7.898)} = 24.40^{ksi} > 22^{ksi}$ N.G.

$f_c = \frac{(24.40)(0.277)}{(9)(1 - 0.277)} = 1.039^{ksi} < 1.125^{ksi}$ OK

CHECK COL LINE 7

$P = 59.6^k$ $M = 710.7^{k'}$ ~SAME AS COL LINE 3

CHECK COL LINE 2

$P = 58.3^k$ $M = 668^{k'}$ $e = 668 \times 12/58.3 + 21 = 158.5$

$e/d = 158.5/51 = 3.08$

$\omega_j = 0.91$ $i = \frac{1}{(1 - \frac{0.91}{3.08})} = 1.414$

$m = q = \frac{(9)(5.00)(1.414)}{(29)(51)} = 0.043$

$k = .253$ $j = .916$ OK

$f_s = \frac{(58.3)(3.08)}{(0.916)(5.00)(1.414)} = 27.98^{ksi} > 22^{ksi}$ N.G.

$f_c = \frac{(27.98)(0.253)}{(9)(1 - 0.253)} = 1.053^{ksi} < 1.125^{ksi}$ OK

CHECK COL LINE 8

$P = 59.9^k$ $M = 664^{k'}$ ~SAME AS COL LINE 2

CHECK COLUMN LINE 1

$P = 54.6^k$ $M = 374.4^{k'}$ $e = 147.2$ $e/d = 2.887$

TRY $j = 0.91$ $L = 1.480$ $m = g = 0.0444$ $k = 0.257$ $j = 0.914$

$$f_s = \frac{(54.6)(2.887)}{(0.914)(5.00)(1.480)} = 23.62^{ksi} > 22^{ksi}$$

$$f_c = \frac{(23.62)(0.257)}{(9)(1-0.257)} = 0.910^{ksi} < 1.125^{ksi} \text{ OK}$$

CHECK COLUMN LINE 9

$P = 54.3^k$ $M = 562.6$ $e = 145.3$ $e/d = 2.850$

try $j = 0.91$ $L = 1.469$ $m = g = 0.0447$ $k = 1258$ $j = 0.914$

$$f_s = \frac{(54.3)(2.850)}{(0.914)(5.00)(1.469)} = 23.05^{ksi} > 22^{ksi}$$

$$f_c = \frac{(23.05)(0.258)}{(9)(1-0.258)} = 0.891^{ksi} < 1.125^{ksi}$$

CHECK COLUMN LINE 10

$P = 49.8^k$ $M = 484.9^{k'}$ $e = 137.8$ $e/d = 2.703$

try $j = 0.91$ $L = 1.5075$ $m = g = 0.0459$ $k = 0.260$ $j = 0.913$

$$f_s = \frac{(49.8)(2.703)}{(0.913)(5.00)(1.5075)} = 19.56^{ksi} < 22^{ksi} \text{ OK}$$

$$f_c = \frac{(19.56)(0.260)}{(9)(1-0.260)} = 0.763^{ksi} < 1.125^{ksi} \text{ OK}$$

BASED ON 3D FRAME ANALYSIS
W33x130 COL DL + WL COMBINATIONS
CHECK ANCHOR BOLTS - FIND CRITICAL COL
LOADING 14 : DL + WL (WE)

MEMBER	149	249	349	449	549	649	749	849	949	1049
LOADING	14	14	14	14	14	14	14	14	14	14
P	20.2	25.3	25.6	27.7	28.8	28.0	26.4	25.0	22.5	17.2
M	240.7	258.7	271.7	284.3	289.9	282.5	265.3	245.2	219.0	209.8

↑ CRITICAL CASE

LOAD CASES FOR DL+WL ARE NOT AS CRITICAL AS FOR DL+WL+SNOW ∴ ALL STRESSES ARE BELOW CURRENT ALLOWABLE LIMITS.

GPU Nuclear

SUBJECT: SEP TOPIC III:2 LAF 82251.09

WIND LOAD COMBINATION 3 TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 47 OF 57
DATE 10/12/83
COMP. BY/DATE PH 11/16/83
CHK'D. BY/DATE DBT 11/22/83

SUMMARY MAXIMUM ANCHOR BOLT AND CONCRETE BEARING OVERSTRESS BASED CURRENT CRITERIA

	1	2	3	4	5	6	7	8	9	10	
A	OK	30.52 KSI	28.76 KSI	34.84 KSI	42.29 KSI	34.84 KSI	31.29 KSI	30.27 KSI	24.50 KSI	OK	LDG 14 BOLT
	OK	1.191	OK	1.346 KSI	1.612 KSI	1.346 KSI	1.260 KSI	1.161 KSI	OK	OK	CONC
F	23.62 KSI	27.98 KSI	29.40 KSI	32.05 KSI	33.18 KSI	31.20 KSI	24.40 KSI	27.98 KSI	23.05 KSI	OK	LDG 15 BOLT
	OK	OK	OK	1.206 KSI	1.241 KSI	1.205 KSI	OK	OK	OK	OK	CONC
J	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	LDG 14 BOLT
	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	CONC

WITH THE EXCEPTION OF 9 COL'S AS NOTED, ALL ANCHOR BOLT AND CONCRETE STRESSES ARE WITHIN THE ALLOWABLES AS PER THE ORIGINAL DESIGN

BOLT = 22 x 4/3 = 29.33 KSI
CONC = 1.125 x 4/3 = 1.50 KSI

WITH ONE SET OF ANCHOR BOLTS STRESSED BEYOND YIELD. STRESSES AS NOTED ABOVE EXCEED THE CURRENT ALLOWABLE STRESS CRITERIA

BOLT = 22 KSI
CONC = 1.125 KSI

ANCHOR BOLT STRESSES FOR COL A-5 WIND LOAD IN THE OPPOSITE DIRECTION = 28.76 KSI WHICH IS WITHIN THE ORIGINAL DESIGN CRITERIA AND HIGHER THAN THE CURRENT CRITERIA. CONCRETE BEARING STRESSES FOR OPPOSITE WIND DIRECTION MEET CURRENT CRITERIA. OTHER COLUMNS ARE NOT AS HEAVILY LOADED AND ARE LESS CRITICAL

REVIEW 3D MODEL TRUSS MEMBER FORCES CONSIDERING LOADING CONDITIONS DL+WL AND DL+SNOW+WL

TRUSS MEMBER RESULTS - COLUMN LINE 5

MEMBER SIZE		CAPACITY REF ⑥	ACTUAL MAX LD	MEMBER No's	
DIAGONAL 7T5x3x1/2	T	161.7	84.8	6 9 38 42	OK
	C	97.0	11.4		
DIAGONAL 7T5x3x5/16	T	103.7	41.5	14 18 22 26 30 34	OK
	C	59.3	6.6		
VERTICAL 7T8x3x3/8	T	123.7	8.0	11 12 36 40	OK
	C	94.0	53.0		
VERTICAL 7T5x3x5/16	T	103.7	68	16 20 24 28 32	OK
	C	74.7	25.1		
TOP CHORD 7T8x6x9/16	T	320.6	26.4	7 8 13 19 21 25 29 33 37 41	OK
	C	290.2	135.7		
BOT CHORD 7T8x6x5/8	T	354.4	129.2	5 10 15 17 23 27 31 35 39 43	OK
	C	292.6	56.1		

ALL TRUSS MEMBER STRESSES ARE LESS THAN THE MAX ALLOWABLE LIMIT.

