

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

BY

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JANUARY, 1984

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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 tornado 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, whether 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

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

PROBLEM TWO DIMENSIONAL FRAME ANALYSIS OF THE TURBINE BUILDING STEEL FRAME INDICATES RESISTANCE CAPACITY LESS THAN TORNADO VELOCITY OF 280 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 168 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 ODE REACTION AND WOULD NOT ADVERSELY AFFECT THE CONTROL ROOM INTEGRITY

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001

SHEET NO. 2 OF 51

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

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

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) THURNS 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 "PHSTRGJ"
- 9) COMPUTER OUTPUT "PHSTRLQ"
- 10) COMPUTER OUTPUT "PHSTRWI"
- 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 50-219 LS05-81-11-033

SUBJECT SEP TOPIC II.2 LAI 82251.07

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

SHEET NO. 3 OF 59

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

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TURBINE BLDG TORNADO CAPACITY

THREE DIMENSIONAL FRAME ANALYSISFRAME 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

SUBJECT **SEP TOPIC III-2 LAI 82251.07**

TURBINE BUILDING TORNADO CAPACITY

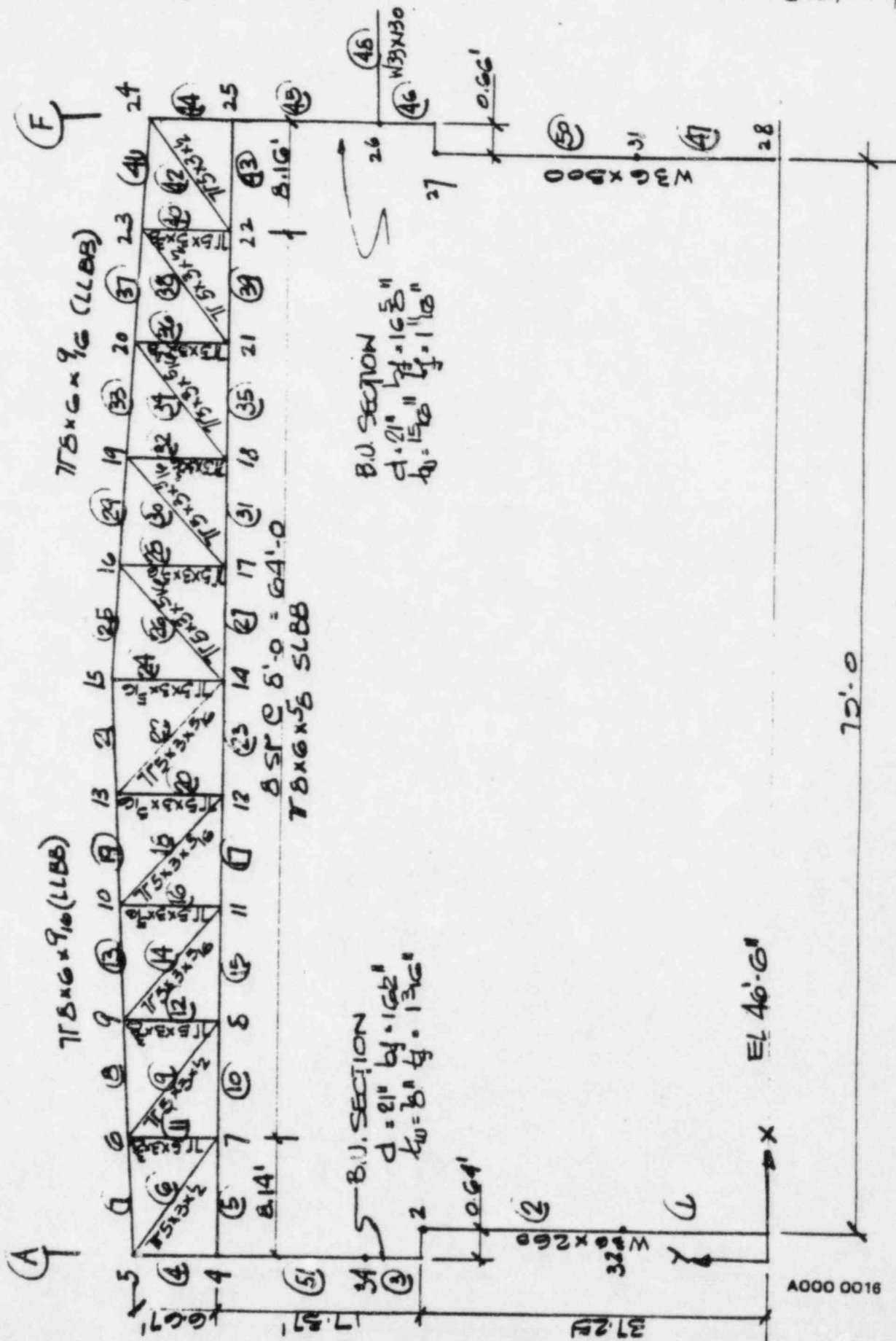
CALC. NO. **C-1202-151-S320-001**

SHEET NO. **4** OF **39**

DATE **11/17/83**

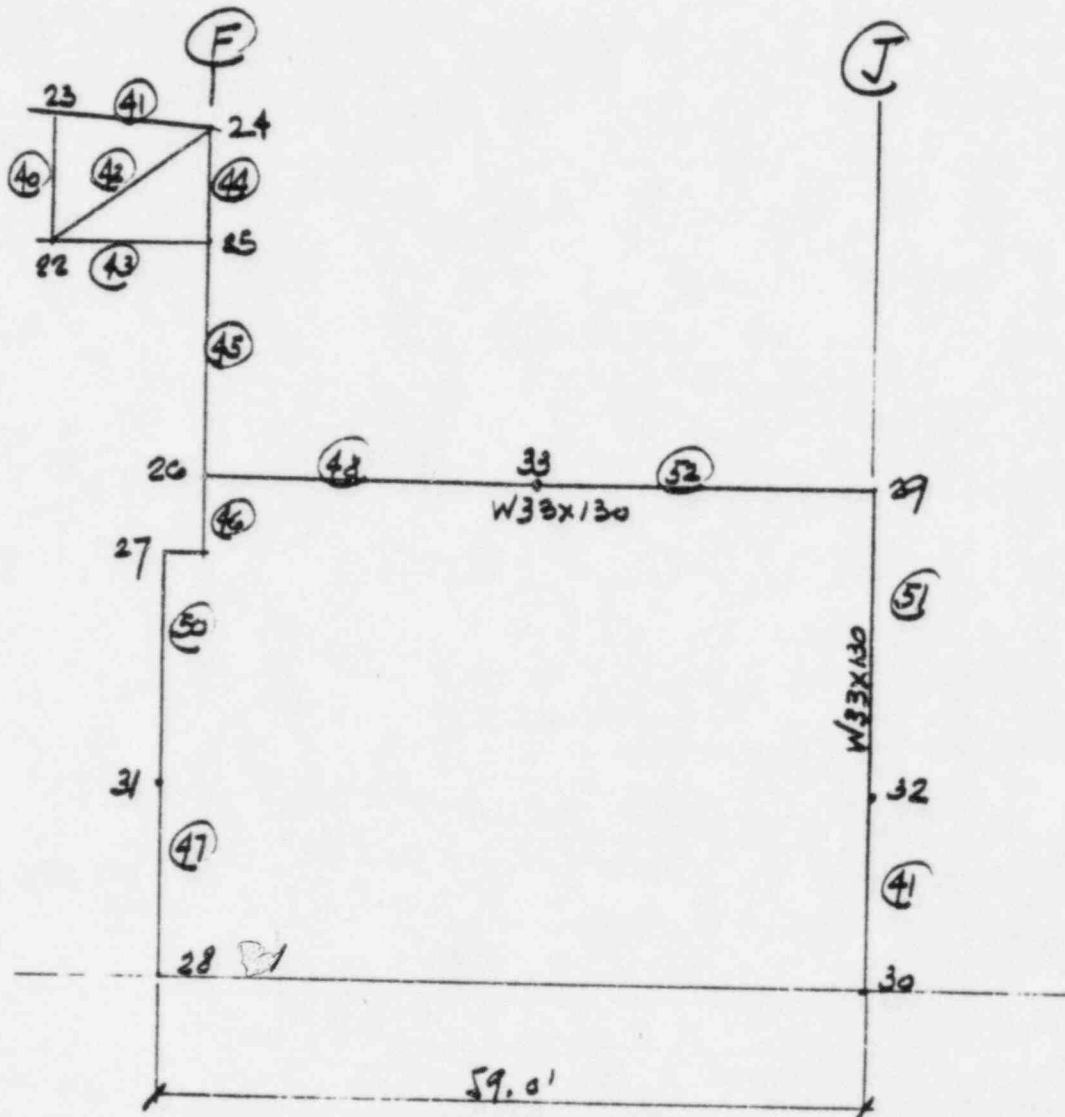
COMP. BY/DATE **PH 11/28/83**

CHK'D. BY/DATE **D.B.T. 12/12/83**



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

CALC. NO. C-1202-121-2220-801
 SHEET NO. 5 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

TURNER BUILDING TORNADO CAPACITY

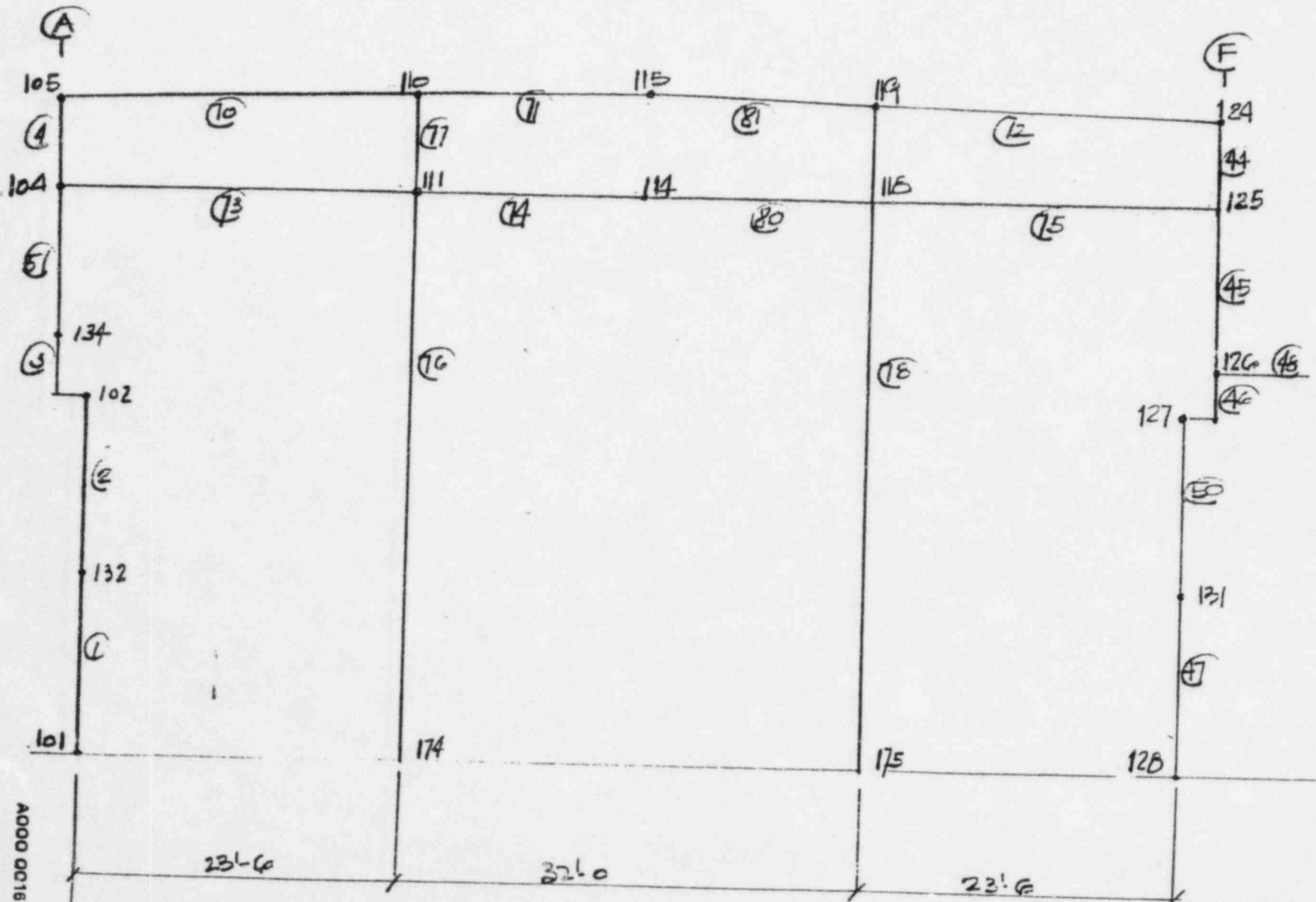
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SHEET NO. 54 OF 54

DATE 11/7/83

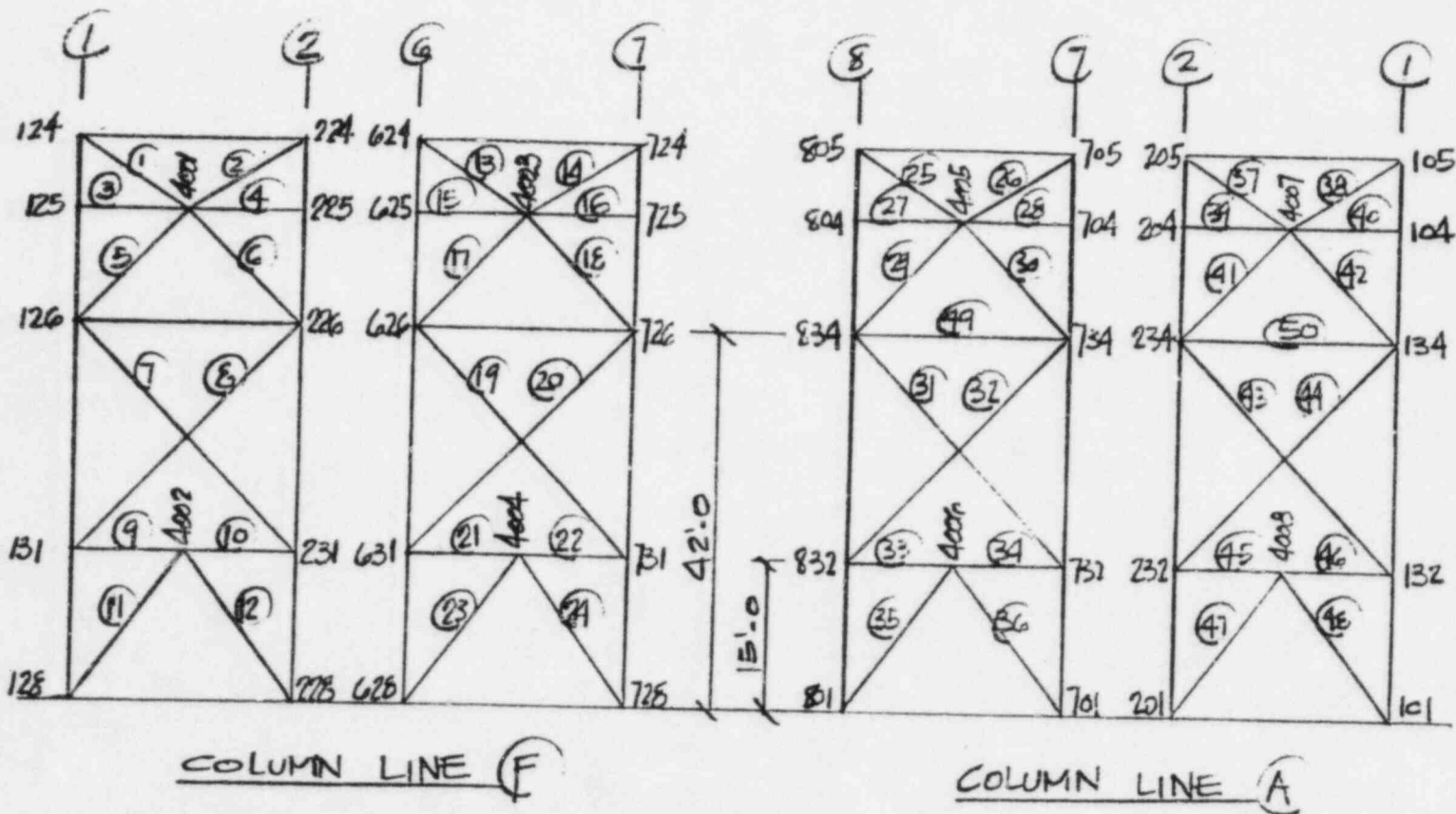
COMP BY/DATE PH 11/28/83

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



PREFIX ALL MEMBER NUMBERS 100 +
ELEVATION ON COLUMN LINE 1

REMAINDER
SAME AS
COL 2-10



PREFIX ALL MEMBER NUMBERS 5000 +

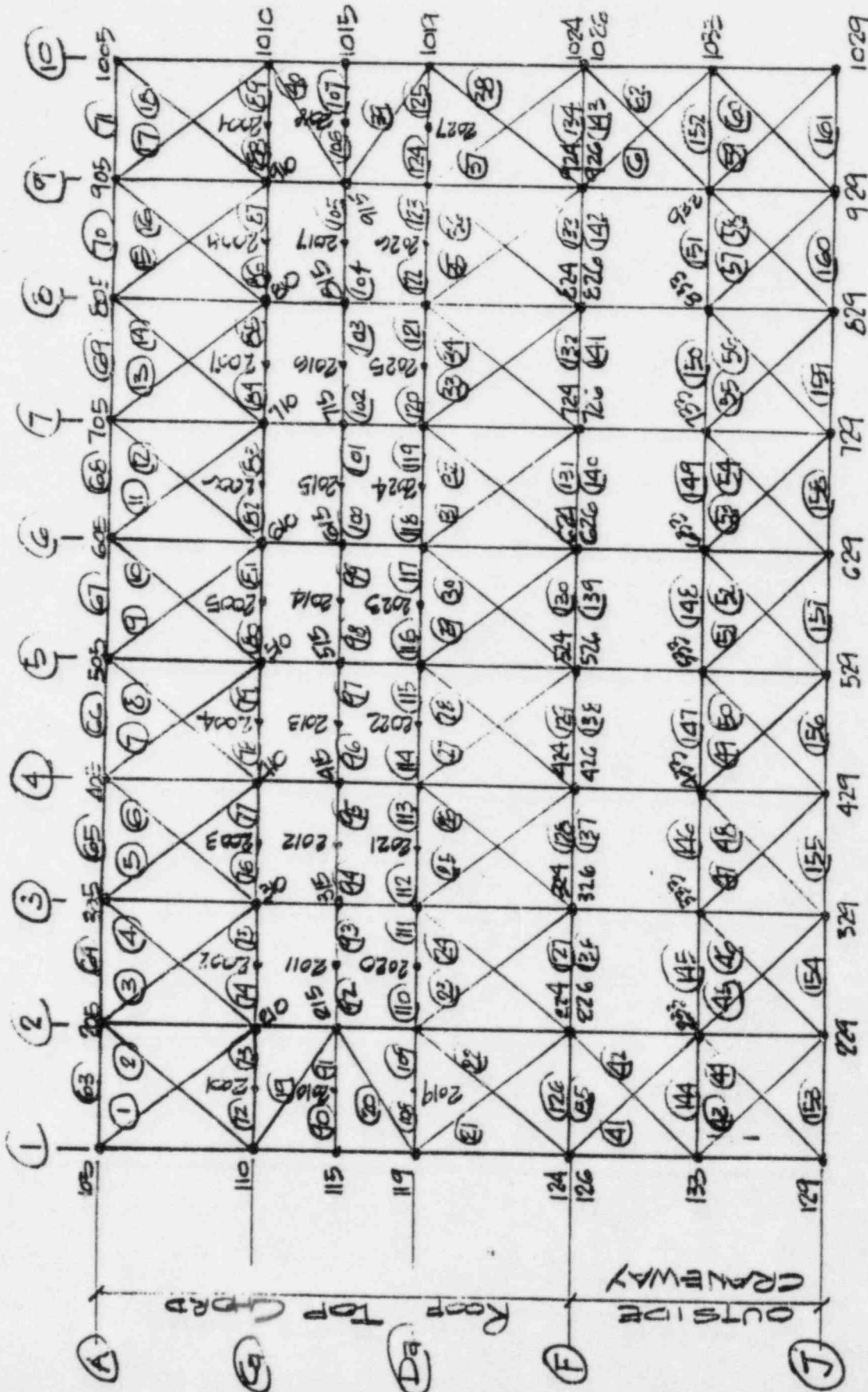
VERTICAL FRAMES @ COLUMN LINES A & F

SUBJECT SEP TOPIC II-2

LA: 82251.07

CALC. NO. C-1302-151-5320-001
 SHEET NO. 8 OF 9
 DATE 11/7/83
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TURBINE BUILDING TORNADO LOADING