TURBINE BLDG

CHECK COL DESIGN FOR 3D VS 2D + WITH ADDL LOAD COMBINATIONS.

MEMBERS 501 502 503 504

M_{BASE} (MAX) = 717.1$^{k'}$ = 8605$^{k''}$ < 2D = 910$^{k''}$

P_{BASE} = 40.0^{k} < 2D = 77.2^{k}

PREVIOUSLY EXAMINED CASE WAS MORE CRITICAL THEREFORE COL IS OK

MEMBERS 544 545 546 547

M_{BASE} (MAX) = 785.7$^{k'}$ = 9428$^{k''}$ < 2D = 9919$^{k''}$

P_{BASE} = 66.1^{k} < 2D = 92.5^{k}

PREVIOUSLY EXAMINED CASE WAS MORE CRITICAL THEREFORE COLUMN IS OK

MEMBERS 549

M_{BASE} (MAX) = 304.7$^{k'}$ = 3656$^{k''}$ < 2D = 3961$^{k''}$

P_{BASE} = 29.0^{k} > 2D = 26.5^{k}

f_a = 29/38.3 = 0.76^{ksi} 0.76/18.07 = 0.042 < 0.15

f_b = 3656/400 = 9.00^{ksi} 9.00/19.75 = 0.456

0.042 + 0.455 = 0.497 < 1.00 ok

Nuclear

CALC. NO. C-1302-151-5320-006
SHEET NO. 49A OF 57
DATE 11-23-83
COMP. BY/DATE DBT 9-15-83
CHK'D. BY/DATE TH 11/23/83

SUBJECT SEP TOPIC III-2 LAI 82251.09

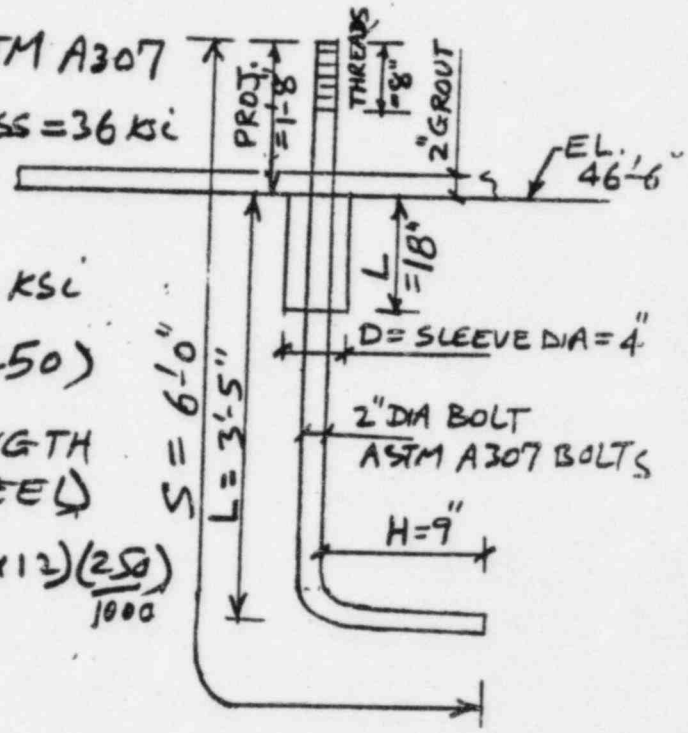
WIND LOAD COMBINATIONS

(TURBINE BLDG.)

TO DETERMINE PULL-OUT VALUE OF ANCHOR BOLTS.

FROM AISC SPEC 1.5.2.1 & ASTM A307

$F_t = 20$ KSI & F_u = YIELD STRESS = 36 KSI



∴ YIELD CAPACITY

$T = F_u \times A_T = 36 \times 2.50 = 90$ KSI

BOND STRENGTH = $\pi D L (250)$

250 = ULTIMATE BOND STRENGTH IN PSI (NON-OILY STEEL) (REF 14 & 15)

∴ BOND STRENGTH = $\pi (2)(3.42 \times 12)\left(\frac{250}{1000}\right)$

$= 64.5^K$

BEARING ON THE HOOK

$= \phi f_c' d H$

$= 0.7 (3)(2)(9)$

$= 37.8^K$

∴ ULTIMATE PULLOUT CAPACITY BASED ON EMBEDMENT

$= 64.5 + 37.8 = 102.3^K > 90^K$

∴ BOLTS ARE FULLY DEVELOPED FOR THE YIELD CAPACITY.

NOTE – [ULTIMATE PULLOUT CAPACITY OF ANCHOR BOLT IN CONCRETE IS MORE THAN THE YIELD CAPACITY OF STEEL.

A000 0016 12-80

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

SHEET NO. 50 OF 57
DATE 11/5/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

FROM COMPUTER OUTPUT "MAREKEZ"
- BASE MOMENT AT COLUMNS A-4, 5 & 6 IS FIXED AT ANCHOR BOLT YIELD MOMENT CAPACITY
- LOADING IS FOR DL + 80MPH WL IN +X DIRECTION
- CHECK STATUS OF OTHER ANCHOR BOLTS

COL REACTION	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
P	36	39	36	39	40	39	53	29	35	27
M	5502 ✓	7374 ✓	7723 ✓				7773 ✓	7167 ✓	6012 ✓	4573

CHECK COL A-7

$e = \frac{7773}{53} + 21 = 167.7''$ $\quad e/d = 3.567$

w/ $j = 0.92$ $\quad i = 1.3475$ $\quad m = g = 0.04962$ $\quad k = 0.269$ $\quad j = 0.910$

$f_s = \frac{(53)(3.567)}{(0.910)(5.0)(1.3475)} = 30.83^{ksi}$

$f_c = \frac{(30.83)(0.269)}{(9)(1-0.269)} = 1.26^{ksi}$

COL A-3

$e = \frac{7723}{36} + 21 = 235.5$ $\quad e/d = 5.011$

w/ $j = 0.92$ $\quad i = 1.2249$ $\quad m = g = 0.0451$ $\quad k = 0.2586$ $\quad j = 0.914$

$f_s = \frac{(36)(5.011)}{(0.914)(5.0)(1.2249)} = 32.22^{ksi}$

$f_c = \frac{(32.22)(0.2586)}{(9)(1-0.2586)} = 1.25^{ksi}$

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATION / TURBINE BLDG

SHEET NO. 21 OF 27
DATE 11/8/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DJT 11/22/83

COL A-2

$e = \frac{7374}{39} + 21 = 210.07 \qquad e/d = 4.4697$

$w/j = 0.92 \quad L = 1.2599 \quad m = q = 0.0464 \quad k = 0.262 \quad j = 0.913$

$f_s = \frac{(39)(4.4697)}{(0.913)(5.0)(1.2599)} = 30.31^{KSI}$

$f_c = \frac{(30.31)(0.262)}{(9)(1-0.262)} = 1.196^{KSI}$

COL A-8

$e = \frac{7167}{29} + 21 = 268.1 \qquad e/d = 5.705$

$w/j = 0.92 \quad L = 1.1923 \quad m = q = 0.0439 \quad k = 0.256 \quad j = 0.915$

$f_s = \frac{(29)(5.705)}{(0.915)(5)(1.1923)} = 30.33^{KSI}$

$f_c = \frac{(30.33)(0.256)}{(9)(1-0.256)} = 1.160^{KSI}$

COL A-9

$e = \frac{6012}{35} + 21 = 192.77 \qquad e/d = 4.1015$

$w/j = 0.92 \quad L = 1.2892 \quad m = q = 0.0475 \quad k = 0.264 \quad j = 0.912$

$f_s = \frac{(35)(4.1015)}{(0.912)(5)(1.2892)} = 24.42^{KSI}$ OK

$f_c = \frac{(24.42)(0.264)}{(9)(1-0.264)} = 0.973^{KSI}$ OK

COL A-1

$e = \frac{5502}{36} + 21 = 173.8 \qquad e/d = 3.699$

$w/j = 0.91 \quad L = 1.3263 \quad m = q = 0.04884 \quad k = 0.267 \quad j = 0.911$

$f_s = \frac{(36)(3.699)}{(0.911)(5)(1.3263)} = 22.04^{KSI}$ OK

$f_c = \frac{(22.04)(0.267)}{(9)(1-0.267)} = 0.892^{KSI}$ OK

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

SHEET NO. 52 OF 57
DATE 11/8/83
COMP. BY/DATE PH 11/15/83
CHK'D. BY/DATE DBT 11/22/83

COL REACTION	F.1	F.2	F.3	F.4	F.5	F.6	F.7	F.8	F.9	F.10
P	39	64	54	61	60	57	68	55	52	39
M	6297	7048	7566	7974	8122	7859	7367	6839	5988	5486
		✓	✓	✓	✓	✓	✓	✓		

COL F.5

$e = \frac{8122}{60} + 21 = 156 \quad e/d = 3.066$

$w/d = 0.91 \quad i = 1.4220 \quad m = q = 0.04327 \quad k = 0.254 \quad j = 0.915$

$f_s = \frac{(60)(3.066)}{(0.915)(5)(1.4220)} = 28.27^{ksi}$ OK

$f_c = \frac{(28.27)(0.254)}{(9)(1-0.254)} = 1.070^{ksi}$ OK

COL F-4

$e = \frac{7974}{61} + 21 = 151.7 \quad e/d = 2.975$

$w/d = 0.91 \quad i = 1.4407 \quad m = q = 0.0438 \quad k = 0.255 \quad j = 0.915$

$f_s = \frac{(61)(2.975)}{(0.915)(5)(1.4407)} = 27.53^{ksi}$

$f_c = \frac{(27.53)(0.255)}{(9)(1-0.255)} = 1.047^{ksi}$ OK

COL F-6

$e = \frac{7859}{57} + 21 = 158.9 \quad e/d = 3.115$

$w/d = 0.91 \quad i = 1.4127 \quad m = q = 0.04298 \quad k = 0.250 \quad j = 0.917$

$f_s = \frac{(57)(3.115)}{(0.917)(5)(1.4127)} = 27.41^{ksi}$

$f_c = \frac{(27.41)(0.250)}{(9)(1-0.250)} = 1.015^{ksi}$ OK

COL F-3

$e = \frac{7566}{54} + 21 = 161.1 \quad e/d = 3.159$

$w/\gamma = 0.01 \quad i = 1.4046 \quad m = q = 0.0427 \quad k = 0.253 \quad j = 0.916$

$f_s = \frac{(54)(3.159)}{(0.916)(5)(1.4046)} = 26.52^{ksi}$

$f_c = \frac{(26.52)(0.253)}{(9)(1-0.253)} = 0.998^{ksi}$

COL F-7

$e = \frac{7367}{68} + 21 = 129.3 \quad e/d = 2.536$

$w/\gamma = 0.02 \quad i = 1.5693 \quad m = q = 0.04775 \quad k = 0.265 \quad j = 0.912$

$f_s = \frac{(68)(2.536)}{(0.912)(5)(1.5693)} = 24.10^{ksi}$

$f_c = \frac{(24.10)(0.265)}{(9)(1-0.265)} = 0.965$

COL F-7

$e = \frac{7048}{64} + 21 = 131.1 \quad e/d = 2.571$

$w/\gamma = 0.02 \quad i = 1.5572 \quad m = q = 0.04738 \quad k = 0.264 \quad j = 0.912$

$f_s = \frac{(64)(2.571)}{(0.912)(5)(1.5572)} = 23.17^{ksi}$

$f_c = \frac{(23.17)(0.264)}{(9)(1-0.264)} = 0.924^{ksi}$

COL F-8

$e = \frac{6839}{55} + 21 = 145.3 \quad e/d = 2.8499$

$w/\gamma = 0.02 \quad i = 1.4767 \quad m = q = 0.04493 \quad k = 0.258 \quad j = 0.914$

$f_s = \frac{(55)(2.8499)}{(0.914)(5)(1.4767)} = 23.22^{ksi}$

$f_c = \frac{(23.22)(0.258)}{(9)(1-0.258)} = 0.897^{ksi}$

GPU Nuclear

CALC. NO. C-P02-151-5320-006
SHEET NO. 54 OF 57
DATE 11/8/83
COMP. BY/DATE PH 11/16/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

COL F.1

$e = \frac{6297}{39} + 21 = 182.46 \quad e/d = 3.578$

$w/g = 0.92 \quad i = 1.346 \quad m = q = 0.4096 \quad k = 0.248 \quad j = 0.917$

$f_s = \frac{(39)(3.578)}{(0.917)(5)(1.346)} = 22.61^{ksi}$ say OK

$f_c = \frac{(22.61)(0.248)}{(9)(1-0.248)} = 0.829^{ksi}$

COL REACTION	J.1	J.2	J.3	J.4	J.5	J.6	J.7	J.8	J.9	J.10
P	20	25	26	28	29	28	26	25	22	17
M	2896	3117	3270	3418	3485	3393	3185	2943	2627	2519

COL F.5

$e = \frac{3485}{29} + 19.5 = 139.67 \quad e/d = 3.104$

$w/g = 0.91 \quad z = 1.4148 \quad m = q = 0.0786 \quad k = 0.326 \quad \gamma = 0.891$

$f_s = \frac{(29)(3.104)}{(0.891)(5)(1.4148)} = 14.44^{ksi}$ OK

$f_c = \frac{(14.44)(0.326)}{(9)(1-0.326)} = 0.776^{ksi}$ OK

SUMMARY MAXIMUM ANCHOR BOLT AND CONCRETE BEARING OVERSTRESS BASED ON CURRENT CRITERIA

	1	2	3	4	5	6	7	8	9	10
A	ok / ok	30.21 / ok	32.22 / 1.25	*	*	*	30.83 / 1.26	30.33 / 1.160	ok / ok	ok / ok
E	ok / ok	23.17 / ok	26.12 / ok	27.53 / ok	28.27 / ok	27.41 / ok	24.10 / ok	23.22 / ok	ok / ok	ok / ok
I	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok	ok / ok

WITH BASES AT A-4, A-5 AND A-6 AT YIELD STRESS, 4 OTHER ANCHOR BOLT SETS EXCEED THE ORIGINAL DESIGN CRITERIA

ABOVE VALUES DEFINE THE EQUILIBRIUM STRESS CONDITION FOR AN 80MPH WIND LOAD + DEAD LOAD.