PREFIX ALL MEMBER NUMBERS 2000 +

ROOF TOP CHORD HORIZONTAL TRUSS
OUTSIDE CRANEWAY HORIZONTAL TRUSS

SUBJECT **SEP TOPIC III.2 LAI 82251.07**

CALC. NO. **C-1502.151.5320-007**

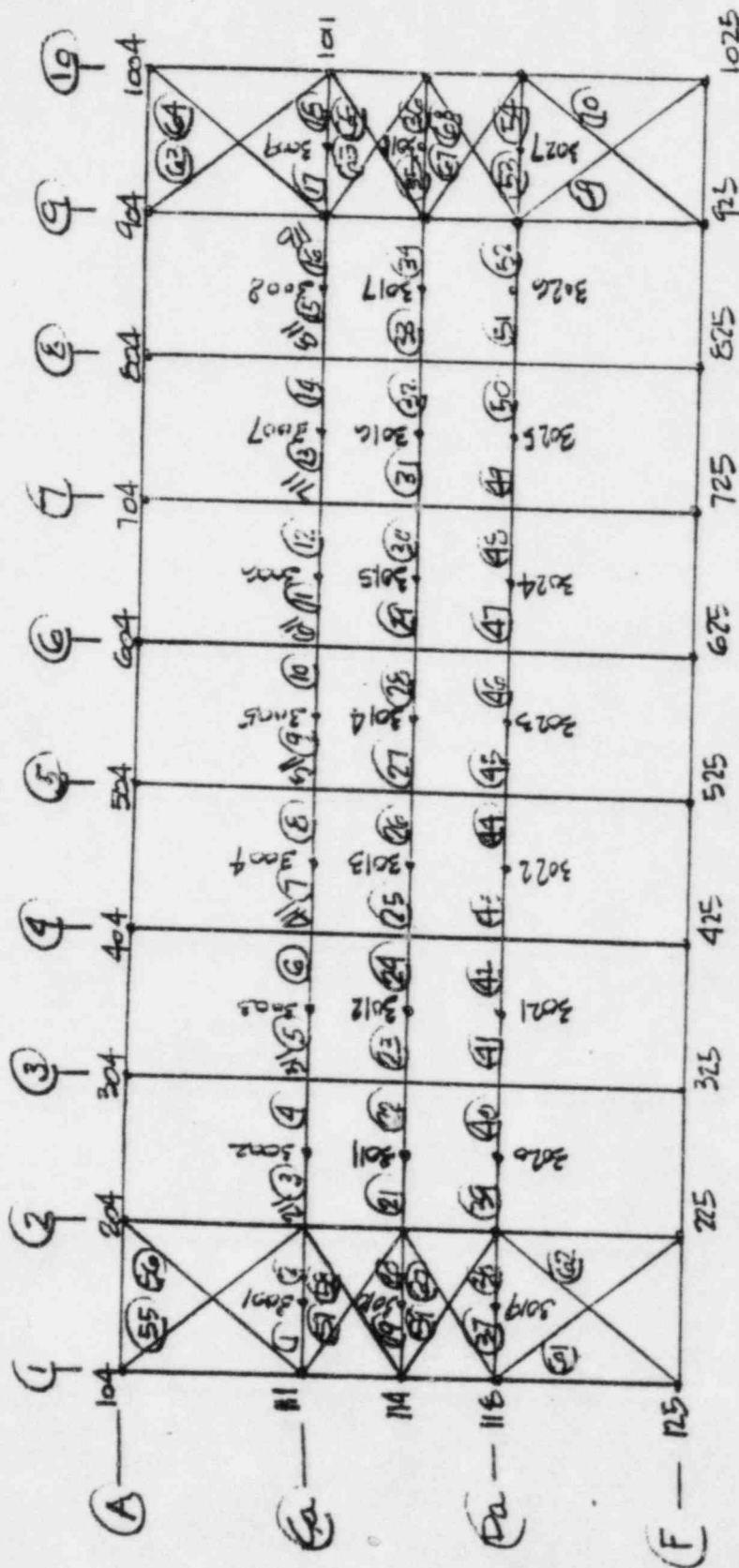
SHEET NO. **9** OF **59**

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COMP. BY/DATE **PH 1/28/83**

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

TURBINE BUILDING TORNADO CAPACITY



PREFIX ALL MEMBER NUMBERS 3000 +
BOTTOM CHORD HORIZONTAL TRUSS

SUBJECT SEP TOPIC III-2 LAI 82251.07

CALC. NO. C-1302151-5320-

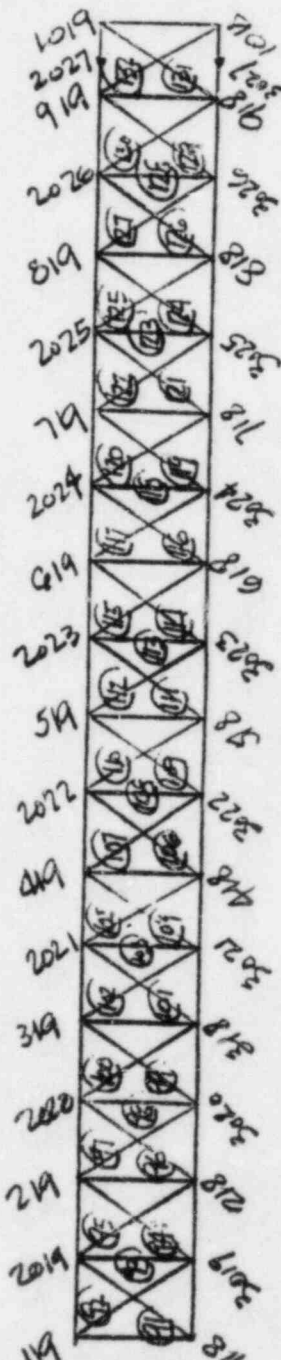
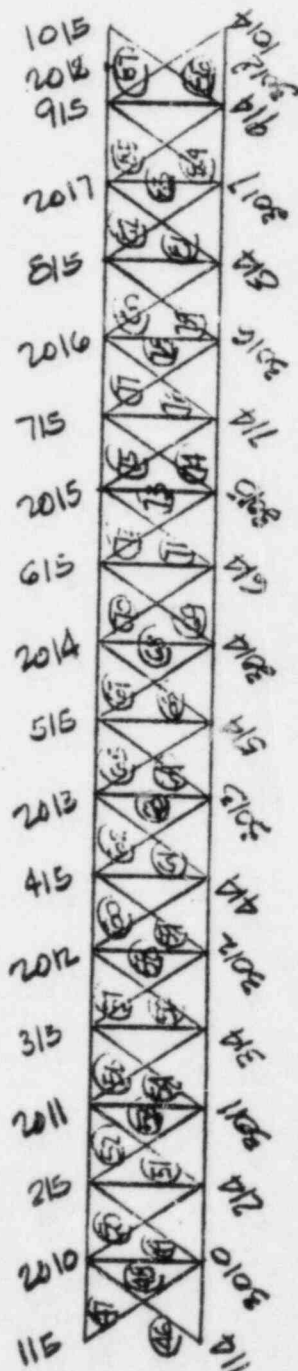
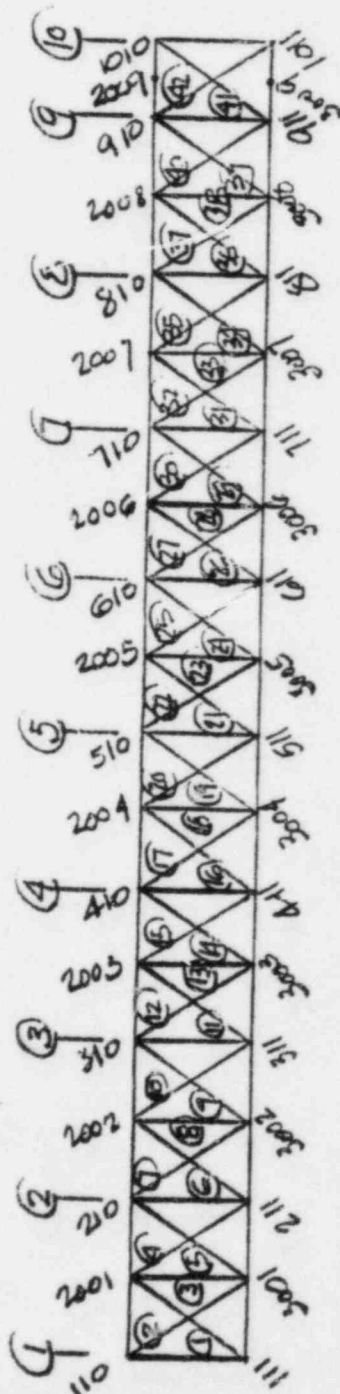
SHEET NO. 10 OF 51

DATE 11/7/83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE DBT 12/21/83

TURBINE BUILDING TORNADO CAPACITY



PREFIX ALL MEMBER NUMBERS 4000 +
ROOF VERTICAL TRUSSES

SUBJECT SEP TOPIC II.2 LAI 82251.07

CALC. NO. C-1302-151-5510-001

SHEET NO. 11 OF 57

DATE 10/24/83

COMP. BY/DATE FH 11/28/83

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

TURBINE DUG TORNADO CAPACITY

TORNADO LOADING

ALLOWABLE STRESS CONC. BEARING

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

$$9.3.2 e \quad \phi = 0.70$$

$$F_p = (0.70)(0.85 \times 5) = 1.785 \text{ ksi}$$

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

$$F_p = (1.785)(2) = 3.57 \text{ ksi}$$

ALLOWABLE STRESS - ANCHOR BOLTS

NUREG 0800 SECT 3.3.4

PARAGRAPH 5.6 for 3.6.(ii)(a)(2)

$$\text{ALLOWABLE} = 1.6S = 1.6 \times 22 = 35.2 \text{ ksi}$$

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

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BULL TORNADO CAPACITY

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

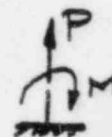
SHEET NO. 12 OF 51

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 $b=26"$ $A_t=5"$
COLUMN LINE A $d=47"$
MEMBER 501 @ JOINT 501LOADING
(a) 17
(b) 187P
93 K T
237 K TM
49245 K
49684 K

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

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

TRY $J = 0.92$

$$L = \frac{1}{(1 - \frac{0.92}{-10.58})} = 0.920$$

$$m = g = 0.03388$$

$$k = 0.2286$$

$$C = 0.924$$

$$f_s = \frac{(95)(-10.58)}{(0.924)(5)(0.920)} = 232.4 \text{ ksi} > 5.2 \text{ ksi}$$

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

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

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

$$L = \frac{1}{(1 - \frac{0.92}{-4.01})} = 0.813$$

$$m = g = 0.02995$$

$$k = 0.2406$$

$$C = 0.918$$

$$f_s = 254.1 \text{ ksi} > 35.2 \text{ ksi}$$

$$f_c = 9.241 \text{ ksi} > 3.57 \text{ ksi}$$

$$\text{OVERSTRESS} = \frac{254.1}{35.2} = 7.219 \leftarrow \text{governs}$$

$$= \frac{9.241}{3.57} = 2.589$$

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

SUBJECT SEP TORC III-2 LAI 82251.07

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SHEET NO. 13 OF 51

DATE 10/24/83

COMP. BY/DATE PH 1/28/83

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TURBINE BULK TORNADO CAPACITY

WIND LOAD COMPONENTS

$$\begin{aligned} P &= DL + 74.2^k(C) - 584.2^k \\ T &= WL - 10.6^k(T) + 3114.3^k \quad (@ 10 \text{ psf STAGNATION PRESS}) \end{aligned}$$

COMBINATION 17 IS BASED ON $1 \times 1.0 + 7 \times 16.0$

$$\text{TRY } 1 \times 1.0 + 7 \times 2.5$$

$$\begin{aligned} P &= (74.2) + (2.5)(-10.6) = 47.7^k \\ M &= -584.2 + (2.5)(3114.3) = 7201.6^k \end{aligned}$$

$$\begin{aligned} e &= 171.98 \quad e/d = 3.66 \\ \text{TRY } j &= 0.92 \quad c = 1.336 \quad m = g = 0.0412 \quad k = 0.268 \quad j = 0.911 \end{aligned}$$

$$f_s = \frac{(47.7)(3.66)}{(0.911)(5)(1.336)} = 28.69 \text{ ksi} < 35.2 \text{ ksi OK}$$

$$\text{TRY } 1 \times 1.0 + 7 \times 3.0$$

$$\begin{aligned} P &= 74.2 + (3)(-10.6) = 42.4^k \\ M &= -584.2 + (3)(3114.3) = 8758.7^k \end{aligned}$$

$$\begin{aligned} e &= 227.6'' \quad e/d = 4.842 \\ \text{TRY } j &= 0.92 \quad c = 1.2346 \quad m = g = 0.0455 \quad k = 0.259 \quad j = 0.913 \end{aligned}$$

$$f_s = \frac{(42.4)(4.842)}{(0.913)(5)(1.2346)} = 36.40 \text{ ksi} > 35.2 \text{ ksi NG}$$

$$\text{TRY } 1 \times 1.0 + 7 \times 2.93$$

$$\begin{aligned} P &= 74.2 + (2.93)(-10.6) = 43.14^k \\ M &= -584.2 + (2.93)(3114.3) = 8540.7^k \end{aligned}$$

$$\begin{aligned} e &= 218.98'' \quad e/d = 4.659 \\ \text{TRY } j &= 0.92 \quad c = 1.246 \quad m = g = 0.0459 \quad k = 0.261 \quad j = 0.913 \end{aligned}$$

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

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

SUBJECT SEP TOPIC III.2 LAI 82251.07

TURBINE BLDG TORNAOO CAPACITY

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

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

CHECK DL + DEPRESSURIZATION

$$P = 276 \text{ K} \\ M = 30479 \text{ K''}$$

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

$$w/\gamma = 0.92 \quad i = \frac{1}{(1 - \frac{0.92}{1.753})} = 0.656 \quad m = \gamma = 0.02226$$

$$k = 0.1899 \quad \gamma = 0.937$$

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

$$\text{OVERSTRESS} \quad 157.43/35.2 = 4.472 \quad \text{--- governs.} \\ 4.10/3.57 = 1.148$$

COMPONENTS

$$\begin{array}{l} \text{1 DL} \quad P = 74.2 \text{ K} \quad M = -584.2 \text{ K''} \\ \text{9 DEP} \quad -13.9 \text{ K} \quad -1186.3 \text{ K''} \quad (\text{BASED 10 PSF}) \\ \quad \quad \quad 1.75 \text{ PSI} = 25.2 \times (10 \text{ PSF DEP}) \end{array}$$

TRY DEP X 5.7

$$P = 74.2 - (5.7)(13.9) = -503 \text{ (T)} \\ M = -584.2 - (5.7)(1186.3) = -7346.1 \text{ K''}$$

SUBJECT SEPTORIC II-2 LAT 82251.07

CALC. NO. C-132151-5320-001

SHEET NO. 15 OF 59

DATE 11/3/83

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

TURBINE BLDG TORNADO CAPACITY

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

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

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

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

TRY DEP x 6.2

$$P = 74.2 - (6.2)(13.9) = -11.98^k \text{ (T)}$$

$$M = -584.2 - (6.2)(1186.3) = -7939.3^k$$

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

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

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

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

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

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

SUBJECT SEP TOPIC III.2 LAI 82251.07

CALC. NO. C-1302-151-0040-001

SHEET NO. 16 OF 59

DATE 11/4/83

COMP. BY/DATE PH 11/28/83

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

TURBINE BLDG TORNADO CAPACITY

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

$$P = 93.7 + (2.93)(-85) = 68.8^{\circ} C$$

$$M = 270.6 + (2.93)(-3297.0) = 9389.8 \text{ k-in}$$

$$e = \frac{9389.8}{68.8} + 21 = 157.47 \quad \phi_d = 3.088$$

$$w_f = 0.92 \quad z = 14243 \quad m \cdot g = 0.0433 \quad k = 0.254 \quad j = 0.915$$

$$f_s = \frac{(68.8)(3.088)}{(0.915)(5)(14243)} = 32.60 \text{ ksi} \quad \{ 35.2 \text{ ksi} \quad \text{OK}$$

$$f_c = \frac{(32.60)(0.254)}{(9)(1-0.254)} = 1233 \text{ ksi} \quad \text{OK}$$

WIND COMBINATION 1 + 8
DOES NOT GOVERN

SUBJECT SEP TOPIC III.2 LAI 82251.07

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DATE 11/3/83

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

TURBINE BLDG TORNADO CAPACITY

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

$$101 \quad P = 41.0 + (13.06)(2.93) = 79.3^k$$

$$M = 81.1 + (1825.4)(2.93) = 5429.5^k$$

$$201 \quad P = 64.9 + (-20.7)(2.93) = 4.2^k$$

$$M = -274.9 + (2612.0)(2.93) = 7378.3^k$$

$$301 \quad P = 64.7 + (-7.97)(2.93) = 41.3^k$$

$$M = -468.5 + (2739.4)(2.93) = 7558.5^k$$

$$401 \quad P = 71.5 + (-9.7)(2.93) = 43.1^k$$

$$M = -552.6 + (2996.9)(2.93) = 8228.3^k$$

$$601 \quad P = 71.8 + (-10.2)(2.93) = 41.9^k$$

$$M = -567.7 + (2999.9)(2.93) = 8222.0^k$$

$$701 \quad P = 69.4 + (-5.5)(2.93) = 53.3^k$$

$$M = -536.4 + (2783.8)(2.93) = 7620.1^k$$

$$801 \quad P = 70.9 + (-11.6)(2.93) = 36.9^k$$

$$M = -481.2 + (2559.8)(2.93) = 7019.0^k$$

$$901 \quad P = 56.6 + (-8.8)(2.93) = 30.8^k$$

$$M = -350.9 + (2110.8)(2.93) = 5833.7^k$$

$$1001 \quad P = 40.7 + (-4.2)(2.93) = 28.4^k$$

$$M = -218.6 + (1799.8)(2.93) = 5054.6^k$$

SUBJECT SEP TOPIC II.2 LAI 82251.07

CALC. NO. C-1301-151-5320-007

SHEET NO. 18 OF 21

DATE 11/3/83

COMP. BY/DATE FH 11/26/83

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

TURBINE BLDG TORNADO CAPACITY

$$b = 26" \quad d = 47"$$

$$101 \quad e = \frac{5429.5}{79.3} + 21 = 89.46" \quad e/d = 1.903$$

$$\omega_j = 0.92 \quad L = 1.9355 \quad m-g = 0.07127 \quad k = 0.313 \quad j = 0.896$$

$$f_s = \frac{(79.3)(1.903)}{(0.896)(5)(1.9355)} = 17.40 \text{ ksi} \quad f_c = 1.881 \text{ ksi}$$