Nuclear

CALC. NO. C-1302-151-1220-006
SHEET NO. 57 OF 57
DATE 10/25/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATION

WIND LOADS ON CONCRETE FRAME

① COMPARE SHEAR @ ELEV 46'-0" FOR TORNADO VS. EARTHQUAKE

TORNADO SHEAR @ 80 mph p = 16.4 psf
p (TOTAL) = (16.4)(1.3) = 21.3 psf

EFFECTIVE AREA = (269.7)(62.7) = 16 935 S.F.

WIND SHEAR = (0.0213)(16 935) = 360^K @ 80 MPH

SEISMIC SHEAR FOR SSE

REF 13 PAGE 36 OBE SHEAR @ EL 46'-6 ≈ 8^K > 3.6^K
∴ OBE GOVERNS OVER DESIGN WIND

WIND WILL NOT GOVERN FRAME DESIGN SINCE SEISMIC SHEAR ACCUMMULATES MORE RAPIDLY THAN WIND SHEAR WITHIN THE CONCRETE PORTION.

② CHECK COMPONENTS – WALL

WIND WALL PRESSURE = 16.4 x 0.8 = 13.1 PSF
REF DWG 4079 SECTION C-C
WALL REINF = #8 @ 12
d = 36-(2+2) = 33.5"
SPAN = 23'-0
FOR MOST CRITICAL CONDITION, ASSUME SIMPLE SPAN

$M = (0.0131)(23)^2/8 = 0.866^{k'}$
$M_u = (0.866)(1.7) = 1.473^{k'}$

$F_{AVAIL} = \frac{(12)(33.5)^2}{12000} = 1.122$

$K_{REQ} = \frac{1.473}{1.122} = 1.31$

$f = 0.79/(12)(33.5) = 0.0020$

K_u AVAIL ≈ 80 > K_{REQ} ∴ OK

A000 0018 12-80

ATTACHMENT III

TURBINE BUILDING ROOF: WIND LOAD ANALYSIS

SUBJECT O.C. SEP TOPIC III-2

TURBINE BUILDING ROOF WIND LOAD

SHEET NO. 1 OF 13
DATE 2/16/83
COMP. BY/DATE FH 3/11/83
CHK'D. BY/DATE THC 4/26/83

PROBLEM

OYSTER CREEK SEP TOPIC III-2, SECTION 4.3.6 REQUIRES ANALYSIS OF THE TURBINE BUILDING ROOF TO DETERMINE ITS WIND LOAD CAPACITY

RESULTS

CAPACITY OF ROOF ELEMENTS

(2)	CAPACITY AT NORMAL ALLOWABLE STRESS			CAPACITY WITH 1/3 INC IN ALLOWABLE STRESS			RED. FC. (1)
	DECK	PURLIN	TRUSS (5)	DECK	PURLIN	TRUSS (5)	TRUSS (5)
TORNADO VELOCITY	221 MPH	118 MPH	193 MPH	253 MPH	127 MPH	218 MPH	240 MPH
ALLOW. DEPRESS.	0.61 PSI	0.17 PSI	0.41 PSI	0.80 PSI	0.20 PSI	0.59 PSI	0.72 PSI

NOTES CONCERNING RESULTS:

(1) ROOF TRUSS CAPACITY IS BASED ON THE MOST CRITICAL TRUSS MEMBER IN THE MOST HEAVILY LOADED TRUSS. AT 240 MPH THE FACTOR OF SAFETY AGAINST BUCKLING IS REDUCED TO 1.04 VS 1.90 AT WORKING STRESS AND 1.43 WHEN A 1/3 INCREASE IN STRESS IS ALLOWED.

(2) WIND VELOCITY AND TORNADO DEPRESSURIZATION HAVE NOT BEEN CONSIDERED SIMULTANEOUSLY FOR THE TABULATED VALUES. SEE ATTACHED GRAPH FOR INTERACTIVE WIND / DEPRESSURIZATION VALUES.

(3) PURLIN FAILURE WOULD BE BY COMPRESSION FLANGE LATERAL BUCKLING. THE ANALYSIS HAS CONSIDERED ONLY THE MOST CRITICAL PURLIN (MAXIMUM SPAN AND FULLY UNSUPPORTED). MOST PURLINS HAVE A SHORTER SPAN AND/OR HAVE THEIR COMP'N FLANGE BRACED AT APPROX. THIRD POINTS THUS INCREASING LOAD CARRYING CAPACITY.

(4) PURLIN LOAD CAPACITY IS LESS THAN DECKING AND ROOF TRUSS. HOWEVER, SINCE PURLIN FAILURE WOULD BE BY LATERAL BUCKLING OF THE COMPRESSION FLANGE, IT IS POSTULATED THAT THE RESULTANT DEFLECTION WOULD FAIL THE DECKING / PURLIN CONNECTION THEREBY RELEASING THE DECKING AND RELIEVING PRESSURE AND ANY FURTHER PURLIN DEFORMATION. DECKING WOULD BE

CARRIED UP AND AWAY FROM THE TURBINE BUILDING WITHOUT POSING A HAZARD TO ITS CONTENTS.

(5) TRUSS CAPACITY IS FOR NORTH/SOUTH WIND DIRECTION ONLY SINCE THE TRUSS PARTICIPATES IN RIGID FRAME ACTION FOR EAST/WEST WIND DIRECTION. THIS SITUATION IS EXAMINED IN A SEPARATE CALCULATION.

REFERENCES

- REG GUIDE 1.117 TORNADO DESIGN CLASSIFICATION
- AISC "SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS" EFFECTIVE NOV 1, 1978
- BURNS AND ROE SPECIFICATION S 2299.45 "SUPERSTRUCTURE CONSTRUCTION"
- BURNS AND ROE W.O. 2299 DRAWING 4209
- H H ROBERTSON PRODUCT CATALOG
- NUREG 0800 SECTION 3.3.2 TORNADO LOADINGS
- LAI 82251.08

ASSUMPTIONS AND BASIC DATA

- ALL STRUCTURAL STEEL ASTM A36
- DECKING INSTALLATION MEETS SUPPLIERS MINIMUM REQUIREMENTS
- WHEN CONSIDERING UPLIFT ON ROOF, NO LIVE LOAD IS CONSIDERED.

SUBJECT O.C. SEP TOPIC III-2

TURBINE BUILDING ROOF WIND LOAD

SHEET NO. 22 OF 13
DATE 1-19-84
COMP. BY/DATE PH 1-19-84
CHK'D. BY/DATE T.H.C. 1/24/84

CONCLUSIONS (CONT'D)

CAPACITY OF ELEMENTS IN ACCORDANCE WITH ALLOWABLE STRESS LEVELS OF NUREG 3 & 4

	VELOCITY	DEPRESSURIZATION
PURLINS	134 MPH	0.22 PSI
ROOF TRUSS	235 MPH	0.69 PSI
DECK	275 MPH	0.94 PSI

SUBJECT ... G.G. SER REVIEW TOPIC III-2

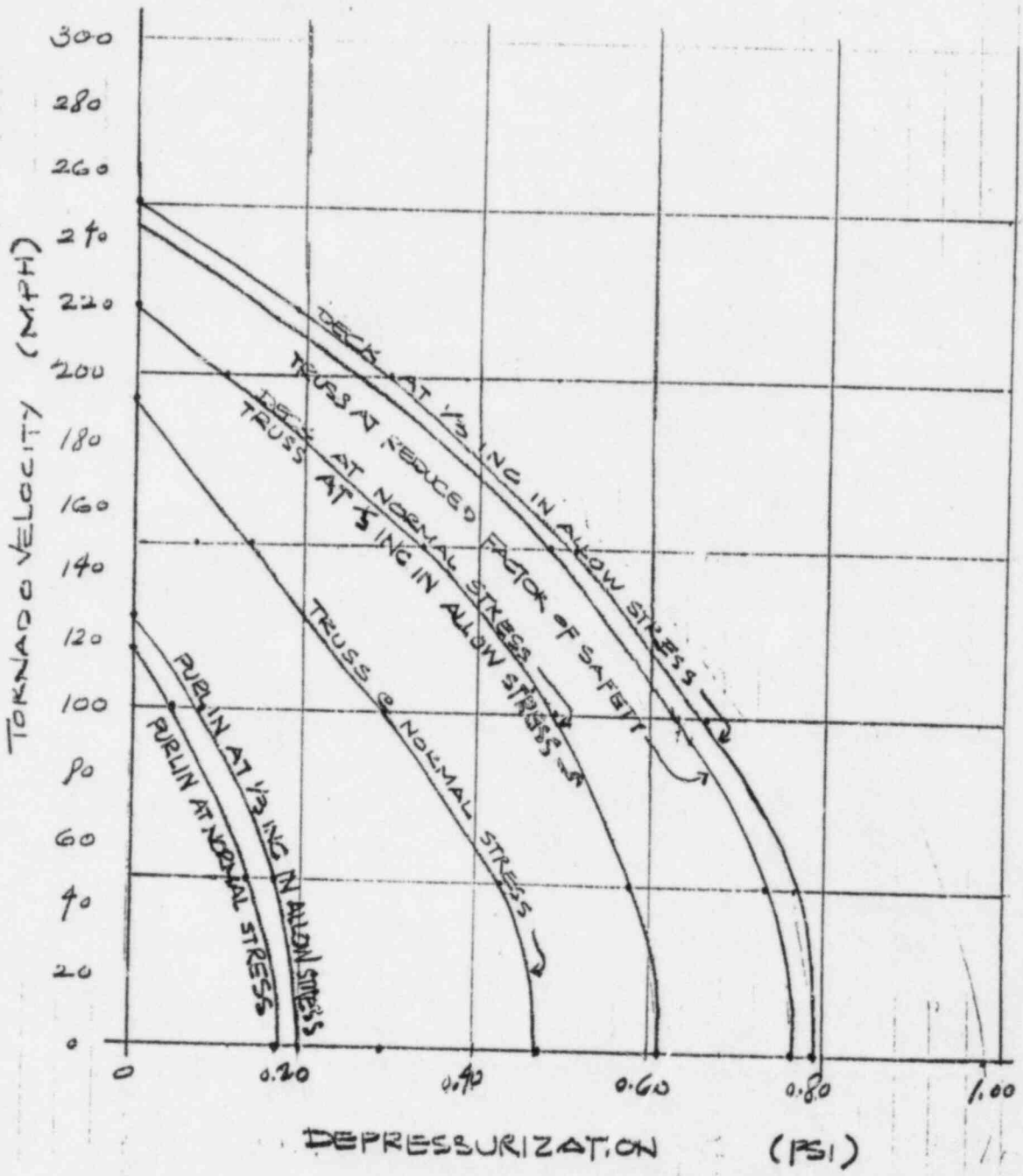
TURBINE BUILDING ROOF WIND LOAD

SHEET NO. 3 OF 13

DATE 2-22-83

COMP. BY/DATE T.H. 3/11/83

CHK'D. BY/DATE TMK 4/6/83



TURBINE BUILDING ROOF COMPONENT CAPACITY AT VELOCITY / PRESSURE COMBINATIONS

SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

SHEET NO. 4 OF 13
DATE 2.15.83
COMP. BY/DATE PH 3/11/83
CHK'D. BY/DATE THC 4/6/83

TURBINE BUILDING ROOF DECKING
HIGH ROOF BTWN COL LINES A-F AND 1-10
APPROX ELEV. 110'-7"

DECKING - ROBERTSON Q DECK SECT 3-18 GA - 8'SPA
RIGID INSULATION - CELLULAR GLASS
BUILT UP ROOFING - 4 PLY WITH GRAVEL

ASSEMBLY WEIGHT

ROOFING	5.5 #/□'
INSULATION	0.7 #/□'
DECKING	2.9 #/□'
	9.1 #/□' TOTAL

DECK SECTION PROPERTIES - REF ROBERTSON CAT.
$+S = 0.398\ IN^3$
$-S = 0.380\ IN^3$
MATERIAL = ASTM A446 $F_y = 33^{KSI}$

CONSIDER SIMPLE SPAN - CRITICAL CASE

AT BASIC ALLOWABLE STRESS OF 20 KSI

$M_{ALLOW} = fS = (20)(0.380)/12 = 0.633^{K'}$
$= 633$ FT-LBS

$M = wL^2/8$
$w = 8M/L^2 = (8)(0.633)/8^2 = 0.079\ ^{K}/□'$
$= 79\ \#/□'$

NET ALLOWABLE UPLIFT
79 #/□' DECK CAPACITY
9.1 ASSEMBLY WEIGHT
88.1 #/□' ↑
↳ 0.61 PSI

EQUIVALENT WIND VELOCITY
FLAT ROOF SHAPE FACTOR = 0.7
EQUIVALENT HORIZ PRESS = 88.1/0.7 = 125.8#

$V = \sqrt{\frac{125.8}{0.00256}} = 221.6$ MPH

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SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

SHEET NO. 5 OF 13
DATE 2-15-83
COMP. BY/DATE PH 3/11/83
CHK'D. BY/DATE TMC 4/6/83

CHECK DECK UPLIFT CAPACITY WITH 1/3 INCREASE IN ALLOWABLE STRESS

$w = (4/3)(79.0) = 105.3$ #/□'
9.1
114.4 #/□' NET UPLIFT
→ 0.79 PSI

EQUIVALENT WIND VELOCITY

$$V = \sqrt{\frac{114.4/0.7}{0.00256}} = 252.7 \text{ MPH}$$

TURBINE BUILDING PURLINS

16B31 · SPAN VARIES 36'-9½" MAX @ 8' o/c
$S = 47.2$ IN^3 $r_T = 1.39$ IN
$L_U = 7.1$ FT $b/2t_f = 6.5$ $C_b = 1.0$