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

$$\omega_j = 0.92 \quad L = 1.025 \quad m-g = 0.0377 \quad k = 0.240 \quad j = 0.920$$

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

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

$$\omega_j = 0.92 \quad L = 1.2690 \quad m-g = 0.0467 \quad k = 0.263 \quad j = 0.912$$

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

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

$$\omega_j = 0.92 \quad L = 1.2563 \quad m-g = 0.0463 \quad k = 0.261 \quad j = 0.913$$

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

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

$$\omega_j = 0.92 \quad L = 1.2486 \quad m-g = 0.04598 \quad k = 0.261 \quad j = 0.913$$

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

$$701 \quad e = \frac{7620}{53.3} + 21 = 163.97" \quad e/d = 3.489$$

$$\omega_j = 0.92 \quad L = 1.358 \quad m-g = 0.0500 \quad k = 0.270 \quad j = 0.910$$

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

SUBJECT SEP TOPIC II.2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. 100-12-2040-001

SHEET NO. 19 OF 51

DATE 11/3/83

COMP. BY/DATE FH 11/25/83

CHK'D. BY/DATE D.B.T. 12/12/83

$$801 \quad e = \frac{7019}{36.9} + 21 = 211.2 \quad \sigma/d = 4.494$$

$$\omega/\delta = 0.92 \quad L = 1.2574 \quad m = g = 0.0463 \quad k = 0.2615 \quad \delta = 0.913$$

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

$$901 \quad e = \frac{58337}{30.8} + 21 = 210.4 \quad \sigma/d = 4.4766$$

$$\omega/\delta = 0.92 \quad L = 1.2586 \quad m = g = 0.04635 \quad k = 0.261 \quad \delta = 0.913$$

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

$$1001 \quad e = \frac{5054.6}{28.4} + 21 = 198.98 \quad \sigma/d = 4.234$$

$$\omega/\delta = 0.92 \quad L = 1.2776 \quad m = g = 0.0470 \quad k = 0.263 \quad \delta = 0.912$$

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

SUBJECT SEP TOPIC II.2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-132/S-5020-001

SHEET NO. 20 OF 31

DATE 11/3/83

COMP. BY/DATE PH 11/28/83

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

$$\begin{aligned}
 128 \quad P &= 50.3 + (8.8)(2.93) = 76.1 \text{ K} \\
 M &= 32.3 + (2099.6)(2.93) = 6184.1 \text{ K} \\
 228 \quad P &= 83.6 + (-16.7)(2.93) = 34.7 \text{ K} \\
 M &= 27.7 + (2266.4)(2.93) = 6668.3 \text{ K} \\
 328 \quad P &= 81.8 + (-7.8)(2.93) = 58.9 \text{ K} \\
 M &= 212.2 + (2350.2)(2.93) = 7098.3 \text{ K} \\
 428 \quad P &= 92.8 + (-9.8)(2.93) = 64.1 \text{ K} \\
 M &= 257.8 + (2460.4)(2.93) = 7466.8 \text{ K} \\
 528 \quad P &= 93.7 + (-10.7)(2.93) = 62.3 \text{ K} \\
 M &= 270.6 + (2495.4)(2.93) = 7582.1 \text{ K} \\
 628 \quad P &= 95.3 + (-9.0)(2.93) = 68.9 \text{ K} \\
 M &= 266.9 + (2411.2)(2.93) = 7331.7 \text{ K} \\
 728 \quad P &= 91.9 + (-10.6)(2.93) = 60.8 \text{ K} \\
 M &= 239.8 + (2256.4)(2.93) = 6851.1 \text{ K} \\
 828 \quad P &= 82.2 + (-8.3)(2.93) = 57.9 \text{ K} \\
 M &= 199.2 + (2089.2)(2.93) = 6315.6 \text{ K} \\
 928 \quad P &= 72.2 + (-5.9)(2.93) = 54.9 \text{ K} \\
 M &= 118.9 + (1832.4)(2.93) = 5487.8 \text{ K} \\
 1028 \quad P &= 50.4 + (-5.6)(2.93) = 34.0 \text{ K} \\
 M &= 285.1 + (1693.6)(2.93) = 5247.3 \text{ K}
 \end{aligned}$$

SUBJECT SEP Tonic III.2 LAI 82251.07

TURBINE BURG TORNADO CAPACITY

CALC. NO. C-1302.151-5326.007

SHEET NO. 21 OF 31

DATE 11/3/83

COMP. BY/DATE TH 11/28/83

CHK'D. BY/DATE DBT 12/14/83

$$b = 21" \quad d = 51" \quad A_T = 5.00 \text{ in}^2$$

$$128 \quad e = \frac{6184.1}{76.1} + 21 = 102.26 \quad e/d = 2.005$$

$$w/y = 0.92 \quad L = 1.848 \quad m = g = 0.0562 \quad k = 0.284 \quad j = 0.905$$

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

$$228 \quad e = \frac{6668.3}{34.7} + 21 = 213.17" \quad e/d = 4.18$$

$$w/y = 0.92 \quad L = 1.2822 \quad m = g = 0.0390 \quad k = 0.243 \quad j = 0.910$$

$$f_s = \frac{(34.7)(4.18)}{(0.910)(5)(1.2822)} = 24.62 \text{ ksi} \quad f_c = 0.878 \text{ ksi}$$

$$328 \quad e = \frac{7098.3}{58.9} + 21 = 141.5 \quad e/d = 2.774$$

$$w/y = 0.92 \quad L = 1.556 \quad m = g = 0.0473 \quad k = 0.264 \quad j = 0.912$$

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

$$428 \quad e = \frac{7466.8}{64.1} + 21 = 137.5 \quad e/d = 2.696$$

$$w/y = 0.92 \quad L = 1.5181 \quad m = g = 0.0462 \quad k = 0.261 \quad j = 0.913$$

$$f_s = \frac{(64.1)(2.696)}{(0.913)(5)(1.5181)} = 24.94 \text{ ksi} \quad f_c = 0.919 \text{ ksi}$$

$$528 \quad e = \frac{7582.1}{62.3} + 21 = 142.70 \quad e/d = 2.798$$

$$w/y = 0.92 \quad L = 1.4899 \quad m = g = 0.0453 \quad k = 0.259 \quad j = 0.914$$

$$f_s = \frac{(62.3)(2.798)}{(0.914)(5)(1.4899)} = 25.60 \text{ ksi} \quad f_c = 0.994 \text{ ksi}$$

$$628 \quad e = \frac{7331.7}{68.9} + 21 = 127.41 \quad e/d = 2.498$$

$$w/y = 0.92 \quad L = 1.5829 \quad m = g = 0.048 \quad k = 0.266 \quad j = 0.911$$

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

SUBJECT SEP TOPIC III-2 LAI 82251.07

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

SHEET NO. 22 OF 59

DATE 11/31/83

COMP. BY/DATE PH 11/28/83

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

TURBINE BUILDING TORNADO CAPACITY

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

$$w/d = 0.92 \quad L = 1.5408 \quad m = g = 0.0469 \quad k = 0.263 \quad j = 0.912$$

$$f_s = \frac{(60.8)(2.621)}{(0.912)(5)(1.5408)} = 22.68 \text{ km} \quad f_c = 0.899 \text{ km}$$

$$\underline{828} \quad e = \frac{6315.6}{57.9} + 21 = 130.48 \quad e/d = 2.5505$$

$$w/d = 0.92 \quad L = 1.5642 \quad m = g = 0.0476 \quad k = 0.265 \quad j = 0.912$$

$$f_s = \frac{(57.9)(2.5505)}{(0.912)(5)(1.5642)} = 20.70 \text{ km} \quad f_c = 0.829 \text{ km}$$

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

$$w/d = 0.92 \quad L = 1.6337 \quad m = g = 0.0497 \quad k = 0.269 \quad j = 0.910$$

$$f_s = \frac{(54.9)(2.372)}{(0.910)(5)(1.6337)} = 17.52 \text{ km} \quad f_c = 0.716 \text{ km}$$

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

$$w/d = 0.92 \quad L = 1.365 \quad m = g = 0.0415 \quad k = 0.250 \quad j = 0.917$$

$$f_s = \frac{(34.0)(3.438)}{(0.917)(5)(1.365)} = 18.68 \text{ km} \quad f_c = 0.692 \text{ km}$$

SUBJECT SEP TOPIC III.2 LAI 82251.07

TURBINE BIDE TORNADO CAPACITY

CALC. NO. C-1302.01-556-007

SHEET NO. 23 OF 59

DATE 11/3/83

COMP. BY/DATE PH 11/28/83

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

$$\begin{aligned} 130 \quad P &= 14.3 + (1.9)(2.93) = 19.9^k \\ M &= 325.1 + (857.5)(2.93) = 1890.3^k \end{aligned}$$

$$\begin{aligned} 230 \quad P &= 19.3 + (1.7)(2.93) = 24.9^k \\ M &= 443.1 + (853.2)(2.93) = 2943.0^k \end{aligned}$$

$$\begin{aligned} 330 \quad P &= 19.5 + (2.0)(2.93) = 25.4^k \\ M &= 486.8 + (887.7)(2.93) = 3087.8^k \end{aligned}$$

$$\begin{aligned} 430 \quad P &= 21.3 + (2.0)(2.93) = 27.2^k \\ M &= 536.9 + (914.2)(2.93) = 3215.5^k \end{aligned}$$

$$\begin{aligned} 530 \quad P &= 22.3 + (2.07)(2.93) = 28.4^k \\ M &= 559.6 + (923.9)(2.93) = 3266.6^k \end{aligned}$$

$$\begin{aligned} 630 \quad P &= 21.6 + (2.0)(2.93) = 27.5^k \\ M &= 547.0 + (896.3)(2.93) = 3173.2^k \end{aligned}$$

$$\begin{aligned} 730 \quad P &= 20.5 + (1.9)(2.93) = 26.1^k \\ M &= 514.1 + (836.8)(2.93) = 2965.9^k \end{aligned}$$

$$\begin{aligned} 830 \quad P &= 19.6 + (1.7)(2.93) = 24.6^k \\ M &= 478.8 + (769.8)(2.93) = 2734.3^k \end{aligned}$$

$$\begin{aligned} 930 \quad P &= 17.6 + (1.5)(2.93) = 22.0^k \\ M &= 425.7 + (686.5)(2.93) = 2437.1^k \end{aligned}$$

$$\begin{aligned} 1030 \quad P &= 12.3 + (1.6)(2.93) = 17.0^k \\ M &= 365.3 + (693.7)(2.93) = 2397.8^k \end{aligned}$$

SUBJECT SEP TOPIC III.2 LAI 82251.07

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

SHEET NO. 24 OF 59

DATE 11/3/83

COMP. BY/DATE PH 11/28/83

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

TURBINE BLDG TORNADO CAPACITY

$$b = 18'' \quad d = 45'' \quad A_T = 3.80''^2$$

$$130 \quad e = \frac{289.3}{19.9} + 19.5 = 164.7 \quad e/d = 3.661$$

$$\omega/f = 0.92 \quad i = 1.3356 \quad m = g = 0.742 \quad k = 0.318 \quad j = 0.694$$

$$f_s = \frac{(19.9)(3.661)}{(0.894)(3.80)(1.3356)} = 16.06 \text{ ksi} \quad f_c = 0.832 \text{ ksi}$$

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

$$\omega/f = 0.92 \quad i = 1.4299 \quad m = g = 0.0794 \quad k = 0.327 \quad j = 0.891$$

$$f_s = \frac{(24.9)(3.060)}{(0.891)(3.80)(1.4299)} = 15.74 \text{ ksi} \quad f_c = 0.850 \text{ ksi}$$

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

$$\omega/f = 0.92 \quad i = 1.4154 \quad m = g = 0.0786 \quad k = 0.326 \quad j = 0.891$$

$$f_s = \frac{(25.4)(3.135)}{(0.891)(3.80)(1.4154)} = 16.62 \text{ ksi} \quad f_c = 0.893 \text{ ksi}$$

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

$$\omega/f = 0.92 \quad i = 1.4298 \quad m = g = 0.0794 \quad k = 0.327 \quad j = 0.891$$

$$f_s = \frac{(27.2)(3.060)}{(0.891)(3.80)(1.4298)} = 17.19 \text{ ksi} \quad f_c = 0.928 \text{ ksi}$$

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

$$\omega/f = 0.92 \quad i = 1.4446 \quad m = g = 0.08025 \quad k = 0.328 \quad j = 0.891$$

$$f_s = \frac{(28.4)(2.989)}{(0.891)(3.80)(1.4446)} = 17.36 \text{ ksi} \quad f_c = 0.941 \text{ ksi}$$

$$630 \quad e = \frac{3173.2}{27.5} + 19.5 = 134.9 \quad e/d = 2.998$$

$$\omega/f = 0.92 \quad i = 1.4428 \quad m = g = 0.08016 \quad k = 0.328 \quad j = 0.891$$

$$f_s = \frac{(27.5)(2.998)}{(0.891)(3.80)(1.4428)} = 16.88 \text{ ksi} \quad f_c = 0.915 \text{ ksi}$$

SUBJECT SEP TOPIC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 25 OF 31
DATE 11/3/85
COMP. BY/DATE PH 11/28/85
CHK'D. BY/DATE DBT 12/12/83

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

$$\omega \quad j = 0.88 \quad z = 1.4233 \quad m = g = 0.0791 \quad k = 0.326 \quad j = 0.891$$

$$f_s = \frac{(26.1)(2.959)}{(0.891)(3.80)(1.4233)} = 16.03 \text{ ksi} \quad f_c = 0.861 \text{ ksi}$$

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

$$\omega \quad j = 0.88 \quad z = 1.4350 \quad m = g = 0.0797 \quad k = 0.321 \quad j = 0.891$$

$$f_s = \frac{(24.6)(2.903)}{(0.891)(3.80)(1.4350)} = 14.70 \text{ ksi} \quad f_c = 0.794 \text{ ksi}$$

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

$$\omega \quad j = 0.88 \quad z = 1.4367 \quad m = g = 0.0798 \quad k = 0.328 \quad j = 0.891$$

$$f_s = \frac{(22.0)(2.895)}{(0.891)(3.80)(1.4367)} = 13.09 \text{ ksi} \quad f_c = 0.710 \text{ ksi}$$

$$1030 \quad e = \frac{2397.8}{17} + 19.5 = 160.55 \quad e/d = 3.5617$$

$$\omega \quad j = 0.89 \quad z = 1.3324 \quad m = g = 0.0740 \quad k = 0.312 \quad j = 0.894$$

$$f_s = \frac{(17)(3.5617)}{(0.894)(3.80)(1.3324)} = 13.40 \text{ ksi} \quad f_c = 0.694 \text{ ksi}$$

SUBJECT SEP TOPIC II-2 LAI 82251.07

TURBINE DUG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-007
SHEET NO. 26 OF 51
DATE 11/3/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE D/B.T. 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}	30.95 ^{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} 1.131 ^{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} 0.944 ^{ksi}	25.60 ^{ksi} 0.994 ^{ksi}	23.17 ^{ksi} 0.961 ^{ksi}	27.68 ^{ksi} 0.899 ^{ksi}	26.76 ^{ksi} 0.619 ^{ksi}	17.51 ^{ksi} 0.76 ^{ksi}	18.66 ^{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} 0.933 ^{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 #2 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

4. 1, 5, 6.