$L/r_T = (12)(36.79)/1.39 = 317.6 > \sqrt{\frac{510\times10^3}{F_y}} = 119$

$F_b = \frac{170000}{(317.6)^2} = 1.68$ KSI $F_B = \frac{(12000)(5.525)(0.440)}{(36.79)(12)(16)} = 4.$ GOVERNS

$M = (4.13)(47.2)/12 = 16.24$ K'

$w = (16.24)(8)/(36.79)^2(8) = 0.012$ K/□'
12 #/□' ↑

TOTAL UPLIFT CAPACITY

BM WGT 3 1/8 = 3.9 #/□'
DECK ASS'Y 9.1
UPLIFT CAPACITY 12.0
25.0 #/□'
→ 0.174 PSI

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SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

SHEET NO. 6 OF 13
DATE 7-15-83
COMP. BY/DATE PH 9/11/83
CHK'D. BY/DATE THC 9/12/83

EQUIVALENT VELOCITY

$$V = \sqrt{\frac{25/0.7}{0.00256}} = 118 \text{ MPH}$$

CHECK UPLIFT CAPACITY WITH 1/3 INCREASE IN ALLOWABLE STRESS

$$\omega = 4/3 \times 12 = 16.0$$
$$9.1$$
$$3.9$$
$$29.0 \#/\square'$$
$$\rightarrow 0.20 \text{ PSI}$$

EQUIVALENT WIND VELOCITY

$$V = \sqrt{\frac{29/0.7}{0.00256}} = 127.2 \text{ MPH}$$

CHECK PURLIN END CONNECTION CAPACITY

PURLIN END REACTION $= \frac{(12)(8)(36.79)(\frac{1}{2})}{1000} = 1.76$

PURLINS FRAME OVER TOP OF ROOF TRUSSES ALLOW FOR (2) 3/4" ϕ A325 BOLTS FROM BOTTOM FLANGE OF PURLIN TO TRUSS TOP CHORD.

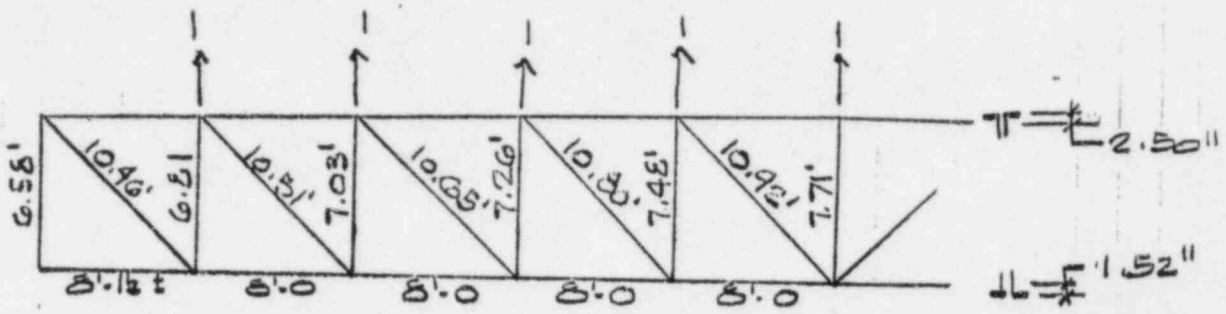
CAPACITY OF A325 BOLT IN TENSION
$P_T = 19.4^K/\text{BOLT}$
$19.4 \times 2 = 38.8^K > R = 1.76^K$

CONNECTION OK FOR 1/3 INC IN ALLOWABLE STRESS BY OBSERVATION.

SUBJECT Q.G. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

ROOF TRUSS CAPACITY



@ COL LINE 7'-0" o.to o. CHORDS
- 0'-4"
6'-8" W.P. TO W.P.

@ PEAK 8'-1½" o.to o. CHOR
- 0'-4
7'-9½ W.P. TO W.P

ROOF SLOPE = 13'2"/40'-1½" = 0.336"/12"

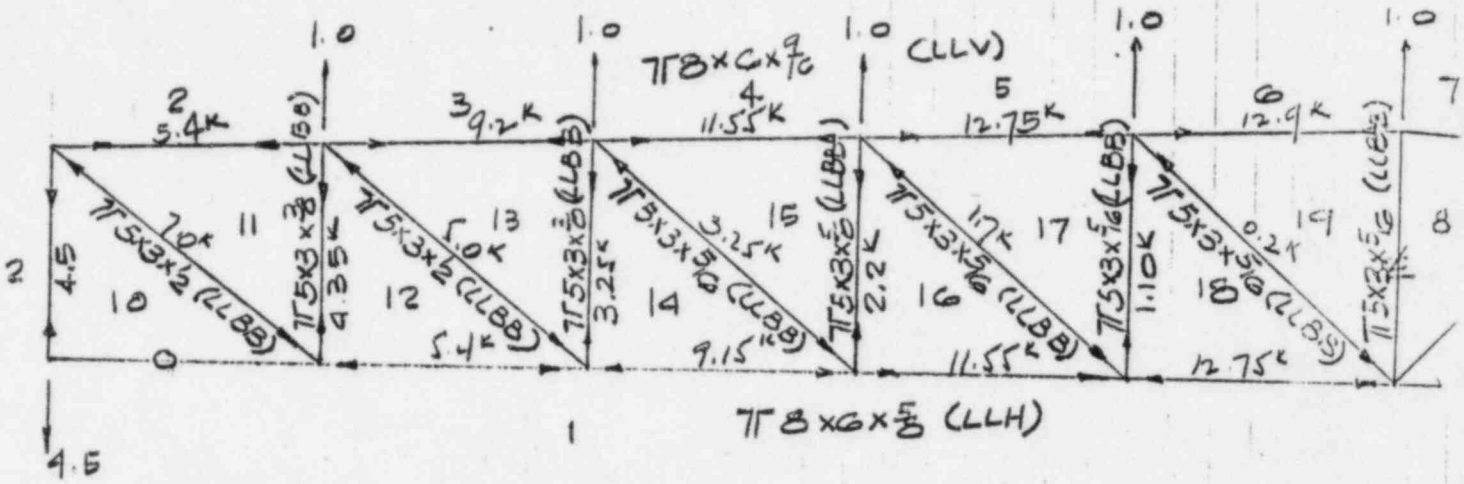
ANALYZE TRUSS FOR UNIT LOADS AT PANEL POINTS AND ISOLATE CRITICAL MEMBER

SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BLDG. ROOF WIND LOAD

SHEET NO. 8 OF 13
DATE 2-16-83
COMP. BY/DATE PH 3/11/83
CHK'D. BY/DATE THC 4/6/83

REV 1



USE GRAPHICAL ANALYSIS -
FOR CLOSURE 8-19 SHOULD = 0
BY GRAPH 8-19 = 0.15K OK

TOP CHORD	P = 12.9K T	w/ L = 8'-0"	7Γ8×6×9/16 LLBB
BOT CHORD	P = 12.75K C	w/ L = 8'-0"	7Γ8×6×5/8 SLBF
DIAGONAL	P = 7.0K C	w/ L = 10.46'	7Γ5×3×1/2 LLBB
	P = 1.7K C	w/ L = 10.80'	7Γ5×3×5/16 LLBF
VERTICAL	P = 4.35K T		7Γ5×3×3/8 LLBF
	P = 1.10K T		7Γ5×3×5/16 LLBF

7Γ8×6×9/16 A = 2×7.56 = 15.12 □"
ALLOW FOR (2) 15/16" Φ HOLES A_{NET} = 15.12 - (15/16)(2)(2)(9/16) = 13.0
PH 1/19/84 P_{ALLOW} = (15.01)(22) = ~~286K T~~ 332.6K T
PH 1/19/84 = (0.85)(13.01)(0.5)(58) = 320.6K T GOVERNS

7Γ8×6×5/8 x-x, y-y A = 2×8.36 = 16.72 □"
L_x = 8.0'
L_y = 16.0'
r_x = 1.77"
I_y = (2)(26.3) + (8.36)(2.52 + 3/8 × 1/2)²(2) = 175.2 in⁴
r_y = (175.2/16.72)^½ = 3.24"
KL/r_x = 8×12/1.77 = 54.2
KL/r_y = 16×12/3.24 = 59.3 ← GOVERNS
F_a = 17.50 ksi
P_{ALLOW} = (17.50)(16.72) = 292.6K C

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SUBJECT D.C. SEP REVIEW TOPIC III-2

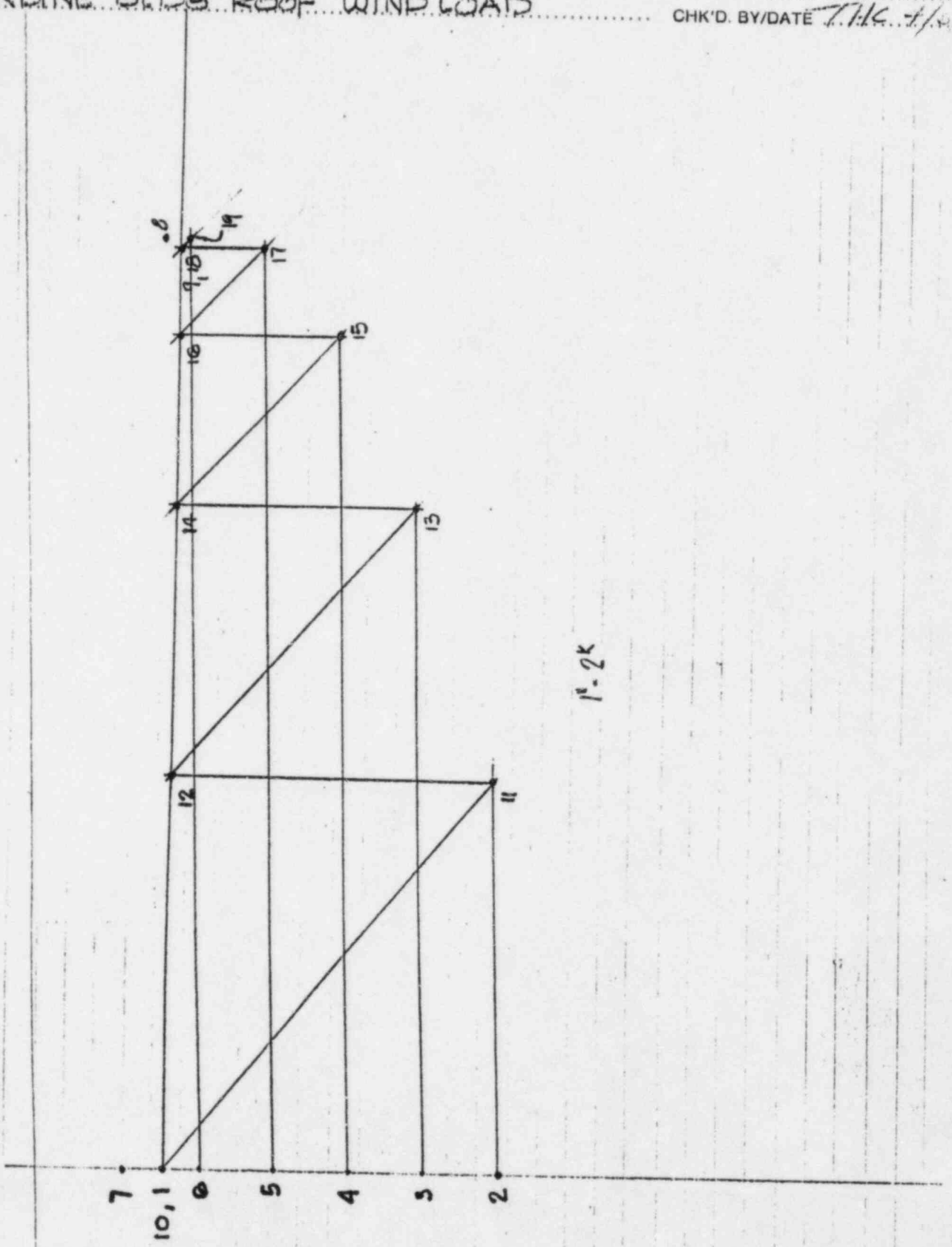
TURBINE BLDG ROOF WIND LOAD

SHEET NO. 9 OF 13

DATE 2-15-83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE THC 3/11/83



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Nuclear

SUBJECT O.G. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

CALC. NO. C-1997-151-2320-001
SHEET NO. 10 OF 13
DATE 2-16-83
COMP. BY/DATE PH 3/11/83
CHK'D. BY/DATE TMK 9/16/83

REV 1

Γ 5x3x½ Γ $L_x = L_y = 10.46'$

$A = 2 \times 3.75 = 7.50 \square''$

$r_x = 1.59''$

$I_y = (2)(2.53) + (3.75)(0.75 + \frac{3}{8} \times \frac{1}{2})^2 (2) = 11.75''$

$r_y = (11.75/7.50)^{\frac{1}{2}} = 1.25''$

$KL/r_y = (10.46)(12)/1.25 = 100.4$

$F_a = 12.93^{ksi}$

$P = (7.50)(12.93) = 97.0^k$ C

Γ 5x3x5/16 $L_x = L_y = 10.65'$

$A = 2 \times 2.40 = 4.80 \square''$

$r_x = 1.61''$

$I_y = (2)(1.75) + (2.40)(0.681 + \frac{5}{16} \times \frac{1}{2})^2 (2) = 7.12 \text{ IN}$

$r_y = (7.12/4.80)^{\frac{1}{2}} = 1.22''$

$KL/r_y = (10.65)(12)/1.22 = 104.8$

$F_a = 12.36^{ksi}$

$P_{ALLOW} = (12.36)(4.80) = 59.3^k$ C

Γ 5x3x3/8 $A = 2 \times 2.86 = 5.72 \square''$

ALLOW FOR (1) 15/16" ϕ HOLE $A_{NET} = 5.72 - (\frac{15}{16})(\frac{3}{8})(2) = 5.02$

$P_{ALLOW} = (5.72)(22) = 125.8^k$ T

$P_{ALLOW} = (0.85)(5.02)(0.5)(58) = 123.7^k$ GOVERNS

Γ 5x3x5/16 $A = 2 \times 2.40 = 4.80 \square''$

ALLOW FOR (1) 15/16" ϕ HOLE $A_{NET} = 4.80 - (\frac{15}{16})(\frac{5}{16})(2) = 4.21$

$P_{ALLOW} = (4.80)(22) = 105.6^k$

$P_{ALLOW} = (4.21)(0.85)(0.5)(58) = 103.7^k$ GOVERNS

CHECK % UTILIZATION OF EACH SECTION

Γ 8x6x9/16	TOP CHORD	12.9/~~288~~ 320.6	~~0.045~~ 0.037
Γ 8x6x3/8	BOT CHORD	12.75/292.6	0.044
Γ 5x3x½	DIAGONAL	7.0/97.0	0.072 ←
Γ 5x3x5/16	DIAGONAL	1.7/59.3	0.029
Γ 5x3x3/8	VERTICAL	4.35/123.7	0.0352
Γ 5x3x5/16	VERTICAL	1.10/103.7	0.0106

PH 1/19/

DIAGONAL Γ 5x3x½ GOVERNS.