USE $E = 1375 \text{ ksi}$ FOR THESE
ANCHOR BOLTS

SUBJECT SEP TOPIC II.2 LAJ 82251.07

TURBINE BUS TORNADO CAPACITY

CALC. NO. C-801-151-5320.007
 SHEET NO. 27 OF 51
 DATE 11/7/83
 COMP. BY/DATE JH 11/2/83
 CHK'D BY/DATE DBT 12/12/83

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

REF CALC C-1302-151-5320-003
 PP 27-29 (BASED 10 PSP)

			2D		3D (LOAD 7)		
+WL			M	P	M	P	
501 @ 501			3391k	11k T	3114k	11k T	OK
551 @ 504			677k	11k T	556k	11k T	OK
547 @ 528			2860k	11k T	2495k	11k T	OK
546 @ 526			470k	11k T	364k	11k T	OK
548 @ 526			917k		785k		OK
552 @ 529			777k		664k		OK
549 @ 530			1081k	2k T	924k	2k T	OK

					(LOAD 8)		
-WL							
501 @ 501			2357k	9k T	2135k	9k T	OK
551 @ 504			230k	9k T	152k	9k T	OK
547 @ 528			2652k	9k T	3297k	9k T	OK
546 @ 526			964k	9k T	844k	9k T	OK
548 @ 526			891k		773k		OK
552 @ 529			850k		745k		OK
549 @ 530			1231k		1083k		OK

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

SUBJECT SEP TOPIC II.2 LA1 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 28 OF 59
DATE 11/21/83
COMP. BY/DATE FH 11/28/83
CHK'D. BY/DATE D.B.T. 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 T5x3x1/2	+0	+0	OK
DIAGONAL T5x3x5/16	-16	-15	OK
VERTICAL T5x3x5/16	+2	+0	OK
VERTICAL T5x3x3/8	-9	-0	OK
VERTICAL T5x3x3/8	+11	+10	OK
VERTICAL T5x3x3/8	+0	+10	OK
VERTICAL T5x3x3/8	+6	+5	OK
TOP CHORD T8x6x9/16	+0	+0	OK
TOP CHORD T8x6x9/16	+25	+24	OK
TOP CHORD T8x6x5/8	-1	-0	OK
TOP CHORD T8x6x5/8	+13	+13	OK
TOP CHORD T8x6x5/8	-29	-28	OK

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

SUBJECT SEP TOPIC III.2 LAI 82251.07

 CALC. NO. C-302/51-5320-001
 SHEET NO. 29 OF 31
 DATE 11/4/83
 COMP. BY/DATE FH 11/25/83
 CHK'D. BY/DATE DBT 12/12/83

TURBINE BUILDING TORNADO CAPACITY

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
 2003 TO 2010, 2023 TO 2036
 2041 TO 2062

 WT 8 x 18 $A = 5.28 \text{ in}^2$
 L $3\frac{1}{2} \times 3 \times \frac{1}{4}$ $A = 1.56 \text{ in}^2$
 L $6 \times 4 \times \frac{5}{16}$ $A = 3.03 \text{ in}^2$

REVIEW AS TENSION ONLY MEMBERS

 $F_t = 22 \text{ ksi}$ ON GROSS AREA $F_t = 29 \text{ ksi}$ ON EFFECTIVE NET AREA
 WT 8 x 18
 $t_f = 0.430 \text{ in}$

$$P_T = (5.28)(22) = 116.2 \text{ k}$$

$$A_e = C_t A_n$$

$$A_n = 5.28 - (13/16)(0.430)(2) = 4.58 \text{ in}^2$$

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

$$A_e = (0.85)(4.58) = 3.893 \text{ in}^2$$

$$P_T = (3.893)(29) = 112.9 \text{ k} \leftarrow \text{governs.}$$

L $3\frac{1}{2} \times 3 \times \frac{1}{4}$

$$P_T = (1.56)(22) = 34.3 \text{ k}$$

$$A_e = C_t A_n$$

$$A_n = (1.56) - (13/16)(0.75)(1) = 1.357 \text{ in}^2$$

$$C_t = 0.75$$

$$A_e = (0.75)(1.357) = 1.018 \text{ in}^2$$

$$P_T = (1.018)(29) = 29.5 \text{ k} \leftarrow \text{governs.}$$

L $6 \times 4 \times \frac{5}{16}$

$$P_T = (3.03)(22) = 66.66 \text{ k}$$

$$A_e = C_t A_n$$

$$A_n = 3.03 - (13/16)(5/16) = 2.776$$

$$C_t = 0.75$$

$$A_e = (0.75)(2.776) = 2.082 \text{ in}^2$$

$$P_T = (2.082)(29) = 60.4 \text{ k} \leftarrow \text{governs.}$$

SUBJECT **SEP TOPIC II.2 LAI 82251.07**

TURBINE BLDG TORNADO CAPACITY

CALC. NO. **C-7324-61-5320.001**

SHEET NO. **30** OF **51**

DATE **11/4/83**

COMP. BY/DATE **PH 11/26/83**

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

TRUSS DIAGONAL CAPACITIES (TENSION)

$WT\ 8 \times 18 \quad 112.9\ k$
 $L\ 3 \times 3 \times 4 \quad 29.5\ k$
 $L\ 6 \times 4 \times 5 \quad 60.4\ k$

} WORKING STRESS VALUES

REF NUREC 0800 SECT 3.8.4

3C (ii) 2 ALLOWABLE STRESS = 1.6 S

TORNADO COMBIN. CAPACITIES

$WT\ 8 \times 18 \quad P_t = 112.9 \times 1.6 = 180.6\ k$
 $L\ 3 \times 3 \times 4 \quad P_t = 29.5 \times 1.6 = 47.2\ k$
 $L\ 6 \times 4 \times 5 \quad P_t = 60.4 \times 1.6 = 96.6\ k$

2001	2002	2017 TO 2022	2037 TO 2040	180.6 k
2003 TO 2006	2023 TO 2036			47.2 k
2041 TO 2062				96.6 k

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

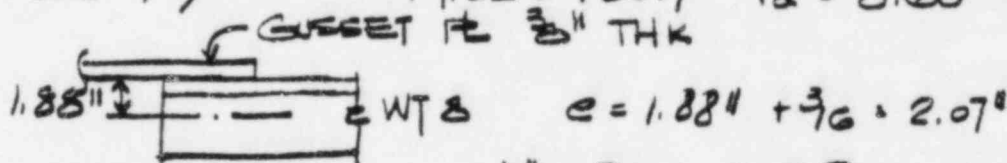
TURBINE BLOS TORNADO CAPACITY

CALC. NO. C-1302-151-5320-001
SHEET NO. 31 OF 59
DATE 11/4/83
COMP. BY/DATE PH 11/26/83
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 = $(16.75^2 + 16^2)^{1/2} = 23.18'$
L(EFF) = 2 TOTAL L SINCE WT 8 IS TACK WELDED TO FURLIN @ INTERSECTION
WT 8x18 A = 5.28" $b_x = 6.985"$ $r_x = 2.41"$ $y = 1.88"$
d = 1.930 $t_f = 0.430"$ $r_y = 1.52"$ $I_y = 12.2 in^4$

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



$M = P_e = 2.07 P$
 $S_t = \frac{30.6}{1.88} = 16.28 in^3$ (COMP'N)
 $S_b = 5.05 in^3$ (TENSION)

DETERMINE F_b

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

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

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

OR $F_b = \frac{(2000)}{(12)(16.56)(7.930)} = 22.87 ksi$

$\frac{P/6.28}{8.60} + \frac{2.07 P/16.28}{22} \leq 1.0$

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

P = 35.97 * COMPIN CAPACITY

$P_a/P_n = \frac{35.97}{5.28} = 0.7970.15 \therefore \text{MUST CHECK 1.6-1a g b}$

SUBJECT SEP TOPK III.2 LAJ 82251.07
TURBINE BUILDING TORNADO CAPACITY

CALC. NO. C-1302 151-5320-007
SHEET NO. 32 OF 59
DATE 11/4/83
COMP. BY/DATE PH 11/20/83
CHK'D. BY/DATE D&T 12/14/83

$$L/r_x = (16.56 \times 12) / 2.41 = 82.5 \quad F'_{cx} = 21.95$$

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

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

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

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

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

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

$$= \frac{191.7 \pm 125.4}{2} = 158.6 \text{ K} \leftarrow 33.2 \text{ K}$$

$$\text{OK } 1.6 \cdot 16 \frac{33.2}{(5.28)(22)} + \frac{(2.07)(33.2)}{(16.28)(22.0)} = 0.304 < 1.0 \text{ OK}$$

FOR TORNADO COMBINATIONS USE $P_c = 33.2 \cdot 1.6 = 53.1 \text{ K}$

CHECK 2039 AND 2070

$$L/r_y = 12 \times 23.16 \times 2 / 1.52 = 91.42 \quad F_a = 14.04$$

$$L/r_t = 12 \times 23.16 \times 2 / 1.871 = 74.27$$

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

$$L/r_x = 12 \times 23.16 \times 2 / 2.41 = 57.7 \quad F'_{cx} = 44.86 \text{ K}$$

SUBJECT SEP TOPIC II.2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5326-001

SHEET NO. 33 OF 59

DATE 11/4/83

COMP. BY/DATE PH 11/28/83

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

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

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

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

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

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

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

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

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

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.

SUBJECT SEP TOPIC II-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

$$\begin{array}{rcl} \underline{2001 + 2002} & 17 & 40.6 + 4.5 = 45.1 \\ & 18 & 44.4 + 69.0 = 108.4 \end{array} \left. \vphantom{\begin{array}{rcl} \underline{2001 + 2002} \\ & 18 \end{array}} \right\} < 180.6 \text{ OK}$$

$$\begin{array}{rcl} \underline{2017 + 2018} & 17 & 125.4 + 89.3 = 194.3 \\ & 18 & 106.0 + 57.6 = 163.5 \end{array} > 180.6 \text{ NG}$$

CHECK ACTUAL CAPACITY

$$P_{OL} = 5.2^k \quad P_{WL} = -6.0^k @ 10 \text{ PSF}$$

$$P_{PL} = 3.5^k \quad P_{WL} = 5.4^k @ 10 \text{ PSF}$$

$$\Delta = 1.7$$

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

$$\begin{array}{rcl} \underline{2019 + 2020} & 17 & 59.5C + 0.6C \\ & 18 & 16.7C + 40.3C \end{array} > P_C = 53.1^k$$

CHECK ACTUAL CAPACITY

$$P_{OL} = 1.8 \quad P_{WL} = 3.6 @ 10 \text{ PSF}$$

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

$$\begin{array}{rcl} \underline{2021 + 2022} & 17 & 58.6 + 37.1 = 95.7 \\ & 18 & 11.7 + 36.5 = 48.2 \end{array} < 180.6 \text{ OK}$$

$$\begin{array}{rcl} \underline{2037 + 2038} & 17 & 57.2 + 4.5 = 61.7 \\ & 18 & 15.5 + 6.0 = 21.5 \end{array} < 180.6 \text{ OK}$$

SUBJECT SEP TOPIC III.2 LAI 82251.07

CALC. NO. C-1304-51-5520-001

SHEET NO. 35 OF 59

DATE 11/4/83

COMP. BY/DATE PH 11/28/83

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

TURBINE BLDG TORNADO CAPACITY

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

L 32x3x4

2003+2004 17 14.4T 0.9T
18 2.0C 25.9T = 27.9 < 47.2K OK

2005+2006 17 21.1T 3.2T
18 2.3T 30.3T < 47.2K OK

2007+2008 17 20.9T 7.4T
18 11.7T 24.6T < 47.2K OK

2009+2010 17 14.7T 13.8T
18 22.5T 14.5T < 47.2K OK

2011+2012 17 9.7T 16.9T
18 30.5T 3.7T < 47.2K OK

SUBJECT SEP TOPIC III.2 LAI 12251.07

TURBINE BLDG TORNADO CAPACITY

$$\begin{array}{rcl} 2013 + 2014 & 17 & 5.7T \quad 14.7T \\ & 18 & 36.2T \quad 7.9C = 44.1^k < 47.2^k \text{ OK} \end{array}$$

$$\begin{array}{rcl} 2015 + 2016 & 17 & 6.0C \quad 17.3T \\ & 18 & 40.7T \quad 20.1C = 60.8^k > 47.2^k \end{array}$$

CHECK ACTUAL CAPACITY

$$P_{PL} = 1.2 \quad P_{WL} = -2.6 @ 10 \text{ PSF}$$

$$P_{DL} = 0.9 \quad P_{WL} = 1.2 @ 10 \text{ PSF}$$

$$\Delta = 0.3$$

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

$$\begin{array}{rcl} 2023 + 2024 & 17 & 28.8T \quad 6.4C = 35.2^k \\ & 18 & 2.6C \quad 10.9T = 13.5^k < 47.2^k \text{ OK} \end{array}$$

$$\begin{array}{rcl} 2025 + 2026 & 17 & 34.8T \quad 3.5C = 38.3^k \\ & 18 & 3.6T \quad 13.6T < 47.2^k \text{ OK} \end{array}$$

$$\begin{array}{rcl} 2027 + 2028 & 17 & 27.7T \quad 5.8T \\ & 18 & 8.8T \quad 12.6T < 47.2^k \text{ OK} \end{array}$$

$$\begin{array}{rcl} 2029 + 2030 & 17 & 15.9T \quad 19.3T \\ & 18 & 14.5T \quad 7.2T < 47.2^k \text{ OK} \end{array}$$

SUBJECT SEP TOPIC II.2 LAI 82251.07

TURBINE BUDS TORNADO CAPACITY

CALC. NO. C-1302-51-5320-001
 SHEET NO. 37 OF 59
 DATE 11/4/83
 COMP. BY/DATE FH 11/26/83
 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 30.6 T = 44.6
 18 10.3 T 0

L 6x4x96 P_T = 96.6

2041 + 2042 17 33.8 T 24.7 C = 58.5
 18 63 C 17.9 T = 24.2 <96.6 OK

2043 + 2044 17 07 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
 18 103 C 11.8 T = 22.1 <96.6

2047 + 2048 17 14.2 T 12.4 C = 26.6
 18 10.8 C 12.1 T = 22.9 <96.6

2049 + 2050 17 8.6 T 7.2 C = 15.8
 18 5.9 C 7.2 T = 13.1 <96.6

2051 + 2052 17 1.7 C 2.3 T = 4.0
 18 3.8 T 1.9 C = 5.7 <96.6

2053 + 2054 17 9.8 C 10.6 T = 20.4
 18 10.4 T 8.7 C = 19.1 <96.6

2055 + 2056 17 15.2 C 16.6 T = 31.8
 18 13.8 T 12.2 C = 26.0 <96.6

2057 + 2058 17 23.0 C 26.7 T = 49.7
 18 21.7 T 21.4 C = 43.1 <96.6

2059 + 2060 17 18.3 T 20.6 C = 38.9
 18 6.8 T 3.8 C = 10.4 <96.6

SUBJECT SEP TOPIC III.2 LAI 82251.07

TURBINE BUDG TORNADO CAPACITY

CALC. NO. C-1302-151-5360-007
 SHEET NO. 38 OF 51
 DATE 11/7/83
 COMP. BY/DATE PH 11/28/83
 CHK'D. BY/DATE DBT 12/12/83

20600 + 2061 17 20.6C 35.4C = 4.8 < 9.6
 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.

SUBJECT **SEPTORC II-2 LAI 82251.07**

 CALC. NO. **C-1302-151-5320-007**
 SHEET NO. **39** OF **59**
 DATE **11/14/83**
 COMP. BY/DATE **PH 11/28/83**
 CHK'D. BY/DATE **DBT 12/12/83**
TURBINE BLDG TORNADO CAPACITY

DETERMINE VELOCITY AT WHICH FRAME COLUMNS WILL CONTACT CONTROL ROOM ROOF

 GAP @ NO LOADING = $2\frac{1}{8}"$

COL LINE	COL LINE (8)	COL LINE (9)	COL LINE (10)
+37.25' 27' D 9' 7 1/2" +27.50' Roof 12.50' +15' 31' D TO ELEVATION 46'-3"	Δ_T $(2.93)(0.1929) = 0.05527$ $\frac{0.56344}{0.61871}"$	$(2.93)(0.17054) = 0.04429$ $\frac{0.4968}{0.54407}"$	$(2.93)(0.17247) = 0.046$ $\frac{0.505}{0.5521}"$
	0.00663 $(2.93)(0.04846) = 0.14151$ $\frac{0.14844}{0.14844}"$	0.00461 $(2.93)(0.04263) = 0.12491$ $\frac{0.12952}{0.12952}"$	0.0078 $(2.93)(0.04065) = 0.1191$ $\frac{0.12693}{0.12693}"$

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

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

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

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

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.

SUBJECT SEP TOPIC III.2 LAI 82251.07

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

SHEET NO. 40 OF 57

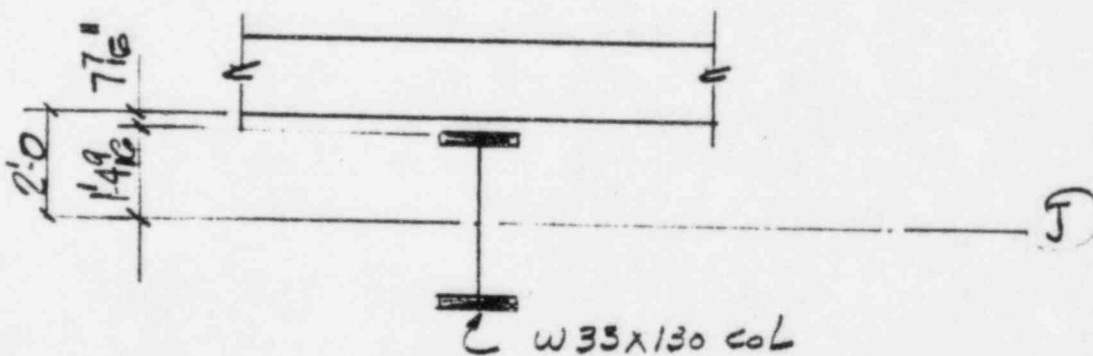
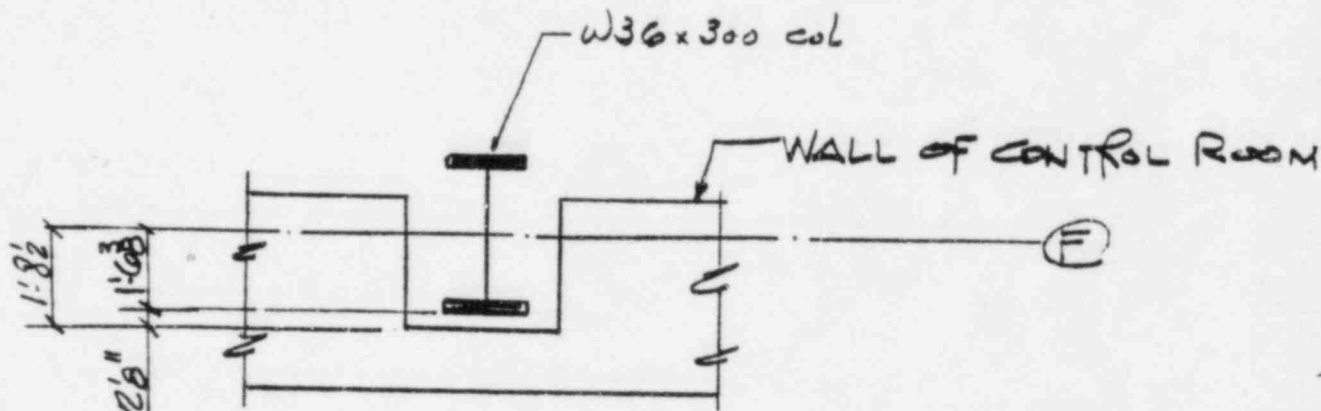
DATE 9-7-83

COMP. BY/DATE PH 11/28/83

CHK'D. BY/DATE D3T 12/12/83

TURBINE BUILDING TORNADO CAPACITY

REF ING 4099



CLEARANCE BETWEEN BUILDING COLUMNS
AND CONTROL ROOM WALLS.