ALLOWABLE PANEL POINT LOAD = 97/7 = 13.86^k ↑

ADD TRUSS WEIGHT FOR NET ALLOWABLE

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SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

CALC. NO. [illegible]
SHEET NO. 11 OF 15
DATE 2-16-83
COMP. BY/DATE P.H. 3/11/83
CHK'D. BY/DATE T.H.G. 4/6/83

TRUSS WEIGHT @ ONE PANEL POINT

8'	7Γ 8 x 6 x 9/16	@ 51.4 #/FT	=	411.2
8'	7Γ 8 x 6 x 5/8	@ 57.0	=	456.0
7.03'	7Γ 5 x 3 x 3/8	@ 19.6	=	137.8
5.25'	7Γ 5 x 3 x 1/2	@ 25.6	=	134.4
5.33'	7Γ 5 x 3 x 5/16	@ 16.4	=	87.4
				1226.8 #

SAY 1.22K

NET ALLOWABLE PANEL POINT LOAD

13.86
1.22
15.08 K = PURLIN REACTION (TOTAL OF 2)

PURLIN LENGTHS = 36'-9½' AND 33'-5½

CONTRIB LGTH = $\frac{36.79 + 33.46}{2}$ = 35.13'

$\omega = \frac{15.08}{(35.13)(8)} = 0.054$ K/□'

54 #/□' ROOF LOADING
9.1 #/□' ROOF ASSY WEIGHT
3.9 #/□' PURLIN WGT
67.0 #/□'
→ 0.47 PSI

EQUIVALENT VELOCITY

$V = \sqrt{\frac{67/0.7}{0.00256}} = 193.3$ MPH

DETERMINE WITH ⅓ INC. IN ALLOW STRESS

$(54 \times \frac{4}{3}) + 13.0 = 85$ #/□'

→ 0.59 PSI

$V = \sqrt{\frac{85/0.7}{0.00256}} = 217.8$ MPH.

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CALCULATE THE REDUCTION IN FACTOR OF SAFETY TO HAVE A CAPACITY OF 240 MPH

$W = 0.00256\,(240)^2 = 147.4\ \#/\square'$

$\times 0.7$

$103.2\ \#/\square'$ ↑ ON ROOF

$-\ 13.0\ \#/\square'$ ROOF WGT

$90.2\ \#/\square'$ NET

$$\text{PURLIN REACTION} = \frac{(90.2)(8)(35.13)}{1000} = 25.34^K$$

$$R_{DIAGONAL} = (25.3)(7) = 177.1^K$$

F.S. FROM COLUMN FORMULA

$$F.S. = (53) + \frac{3(KL/r)}{8C_c} - \frac{(KL/r)^3}{8C_c^3} \qquad C_c = 126,\ KL/r = 100.4$$

$F.S. = 1.90$

$P_{ULT} = 1.90 \times 97.0 = 184.3 > 177.1^K$

$F.S. = 184.3/177.1 = 1.04$ AT 240 MPH TORNADO

CHECK CAPACITY OF ROOF DECK ATTACHMENT TO PURLINS.

SPECIFICATION & DRAWINGS DO NOT SHOW ATTACHMENT REQUIREMENTS. ASSUME MINIMUM VENDOR REQUIREMENTS HAVE BEEN MET.

ROBERTSON CATALOG
SPECIFICATION FOR SECTIONS 3, 21 AND 12

3/4" ϕ FUSION WELDS

- OUTSIDE EDGE AT 1ST, 3RD & 5TH LOW CORRUGATION
- JOINTS AT 1ST, 3RD & 5TH LOW CORRUGATIONS
- INTERMEDIATE SUPPORTS AT 2ND & 4TH LOW CORRUGATIONS

PUDDLE WELD CAPACITY PER ROBERTSON CATALOG
18 GA DECK 1540 # SHEAR / WELD

PANEL WIDTH = 24" w/2 WELDS PER SUPPORT
∴ END CONN. CAPACITY = 1540#/FT ASSUMING TENSION CAPACITY IS SAME AS SHEAR CAPACITY.

$w = 1540/8 = 192.5$ #/□' THIS IS GREATER

THAN THE DECK BENDING CAPACITY AND WILL NOT GOVERN.

SUBJECT O.C. SEP REVIEW TOPIC III-2

TURBINE BUILDING ROOF WIND LOAD

CALC. NO. ..... SHEET NO. 13a OF 13
DATE 1-19-84
COMP. BY/DATE FH 1/19/84
CHK'D. BY/DATE THC 1/23/84

CHECK CAPACITY OF PURLIN @ F_B = 1.6S
AS PER NUREG 3.8.4
REF PG 5
$\omega = 1.6 \times 12 = 19.2$ PSF UPLIFT CAPACITY

TOTAL WIND UPLIFT CAPACITY

$3.0 + 9.1 + 19.2 = 32.2$ PSF

EQUIVALENT VELOCITY

$$V = \sqrt{\frac{32.2/0.7}{0.00256}} = 134 \text{ MPH}$$

DEPRESSURIZATION $32.2/144 = 0.22$ PSI

CHECK CAPACITY OF TRUSS @ F = 1.6S
AS PER NUREG 3.8.4

REF PG 11
$\omega = 54 \times 1.6 + 13.0 = 99.4$ PSF = 0.69 PSI

$$V = \sqrt{\frac{99.4/0.7}{0.00256}} = 235 \text{ MPH}$$

CHECK CAPACITY OF ROOF DECK @ F = 1.6S
AS PER NUREG 3.8.4

REF PG 4
$\omega = 79 \times 1.6 + 9.1 = 135.5$ PSF = 0.94 psi

$$V = \sqrt{\frac{135.5/0.7}{0.00256}} = 275 \text{ MPH}$$

$\frac{1.6}{1.33} = 1.203$

$\sqrt{1.203} = 1.097$

$0.801 \times 1.203 = .96$ (psi) ~ .94
$0.20 \times 1.203 = .24$ psi — .24
$0.59 \times 1.203 = .71$ psi — .69

$253 \times 1.097 = 277$ MPH ~ 275
$127 \times 1.097 = 139$ MPH — 134
$218 \times 1.097 = 239$ MPH — 235

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