SUBJECT

SEP TOPIC III.2 LA1 82251.07

TORNADO BUILDING TORNADO CAPACITY

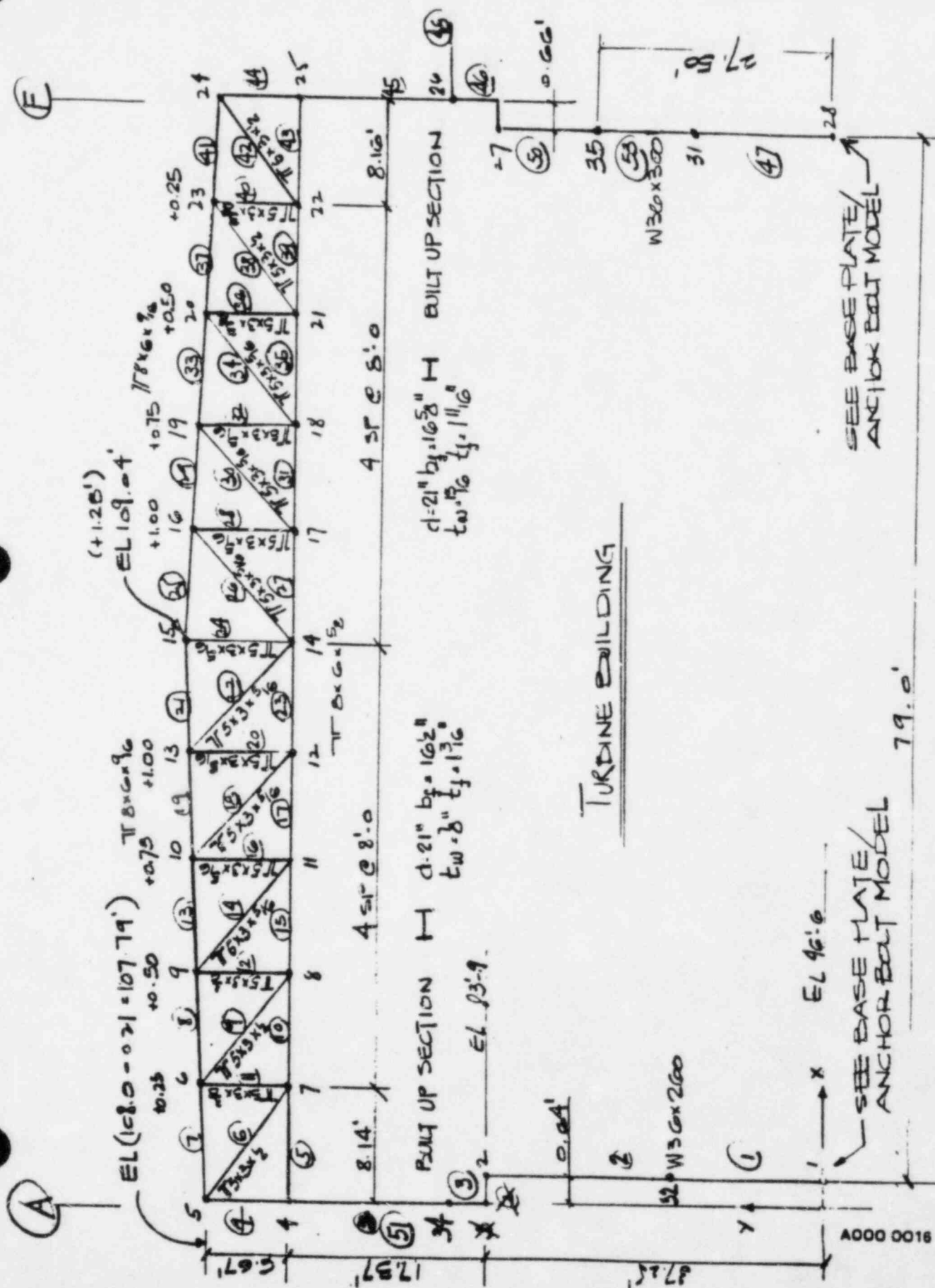
CALC. NO. C-1302 751-5320-007

SHEET NO. 41 OF 59

DATE 9-8-83

COMP. BY/DATE PH 11/26/63

CHK'D. BY/DATE DBT 12/14/83



TYPICAL FRAME COLUMNS 2-9

SUBJECT SEP Topic III-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

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

SHEET NO. 42 OF 59

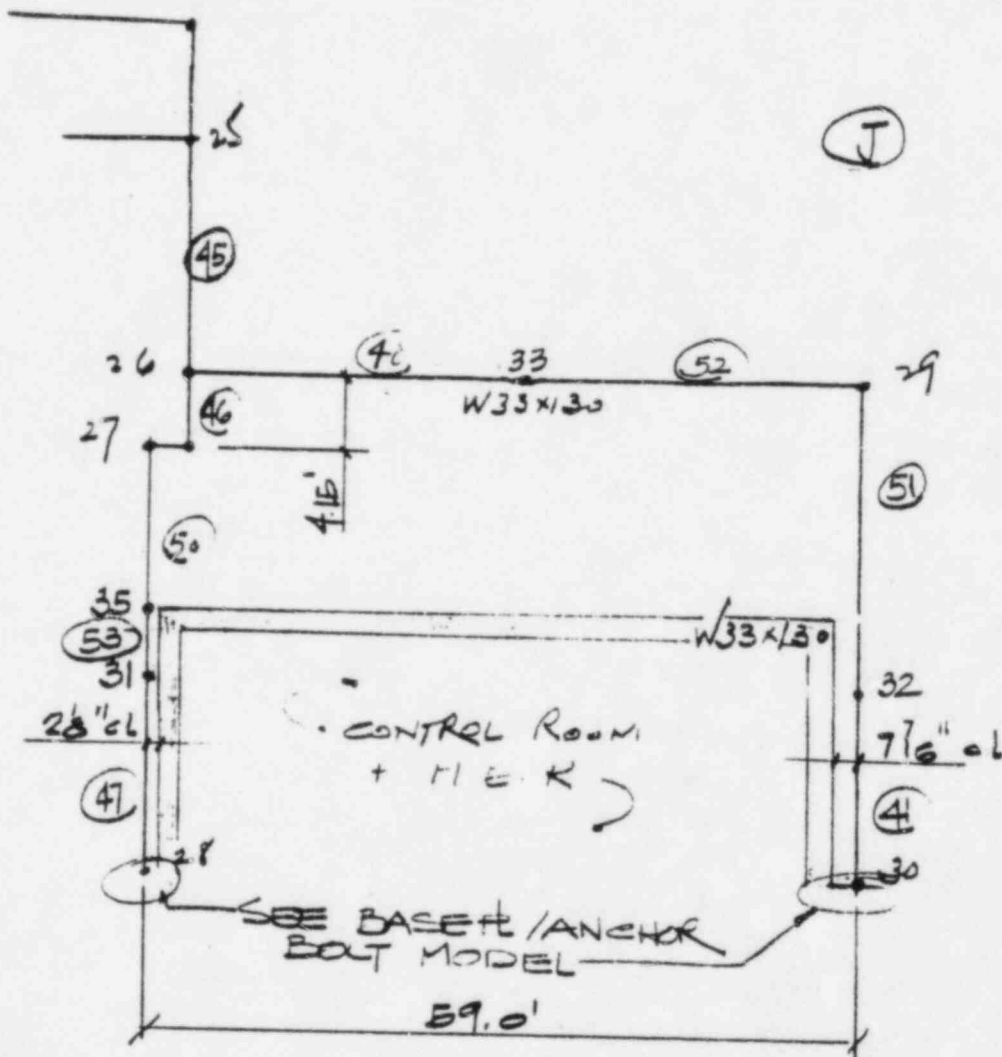
DATE 9-8-83

COMP. BY/DATE PH 11/28/83

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

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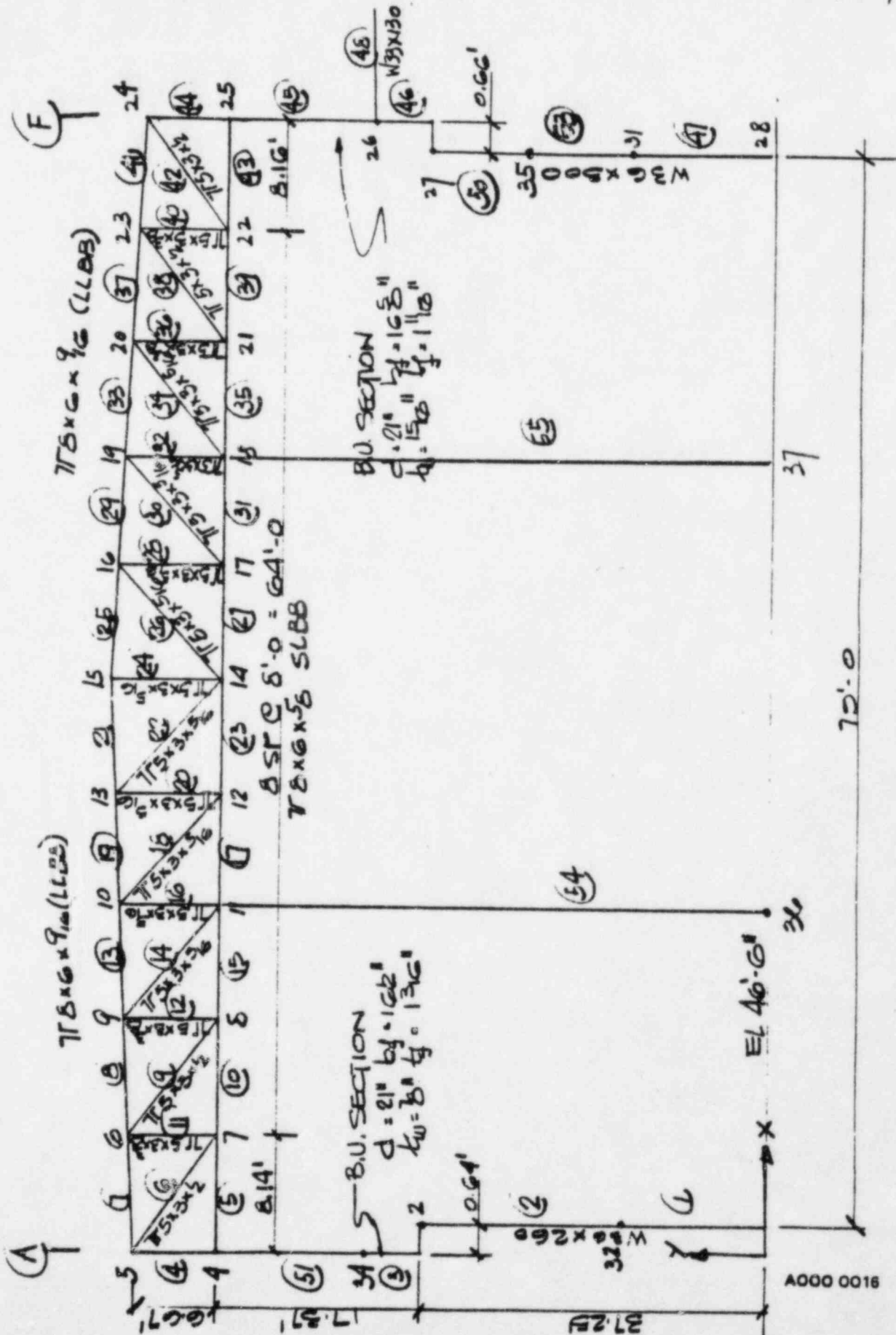
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TURBINE BUILDING

TURBINE BUILDING TORNADO CAPACITY

CALC. NO. 61304.151.5320.001
SHEET NO. 43 OF 59
DATE 11/8/83
COMP. BY/DATE PH 11/28/83
CHK'D BY/DATE DBT 12/12/83

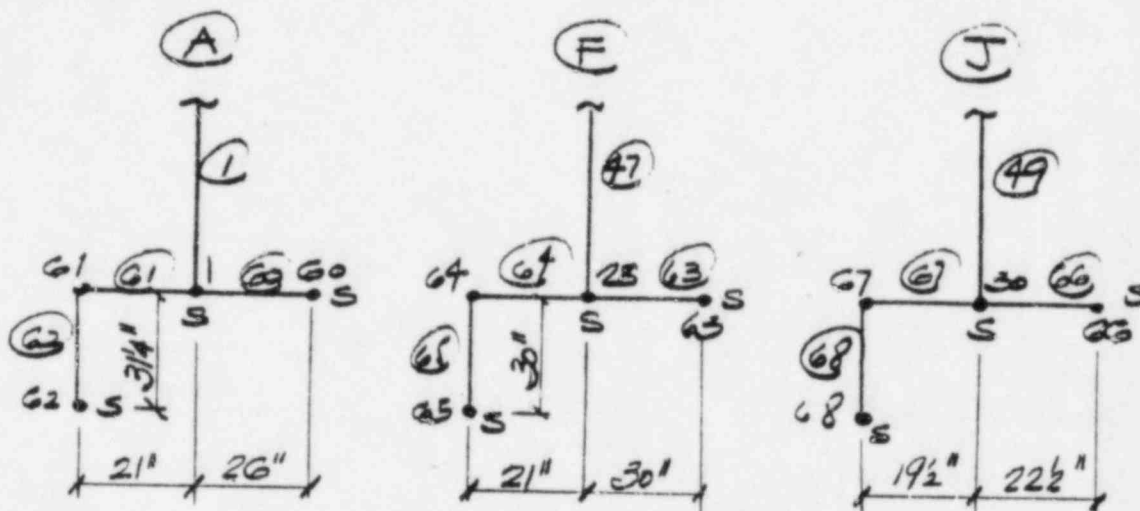


FRAME ON COLUMN LINE 1D
PREFIX ALL JOINT NO'S AND MEMBER NO'S WITH 1000 +

SUBJECT SEP TOPIC II.2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151.532a-007
 SHEET NO. 44 OF 59
 DATE 11/2/83
 COMP. BY/DATE PH 11/20/83
 CHK'D BY/DATE DBT 12/12/83



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

ASSUME THAT BASE PLATE W/36 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
 E 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.

SUBJECT SEP TOPIC II-2 LAI 82251.07

TURBINE BUILDING TORNADO CAPACITY

 CALC. NO. C-1302-515320-001
 SHEET NO. 45 OF 51
 DATE 11/4/83
 COMP. BY/DATE PH 11/28/83
 CHK'D. BY/DATE DBT 12/12/83

TENSILE PROPERTIES

1-11

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 .

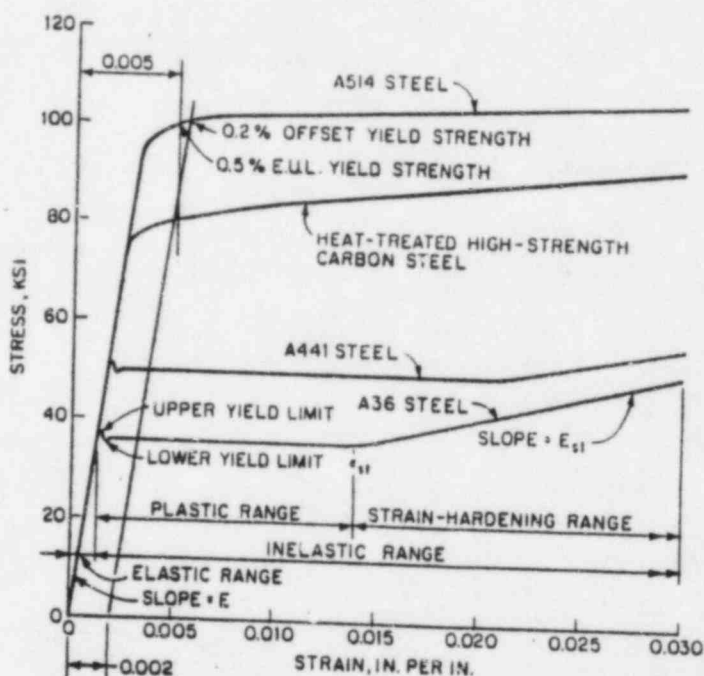


Fig. 1-4 Partial stress-strain curves for structural steels strained through the plastic and into the strain-hardening range. (From R. L. Brockenbrough and B. G. Johnston, "USS Steel Design Manual," U.S. Steel Corporation, with permission.)

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.

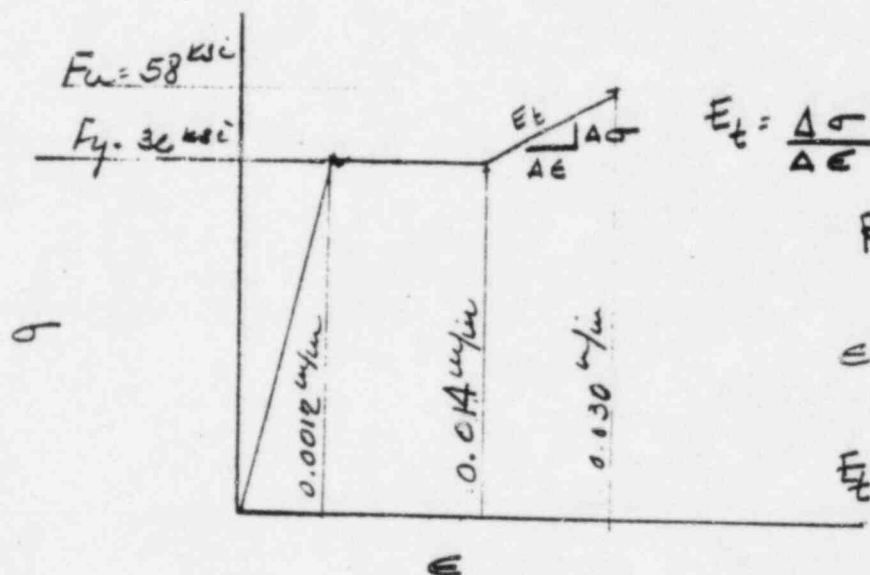
The strains beyond the elastic range in the tension test are termed the "inelastic range." For carbon steel and high-strength, low-alloy steel, this range has two parts. First comes a "plastic range," in which strain increases with no appreciable increase in stress. This is followed by a "strain-hardening 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_u) and the rate at which stress increases with strain in the strain-hardening range (the strain-hardening modulus E_u) have

SUBJECT SEP TOPIC II-2 LAI 92251.07

CALC. NO. C-1302-151-5320-007
 SHEET NO. 46 OF 51
 DATE 9-13-83
 COMP. BY/DATE PH 11/25/83
 CHK'D. BY/DATE DBT 12/12/83

TURBINE BUILDING TORNADO CAPACITY

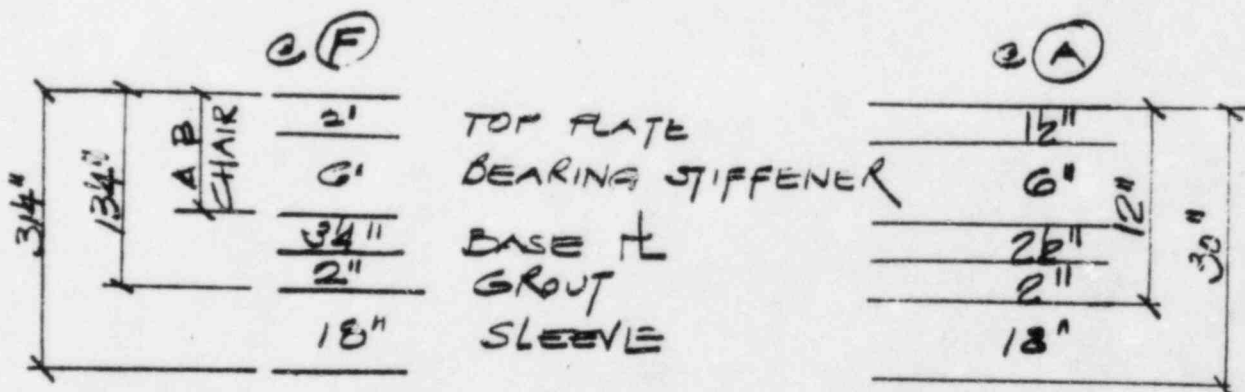


REF "STRUCTURAL STEEL
 DESIGNERS HANDBOOK"
 MERRIT PG 1-11
 $\epsilon = \frac{\sigma}{E} = \frac{36}{29000} = 0.0012$

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

STRUCTURAL STEEL STRESS STRAIN CURVE
FOR ANCHOR BOLTS

LENGTH OF ANCHOR BOLT



ASSUME $L = 3 1/4"$ FOR STRAIN LENGTH FOR BOTH COL'S

$$\Delta F_u \Delta L = (31.25)(0.030) = 0.9375" \text{ EXTENSION}$$

$$\Delta F_y \Delta L = (31.25)(0.0012) = 0.0375" \text{ EXTENSION}$$

SUBJECT SEP TOPIC III.2 LAI 82251.07

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 DIST 12/12/83

TURBINE BLDG TORNADO CAPACITY

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	
①	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	130.0	CAPACIT
②	87.0	168.5	154.9	169.4	176.5	169.9	150.5	144.5	120.0	103.2	107 MPH
③	95.0	11.5	25.1	10.6	3.5	10.1	29.5	35.5	60.0	76.8	RESERV
④	32.1	64.8	61.8	Y	Y	Y	57.3	59.4	40.5	40.5	T/10 PSF
⑤	2.897	0.171	0.406				0.515	0.598	1.290	1.896	RATIO
⑥	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	CAPACIT
⑦	83.4	123.1	115.2	124.7	128.0	119.4	113.4	103.5	87.6	93.4	107 MPH
⑧	96.6	56.9	64.8	55.3	57.0	60.6	66.6	76.5	92.4	86.6	RESERV
⑨	34.5	55.9	49.7	52.9	59.0	46.7	52.3	43.0	37.1	36.3	T/10 PSF
⑩	2.800	1.018	1.304	1.075	0.963	1.278	1.276	1.779	2.491	2.326	RATIO
⑪	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	CAPACIT
⑫	61.0	59.8	63.2	65.3	66.0	64.1	60.9	55.9	49.7	50.9	107 MPH
⑬	75.8	77.0	73.6	71.5	70.8	72.7	75.9	80.9	87.1	85.9	RESERV
⑭	19.8	19.9	21.0	22.1	22.5	21.5	19.4	17.5	15.6	15.9	T/10 PSF
⑮	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
 1341 ϕ

(5.0)(36) = 180.0K
 (3.8)(36) = 136.8K

COL LINES ① & ⑥
 COL LINE ⑪

CHECK ANCHOR BOLT EXTENSION ON A-4, 5 & 6 TO BE SURE THAT ULTIMATE STRAIN HAS NOT BEEN REACHED

JOINT	Δy			
461	0.00017"	/10 PSF <	0.9375"	OK
561	0.00323"	/10 PSF <	0.9375"	OK
661	0.00000"	/10 PSF <	0.9375"	OK

SUBJECT SEP TORC III-2 LAI 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1312-151.1320-001
 SHEET NO. 46 OF 59
 DATE 11/11/83
 COMP. BY/DATE FH 11/26/83
 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
5.15 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.

SUBJECT

SEP TOPIC II-2 LAI 82251.07

 CALC. NO. C-1302-19-5320-007
 SHEET NO. 41 OF 59
 DATE 11/15/83
 COMP. BY/DATE FH 11/28/83
 CHK'D BY/DATE DBT 12/12/83

TURBINE BURG TORNADO CAPACITY

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 "PHSTR L9"

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	
(A)	180.0	180.0	180.0	80.0	180.0	80.0	180.0	180.0	180.0	180.0	CAPACIT
	87.0	168.5	154.9	69.4	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 MPH
	92.7	180.0	165.8				160.6	155.0	128.2	110.9	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
	83.1	123.1	115.6	124.7	128.0	119.4	113.4	103.5	87.6	73.4	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 MPH
	89.5	133.0	124.0	134.1	137.6	127.7	122.6	111.1	94.2	79.8	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	67.3	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	50.9	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 MPH
	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
 $V = 121 \text{ MPH}$

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	0.0933	0.0946	0.0927	0.0353	0.0340
TOTAL Δ	0.0404	0.0400	0.0933	0.0946	0.0927	0.0353	0.0340

Δ ALLOW = 0.9375" ∴ OK

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

SUBJECT SEP TOPIC II-2 LAI 82251.07

 CALC. NO. C-1302-151-5320-007
 SHEET NO. 50 OF 59
 DATE 11/16/83
 COMP. BY/DATE FH 11/20/83
 CHK'D. BY/DATE DBT 12/12/83

TURBINE BLOS TORNAOO CAPACITY

	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 MP
	27.8									29.1	Δ TO 12
	120.5									139.5	121 MP
	59.5									40.5	RESERV
	55.5									55.0	T/10 FS
	1.072									0.734	RATIO
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	122.6	111.1	94.2	99.8	110 MP
	29.0	44.1	40.1	42.0	42.4	37.2	40.9	34.2	29.4	27.8	Δ TO 12
	118.5	177.1	164.1	176.1	180.0	164.9	143.5	145.3	123.6	127.6	121 MP
	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/10 FS
	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	60.9	69.2	70.0	67.9	64.3	59.0	52.5	53.7	110 MP
	16.2	16.2	16.7	12.2	12.2	16.5	15.1	13.7	12.0	12.0	Δ TO 12
	80.7	79.5	83.6	56.4	87.2	84.4	79.4	72.7	64.5	65.7	121 MP
	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 FS
	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 MP
 $V = 132.3 \text{ MPH}$

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

JOINT	301	361	401	561	661	761	861
Δ 121 MPH	0.0404	0.0400	0.0540	0.0558	0.0533	0.1353	0.0040
Δ TO 132 MPH	0.0772	0.0557	0.0601	0.0613	0.0582	0.0469	0.0531
Δ @ 132 MPH	0.0476	0.0957	0.1141	0.1171	0.1115	0.0822	0.0571

ALLOW = 0.9375" ∴ OK

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

SUBJECT SEP TOPIC II.2 LAI 82251.07

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

TURBINE BLDG TORNAIDO CAPACITY

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

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	
	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	76.7	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 1013
	105.9	105.5	111.2	114.9	115.5	111.1	103.2	93.5	82.2	83.4	1321
	30.9	31.3	28.6	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 PSI
	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 = 4.75 PSF
 VELOCITY = 139.2 MPH

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

JOINT	231	361	461	561	661	761	861
Δ 132 MPH	0.0476"	0.0957"	0.1411"	0.1171"	0.1115"	0.0822"	0.0571"
Δ 1013.2	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

 $\uparrow < 0.9375" \therefore \text{OK}$

CONSIDER ALL BOLTS YIELDED

 + ANALYZE CASE WITH RIGID SUPPORT
 AT 835 935 1035

SUBJECT SEP TOPIC III-2 LAI 82251.07

 CALC. NO. 6.1301.151.52.60-001
 SHEET NO. 52 OF 59
 DATE 11/24/83
 COMP. BY/DATE PH 11/28/83
 CHK'D. BY/DATE DBT 12/12/83

TURBINE BLDG TORNADO CAPACITY

ALL ANCHOR BOLTS YIELDED

JOINT DISPLACEMENT - 835 @ CONTROL ROOM ROOF

$$\Delta \text{ FOR 10 PSF} = 0.64868''$$

$$\Delta \text{ CLEAR} = 0.945''$$

$$\text{ADJL WIND LOAD CAPACITY} = \frac{0.045}{0.64868} = 14568 \times 10$$

$$= 14.57 \text{ PSF}$$

$$P = (0.00256)(139)^2 + 14.57 = 64.03 \text{ PSF}$$

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

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

$$\Delta = 0.1610' (0.139 \text{ MPH})$$

$$\Delta = \frac{0.1608}{0.3218''} (1.457)(0.11039)$$

$$< 0.9375'' \therefore \text{ANCHOR BOLTS ARE BELOW ULTIMATE CAPACITY}$$

SUBJECT SEP TOPIC III.2 LAI 82251.07

TURBINE BURG TORNADO CAPACITY

CALC. NO. 1206-101-0260-001
SHEET NO. 53 OF 59
DATE 11/18/83
COMP. BY/DATE FH 11/28/83
CHK'D BY/DATE DBT 12/12/83

CHECK COLUMN A-B FOR COMBINED LOADING
501 @ 501

		WL VELOCITY (MPH)						
DL		107	110	121	132	139	158	
P	74.2	-10.6	-10.2	-10.6	-10.7	-11.1	-11.5	10 PSF WIND PRESS
M	-584.1	+3114.3	+537.6	+604.6	+780.9	+879.9	+1104.9	
		2.93	2.177	0.644	0.736	0.478	1.457	WL FACTORS INCREMENTAL LOADING
P	74.2	-31.1	-1.8	-6.8	-7.9	-5.3	-16.7	
M	-584.1	+924.9	+95.2	+389.4	+574.7	+422.6	+1609.8	
P	74.2	43.1	41.3	34.3	26.6	21.3	4.6	SUMMARY - LOADINGS
M	-584.1	8540.8	8636.0	9025.4	9600.1	10020.7	11630.5	

$F_a = 18.05 \text{ ksi}$ $F_b = 24 \text{ ksi}$

@ 129 MPH

$f_a = \frac{21.3}{76.5} = 0.28 \text{ ksi}$

$f_a/F_a = 0.016 < 0.150$

$f_b = \frac{10020.7}{953} = 10.51 \text{ ksi}$

$f_b/F_b = 0.438$

$0.454 < 1.00 \text{ OK}$

WITHOUT CONSIDERING
1.6 FACTOR

@ 158 MPH

$f_a = \frac{4.6}{76.5} = 0.06 \text{ ksi}$

$f_a/F_a = 0.003$

$f_b = \frac{11630.5}{953} = 12.20 \text{ ksi}$

$f_b/F_b = 0.508$

$0.511 < 1.00 \text{ OK}$

W/O CONSIDERING
1.6 FACTOR

SUBJECT SEI Topic II.2 LAS 82251.07

TURBINE BLDG TORNADO CAPACITY

CALC. NO. C-1302-151-5360-001
 SHEET NO. 54 OF 54
 DATE 11/21/83
 COMP. BY/DATE PH 11/26/83
 CHK'D. BY/DATE DBT 12/12/83

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

$$\begin{aligned} P &= \overset{158 \text{ MPH}}{4.6} + \overset{\text{TO } 212 \text{ MPH}}{(-11.6)(5.153)} = -55.2^k \quad (\text{TENSION}) \\ M &= 11620.5 + (1218.6)(5.153) = 17909.9^k\text{-ft} \end{aligned}$$

$$f_a = 55.2 / 76.5 = 0.72^k\text{-ft} \quad f_b / F_b = 0.72 / 2.2 = 0.032$$

$$f_b = 17909.9 / 953 = 18.79^k\text{-ft} \quad f_b / F_b = 18.79 / 24 = 0.783$$

$$0.815$$

$$< 1.600$$

OK

COLUMN A-5 STRESS @ BASE - OK

SUBJECT SEP TOPIC III-2 LAI 82251.07

CALC. NO. 6-1204-101 0240-001
SHEET NO. 55 OF 59
DATE 11/8/83
COMP. BY/DATE JH 11/28/83
CHK'D. BY/DATE DBT 12/12/83

TURBINE BLDG TORNADO CAPACITY

ANALYSIS DEFLECTION SUMMARY

CLOSURE OF GAP BETWEEN STEEL COLUMN
AND CONTROL ROOM ROOF (28" ORIGINAL CLEARANCE)

STRESS STATE	VELOCITY	Δ 83'	AVAIL CLEAR
FIRST ANCHOR BOLT REACHES ALLOWABLE STRESS (Δ CLWL)	107 MPH (29.3 PSF)	0.413"	1.712"
COL'S A-4, 5 & 6 YIELDED \rightarrow 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 \rightarrow 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 \rightarrow 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 \rightarrow 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"

SUBJECT SEP TOPIC II-2 LAI 82257.07

CALC. NO. C-1302-151-5320-001

SHEET NO. 56 OF 57

DATE 11/21/83

COMP. BY/DATE PH 11/28/83

CHK'D BY/DATE D.B.T. 12/12/83

TURBINE BLDG TORNADO CAPACITY

AFTER CONTACT WITH CONTROL ROOM/NER 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: $12.7 \times 5.7/10 = 7.2K$

935 R: $6.7 \times 5.7/10 = 3.8K$

1035 R: $10.0 \times 5.7/10 = 5.7K$

16.7K ROOF SHEAR AT POINT
OF SIDING FAILURE.

SUBJECT SEP TOMIC III.2 LAT 82251.07

TURBINE BLOS TORNADO CAPACITY

ESTIMATE FAILURE VELOCITY BASED ON NO SIDING FAILURE

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

$$\Delta @ 155 \text{ MPH} = 0.3218''$$

$$\Delta / 10 \text{ PSF w/ STEEL CONTACT @ ROOF} = 0.11944''$$

$$\Delta @ \text{ULTIMATE} = 0.9375''$$

$$P (\text{EXC'D}) = \frac{(0.9375 \cdot 0.3218)}{0.11944} = 5.153 \times 10 = 51.53 \text{ PSI}$$

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

REACTION AT CONTROL ROOM/MER ROOF @ ULTIMATE

$$P = 16.7 + (5.153)(12.7 + 6.7 + 10.0) = 168.2 \text{ K}$$

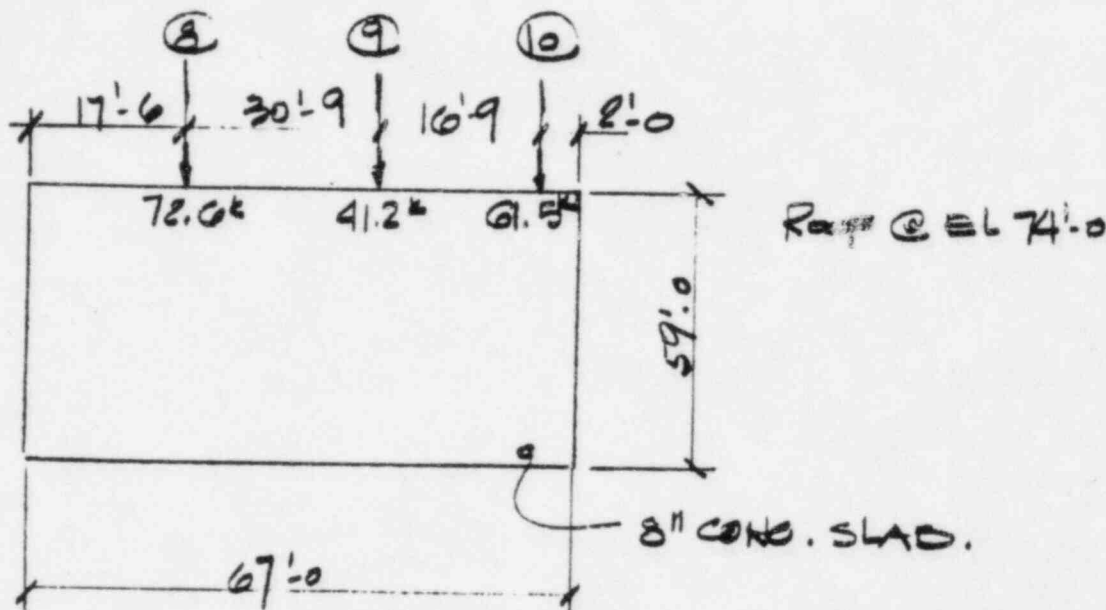
COMPARE SHEAR TO DESIGN CAPACITY AS VERIFIED BY CALCULATION FOR ADDITION OF CABLE

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

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

TURBINE BLDG TORNADO CAPACITY

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 PG 27)

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

DUE TO FRAME REACTIONS

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

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

$$V_{\text{EAST}} = (0.236)(168) + (0.011084)(4633) = 39.6 \text{ k}$$

$$V_{\text{WEST}} = (0.764)(168) + (0.011046)(4633) = 179.8 \text{ k}$$

FROM REF 12

$V_{\text{NORTH}} = 62 \text{ k}$	$> 27.7 \text{ k}$	OK
$V_{\text{SOUTH}} = 42 \text{ k}$	$> 27.7 \text{ k}$	OK
$V_{\text{EAST}} = 170 \text{ k}$	$> 39.6 \text{ k}$	OK
$V_{\text{WEST}} = 414 \text{ k}$	$> 179.8 \text{ k}$	OK

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

SUBJECT SEP TOPIC III.2 LAI 82251.07

TURBINE FLODS TORNADO LOADING

CALC. NO. C-1502-151-5320-001
SHEET NO. 59 OF 59
DATE 11/21/83
COMP. BY/DATE PH 11/28/83
CHK'D BY/DATE DBT 12/1/83

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-1502-151-5320-003, 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 ONE EARTH QUAKE AND THEREFORE NEED NOT BE ANALYZED.

ATTACHMENT II

TURBINE BUILDING: WIND LOAD COMBINATIONS

SUBJECT SEP TOPIC III.2 LAI 82251.09
WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. G-1302-151-5320-006
 SHEET NO. 1 OF 57
 DATE 10/19/83
 COMP. BY/DATE PH 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 29.3 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

ECT SEP TOFC III.2 LAT 82251.09

CALC. NO. C-1302-151-5320-006
 SHEET NO. 2 OF 51
 DATE 10/19/83
 COMP. BY/DATE AH 11/15/83
 CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS TURBINE BLDG

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

SUBJECT SEP TOPIC II.2 LAI 82251.09

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

SHEET NO. 3 OF 57

DATE 8/21/83

COMP. BY/DATE PH 11/18/83

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

WIND LOAD COMBINATIONS

TURBINE BUILDING

REFERENCES

- ① NUREG 0800 "3.8.4 OTHER SEISMIC CATEGORY I STRUCTURES"
- ② ANSI ASS.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 "BC300006"
- ⑧ COMPUTER OUTPUT "BCA1JVT" (TURBINE BUILDING)
- ⑨ COMPUTER OUTPUT "BC300DCJ" (TURBINE BLDG BASE FB)
- ⑩ SEP TOPIC II-2.A SEVERE WEATHER PHENOMENA
- ⑪ ACI 341-79 "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 FINNETD 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

SUBJECT SEP TOPIC II:2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BUILDING

CALC. NO. C-1302-151-5320-06

SHEET NO. 4 OF 57

DATE 7-25-83

COMP. BY/DATE PH 11/6/83

CHK'D BY/DATE D.B.T. 11/22/83

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

	COMB	LIMIT
(3)	D+L+W	S
(2)	D+L+W + R ₀ + W	1.55

D = STRUCTURE DEAD LOAD. NO EQUIPMENT LOADS ARE APPLICABLE

L = SNOW LOAD P_g = 20 PSF (REF ANSI A58.1-82)T₀ = OPERATING THERMAL EFFECTS - NONE PRESENTR₀ = 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

SUBJECT ~~SEP~~ TOPIC II-2 LAF 82251.09

CALC. NO. C-1302-151.5320-0060

SHEET NO. 5 OF 57

DATE 7/5/83

COMP. BY/DATE PH 11/18/83

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

WIND LOAD COMBINATIONS TURBINE BLDG

TURBINE BUILDING STEEL FRAME

LOADING CONDITION

D+L+W

WHERE "L" INCLUDES SNOW LOADING

SNOW $P_g = 20$ PSF (REF II)

REF ANSI A58.1-1982, SECTION 7

$$P_f = 0.7 C_e C_t I P_g$$

$$C_e = 1.0 \text{ TABLE 18 } *$$

$$C_t = 1.0 \text{ TABLE 19}$$

$$I = 1.2 \text{ TABLE 20 CATEGORY III}$$

$$P_f = (0.7)(1.0)(1.0)(1.2)(20) = 16.8 \text{ PSF}$$

* 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

$$P_f \geq P_g I = (20)(1.2) = 24 \text{ PSF} \leftarrow \text{GOVERNS}$$

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

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

ANSI A58.1-1982

$$q_z = 0.0025 C K_z (IV)^2$$

$$V = 80 \text{ MPH}$$

$$I = 1.1 \text{ TABLE 5 CATEGORY III AT OCEAN LINE}$$

K_z FROM TABLE 6

$$q_z = (0.0025)(1.1)(80)^2 K_z = 20.19 K_z$$

SUBJECT SEP TOPIC II-2 LAI 82251.09

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

SHEET NO. 6 OF 57

DATE 7/5/83

COMP. BY/DATE PH 11/18/83

CHK'D BY/DATE D.B.T. 11/22/83

WIND LOAD COMBINATIONS TURBINE BLDG

FOR MAIN FRAME ANALYSIS

$P = q_z G_H C_p$ FOR WINDWARD WALL

$$G_H = G_{H,5} = 1.174$$

$$C_p = 0.80$$

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

$P = q_h G_H C_p$ FOR LEEWARD WALL

$$G_H = G_{H,5} = 1.174$$

$$C_p = -0.50$$

$$q_h = q_{h,5} = (20.19) K_{z,5} = (20.19)(1.3225) = 26.70 \text{ psf}$$

$$P = (26.70)(1.174)(-0.50) = -15.67 \text{ psf}$$

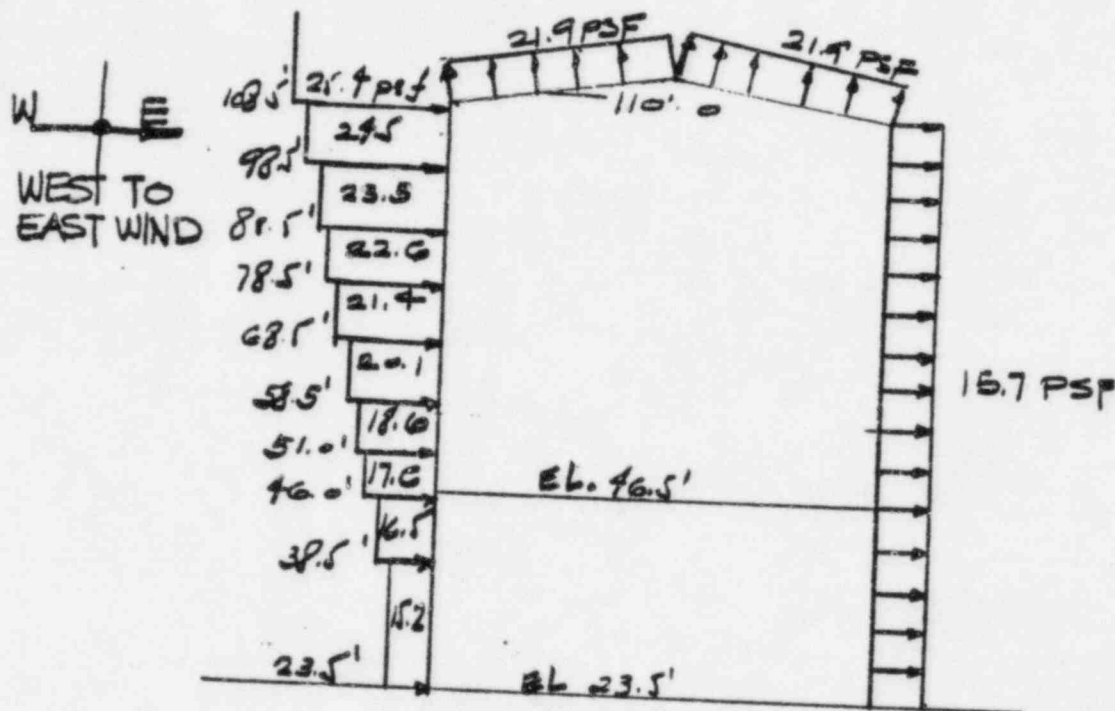
HGT ABOVE GRADE	K_z	WINDWARD $P, 18.96 K_z$	LEEWARD	ACTUAL ELEV.
0-15	0.80	15.2	-15.7	23.5 - 38.5
20	0.87	16.5	↑	43.5 46
25	0.93	17.6		48.5 51
30	0.98	18.6		53.5 58.5
40	1.06	20.1		63.5 68.5
50	1.13	21.4		73.5 78.5
60	1.19	22.6		83.5 88.5
70	1.24	23.5		93.5 98.5
80	1.29	24.5	↓	103.5 108.5
90	1.34	25.4	-15.7	113.5

ROOF SUCTION

$$P = q_h G_H C_p = (26.70)(1.174)(-0.7) = -21.9 \text{ psf}$$

SUBJECT SEP TOPIC III-2 LAI 82251-09

WIND LOAD COMBINATIONS TURBINE BLDG



TURBINE BLDG WIND LOADING (80 MPH)

LOADING FOR COMPUTER MODEL

ROOF SUCTION

$P = (21.9 \times 35.125)(8) = 6154\#$ @ EACH INTERIOR PANEL POINT (JOINTS 6, 9, 10, 13, 15, 16, 19, 20, 23)
 $P = 2 \times 6154 = 3077\#$ @ EACH EXTERIOR PANEL POINT (JOINTS 5 & 24)

WINDWARD WALL LATERAL FORCE
 APPLY CONCENTRATED LOADS AT GIRT BEV.

ELEV
 109' 3 1/2
 100' 7
 93' 2 1/2
 85' 10
 78' 3
 70' 6
 62' 8
 54' 10
 CONCR. 46' 6

CT SEP TOPIC II.2 LAI 82251.09

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

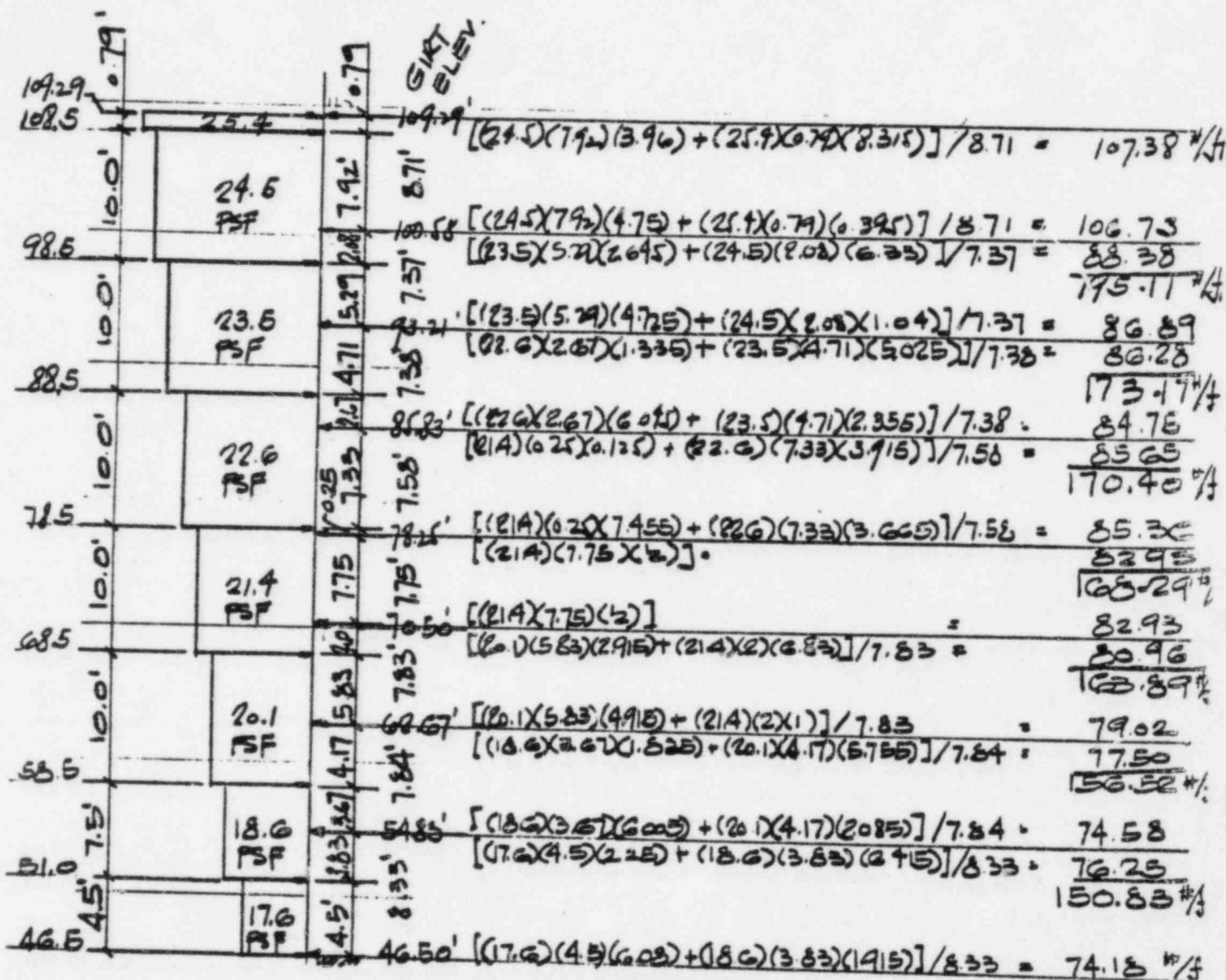
SHEET NO. 8 OF 57

DATE 7/6/83

COMP. BY/DATE FH 11/18/83

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

WIND LOAD COMBINATIONS TURBINE BLDG



ΣP = 1359.77 #/ft

ΣR = 1359.77 # CHECK

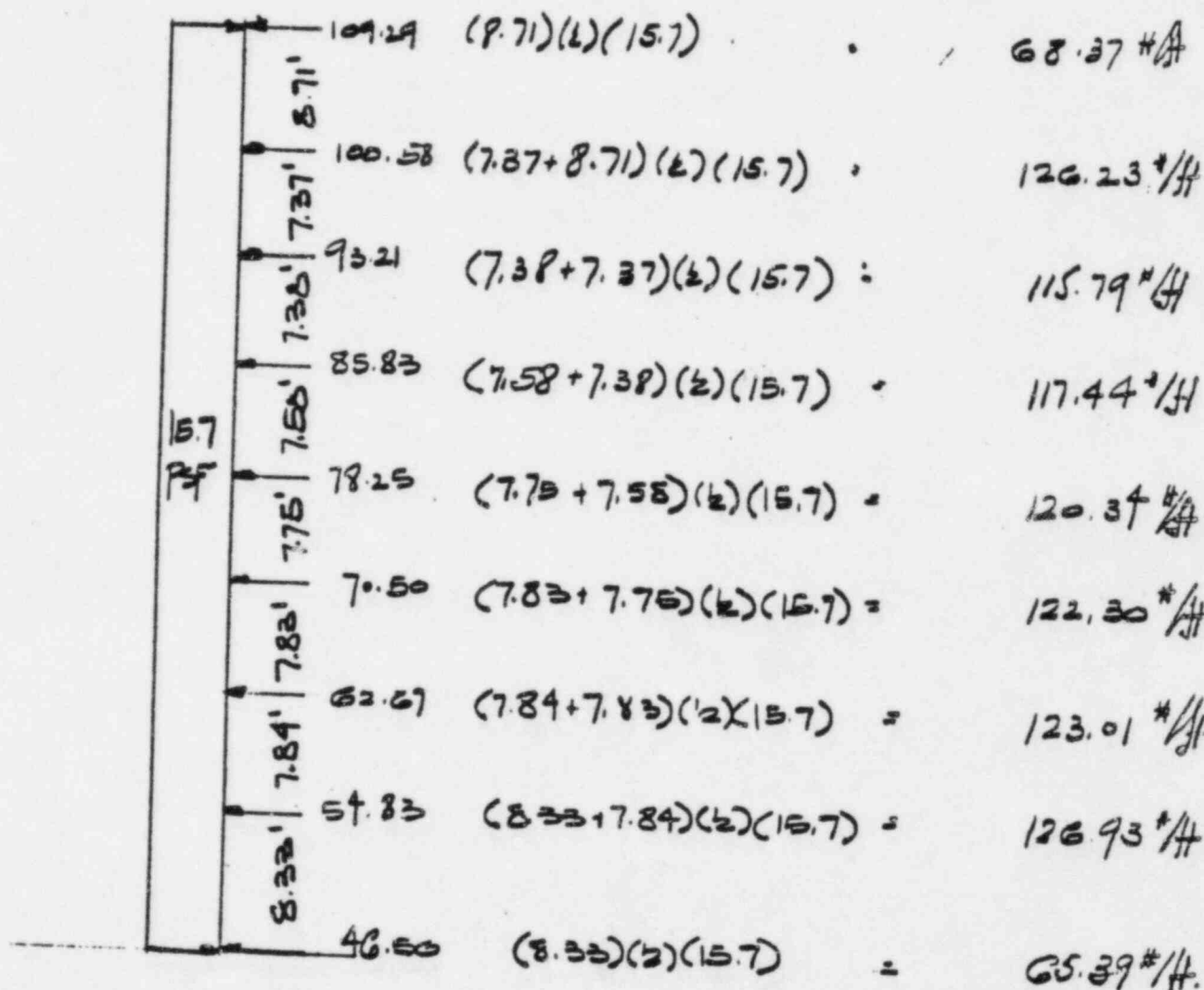
107.29	107.38	x 35.125	=	3772
106.58	105.11		=	6853
93.21	173.17		=	6083
88.38	170.40		=	5985
78.26	168.29		=	5911
70.50	163.89		=	5757
62.67	156.52		=	5498
54.83	150.83		=	5298
46.50	74.18		=	2606

GIR REACTIONS
AT FRAME COL.
ON WINDWARD SIDE

ECT. SEP TOPIC II-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	68.37	x 35.125 =	2401 #	} GIRI 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	

SUBJECT SEP TOPIC II-2 LAI 82251.09

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

SHEET NO. 11 OF 57

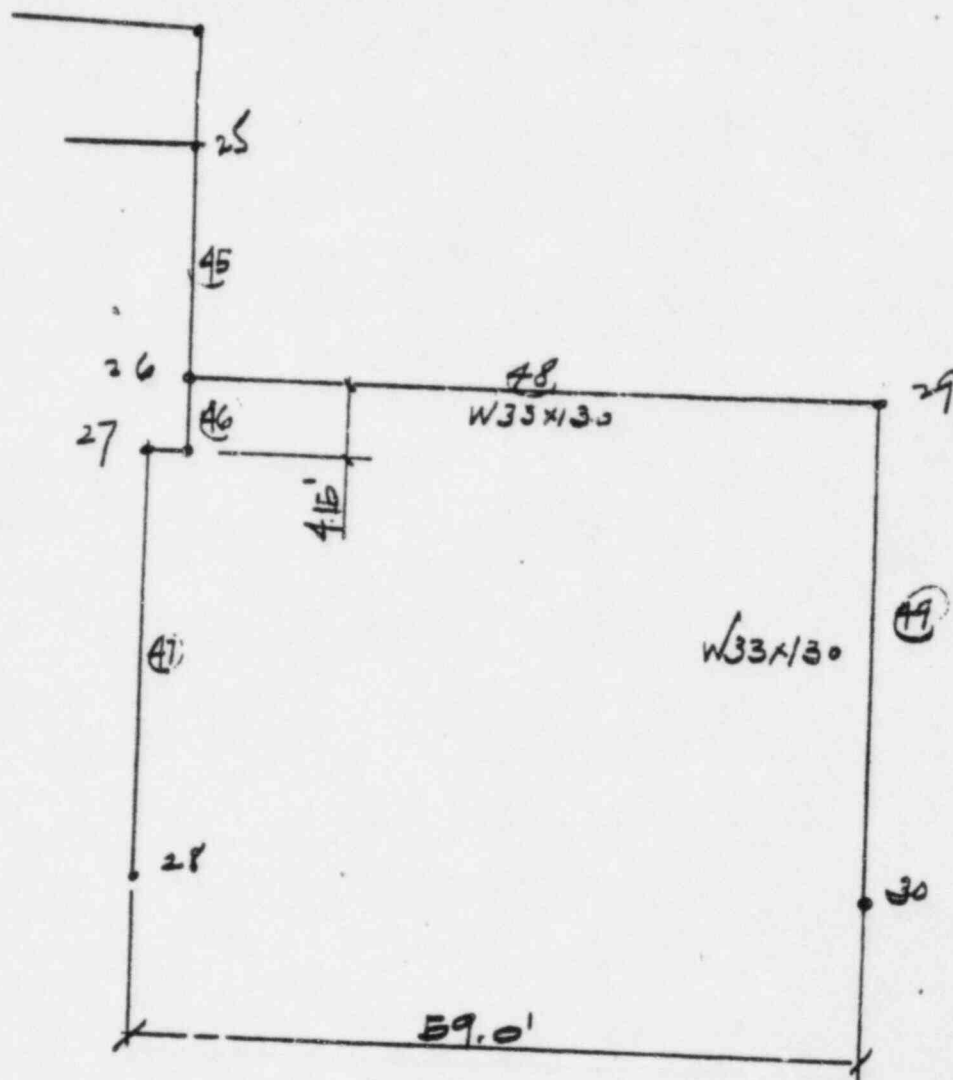
DATE 7/6/83

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

WIND LOAD COMBINATIONS

TURBINE BLDG



SUBJECT SEP TOPIC III.2 LAI 8251.09

CALC. NO. C-1302-151-532-006

SHEET NO. 12 OF 57

DATE 7/19/83

COMP. BY/DATE FH 11/16/83

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

WIND LOAD COMBINATIONS
TURBINE BLDG

ROOF DECK & FURLING

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
INSULATION (CELLULAR GLASS)	0.7 PSF
	<u>9.1 PSF</u>

DECK LOADING COMBINATION
DEAD + SNOW + WIND
 $9.1 + 24.0 - 21.9 = 11.2 \text{ PSF}$ DECK SECTION PROPERTIES - REF ROBERTSON CAT. LOG
+S = 0.398 in^3
-S = 0.380 in^3
MATERIAL = ASTM A446 $F_y = 33 \text{ ksi}$

CONSIDER SIMPLE SPAN - CRITICAL CASE

$$+M_{\text{ALLOW}} = f_s = \frac{(20)(0.398)}{12} = 0.663 \text{ k}'$$

663 ft. lb

$$+M = w \frac{l^2}{8} \quad l = 8' \text{ SPAN}$$

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

OK

CHECK FURLIN

16 B31 w/ MAX SPAN OF 36'-9 1/2" @ 8' o/c
S = 47.2 in^3 CONSIDER TOP FLANGE FULLY SUPPORTED
BY ROOF DECK $\therefore F_b = 24 \text{ ksi}$

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

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

$$\frac{1}{6} \cdot \frac{20.40 \times 12}{17} = 519 \text{ ksi} < 24 \text{ ksi} = \text{OK}$$

ECT SEP TOPIC III.2 LAI 82251.09

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

WIND LOAD COMBINATIONS

TURBINE BLDG

TRUSS MEMBER RESULTS

MEMBER SIZE	CAPACITY (REF ⑥)	ACTUAL MAX LD (REF ⑥)	MEMBER N°'S	
DIAGONAL T 5x3x1/2	T 161.7 C 97.0	T 46.8 C 51.2	6 9 38 42	} OK
DIAGONAL T 5x3x5/8	T 103.7 C 59.3	T 25.3 C 27.5	4 18 22 26 30 34	} OK
VERTICAL T 5x3x3/8	T 123.7 C 94.0	T 32.3 C 29.6	11 12 36 40	} OK
VERTICAL T 5x3x5/8	T 103.7 C 74.7	T 18.4 C 16.4	16 20 24 28 32	} OK
TOP CHORD T 8x6x1/2	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 T 8x6x5/8	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

SUBJECT SEP Topic II.2 TAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG

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

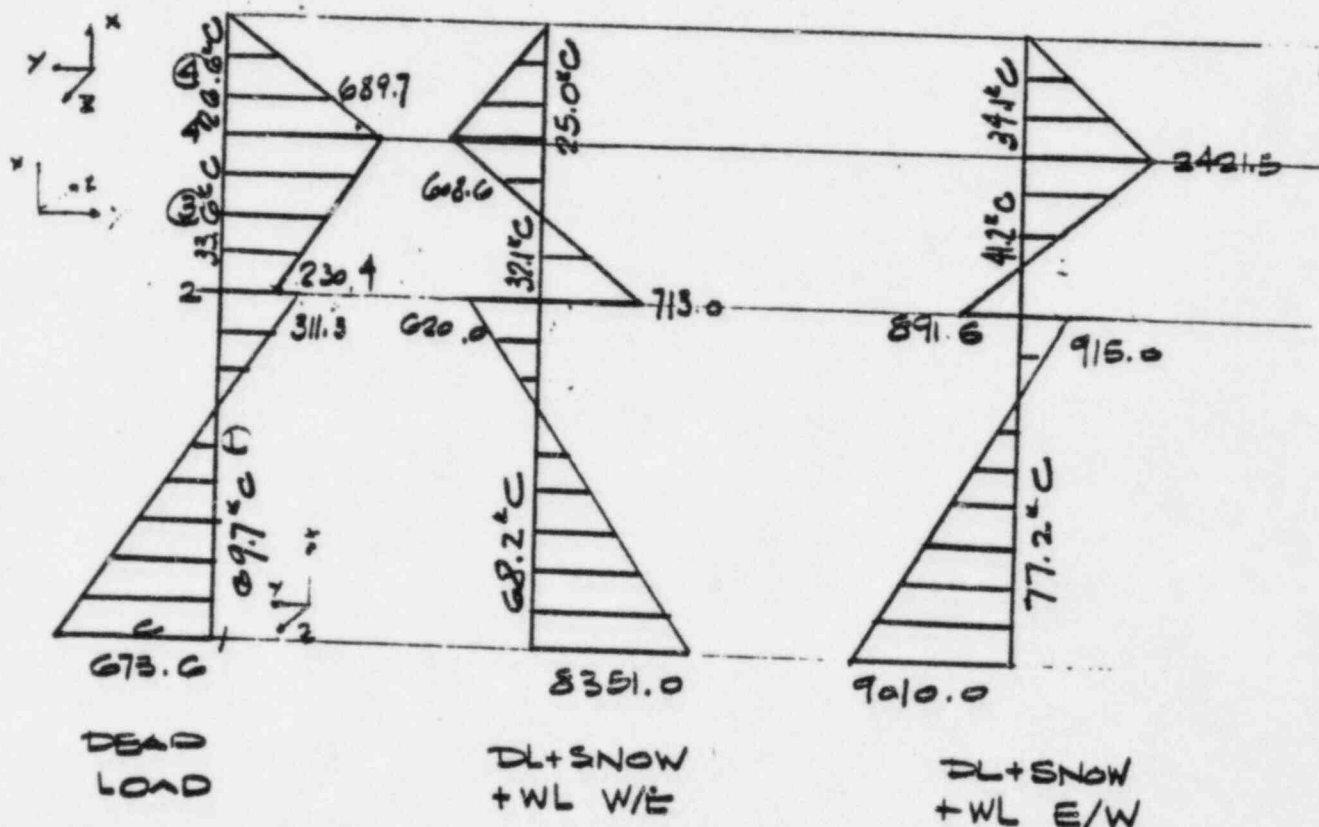
SHEET NO. 14 OF 57

DATE 7/26/83

COMP. BY/DATE FH 11/18/83

CHK'D. BY/DATE D.B.T. 11-22-83

CHECK COLUMN STRESSES
MEMBERS 1-3-4



MOMENT PLOT ON COMP'N SIDE (K'')

REF CALC NO C-1302-151-5320-003

PG 30 $K_x = 1.22$

W36x200

$A = 76.5 \text{ in}^2$

$S_x = 953 \text{ in}^3$

$r_x = 15.0 \text{ in}$

REF PG 31 ABOVE CALC

$F_a = 18.05 \text{ ksi}$ $F_b = 24 \text{ ksi}$

D+L+WL E/W

$f_a = 772/76.5 = 10.1 \text{ ksi}$

$f_b = 9010/953 = 9.45 \text{ ksi}$

$f_a/F_a = 10.1/18.05 = 0.56 < 0.15$

$0.00 + \frac{9.45}{24} = 0.00 + 0.39 = 0.45 < 1.00 \text{ OK}$

SUBJECT SEP TOPIC II.2 LAI 82251.09

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

SHEET NO. 15 OF 57

DATE 7/27/83

COMP. BY/DATE H. 11/18/83

CHK'D. BY/DATE D.B.T. 11-72-83

WIND LOAD COMBINATIONS

TURBINE BLDG

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

REF CALC NO C-1302-151-5320-003 (SHEETS 15 + 21)

$$A = 55.5 \text{ m}^2$$

$$F_a = 14.12 \text{ kN}$$

$$S_x = 411.4 \text{ m}^3$$

$$F_b = 22 \text{ kN}$$

$$f_a = 34.1 / 55.5 = 0.61 \text{ kN}$$

$$f_b / F_a = 0.61 / 14.12 = 0.04 < 0.15$$

$$0.04 + \frac{24.15}{\frac{411.4}{22}} = 0.04 + 0.27 = 0.31 < 1.00 \text{ OK}$$

CHECK ANCHOR BOLT CAPACITY

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

$$b = 26 \text{ mm}$$

$$d = 47 \text{ mm}$$

$$d'' = 21 \text{ mm}$$

$$A_s = 20 \text{ 2" } \phi \text{ A.B.}$$

$$A_s = (2)(2.50) = 5.00 \text{ in}^2 \quad A_T (2" \phi) = 2.50 \text{ in}^2$$

$$f_t c = 3000 \text{ PSI} \quad \lambda = 2$$

$$M = 9010 \text{ kN}$$

$$P = 77.2 \text{ kN}$$

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

$$e/d = 137.7/47 = 2.93$$

TRY $\gamma = 0.91$

$$L = \frac{1}{(1 - \gamma \frac{e}{d})} = \frac{1}{(1 - 0.91 \frac{2.93}{2.93})} = 1.45$$

$$m = \gamma = \frac{\lambda A_s L}{b d} = \frac{(2)(5.0)(1.45)}{(26)(47)} = 0.053$$

$$k = \frac{1}{\sqrt{m^2 + 2\gamma}} - m = 0.278$$

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

JECT 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 7/27/83
COMP. BY/DATE FH 11/16/83
CHK'D. BY/DATE D.B.T. 11-22-83

$$f_s = \frac{N}{A_{si}} \frac{e}{a} = \frac{(77.2)(2.93)}{(0.907)(5.00)(1.45)} = \frac{34.4 \text{ ksi}}{NG} > 22 \text{ ksi}$$

$$f_c = \frac{f_s}{n} \frac{b}{(1-k)} = \frac{(34.4)(0.278)}{9(1-0.278)} = \frac{1.47 \text{ ksi}}{NG} > 1.125 \text{ ksi}$$

ANCHOR BOLT STRESSES EXCEED ALLOWABLE
CONCRETE BEARING EXCEEDS ALLOWABLE

USE NPS STIFFPLATE PROGRAM FOR MORE EXACT
ANALYSIS. REF ① P = 94,761 LB TENSION

$$f_s = \frac{94.761}{2.5} = 37.9 \text{ ksi BOLT STRESS}$$

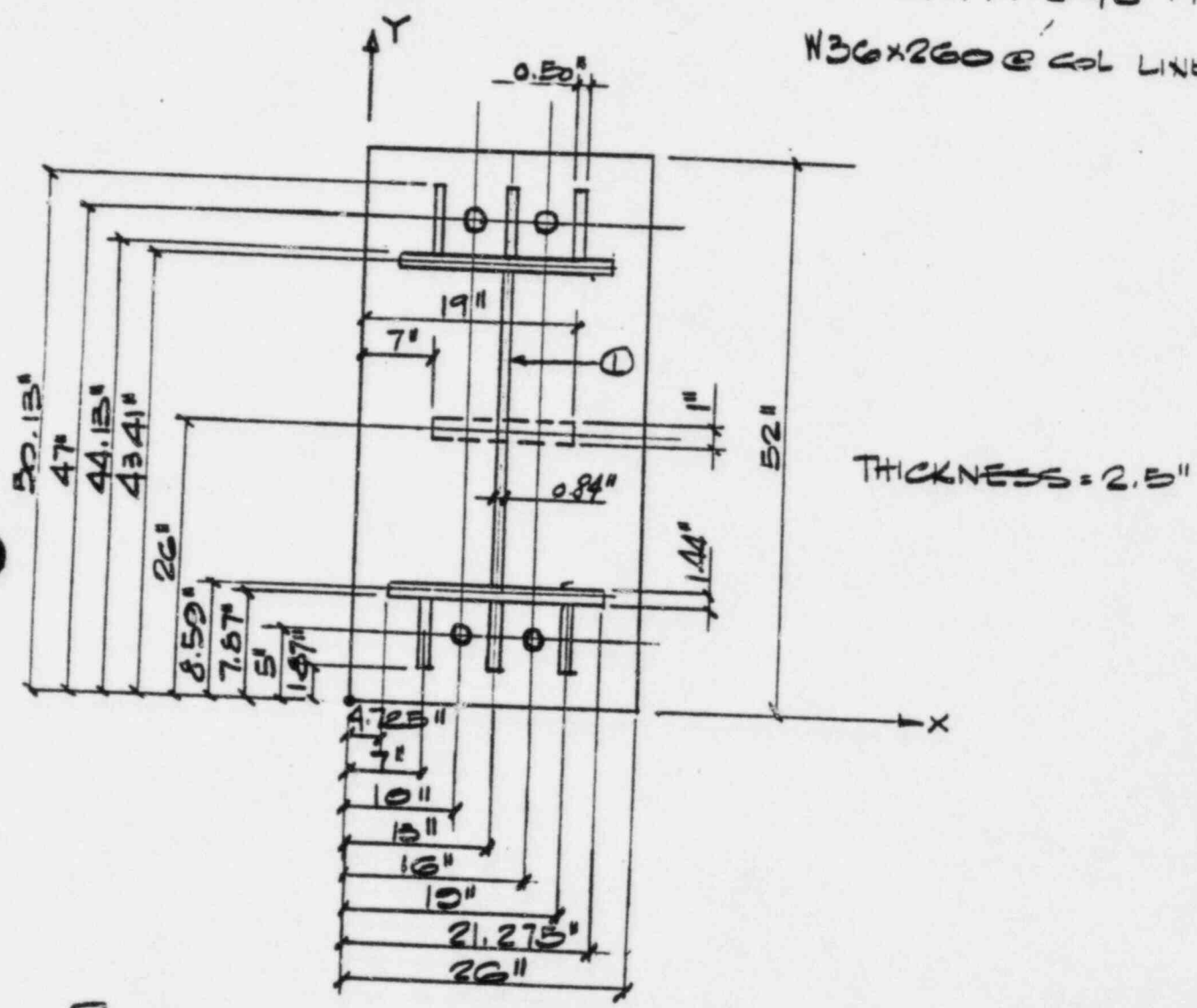
SUBJECT SEP TOPIC III.2 LAI 82251.09

CALC. NO. 1302.1E1.5320-006
 SHEET NO. 17 OF 57
 DATE 8/1/83
 COMP. BY/DATE TH 11/18/83
 CHK'D. BY/DATE DBT 11-22-83

WIND LOAD COMBINATIONS
TURBINE BLDG

ANALYZE BASE PL USING NPS STIFFPLATE PROGRAM

W36x260 @ COL LINE A



$P = 77.2$ $M = 9010 \text{ K-IN}$

CALC. NO. 6-1302-151-5320-0060

SHEET NO. 18 OF 57

DATE... 8/1/83

COMP. BY/DATE PH 11/18/83

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

SIIRJECT SEP 20 1963 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BUDG

INPUT DATA

BASE-11

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

LOAD	-6000	0	0	-77200	9010000	0	0
BOLT		047500		0000			
BOLT							
BOLT							
BOLT							

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	4	0.5
↑	7	40.53	7	50.13	0	0.5
↑	13	1.87	13	11.47	0	0.5
↑	13	40.53	13	50.13	0	0.5
↑	19	1.87	19	11.47	0	0.5
↑	19	40.53	19	50.13	0	0.5
↓	7	26	19	26	4	0.5
STIFF	20	10	10		1.0	
OPTION						

NOTE: BASED ON PROGRAM DATA GENERATION ALGORITHM, IT IS REQUIRED THAT THERE BE A SPACE BETWEEN THE EDGE OF THE STIFFENERS AND THE COLUMN FLG'S. 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 FLANGES.

SUBJECT SEP TOPIC II-2 LAI 82251.09

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

SHEET NO. 19 OF 57

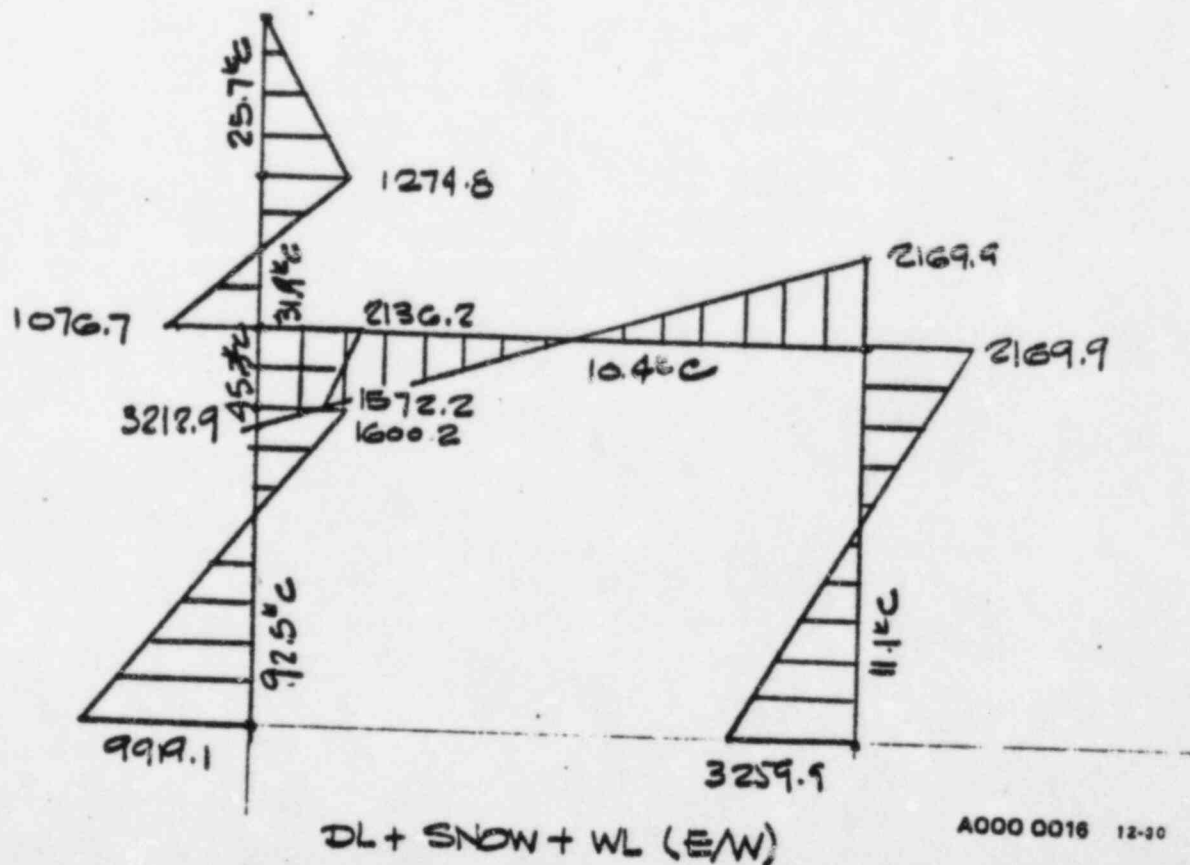
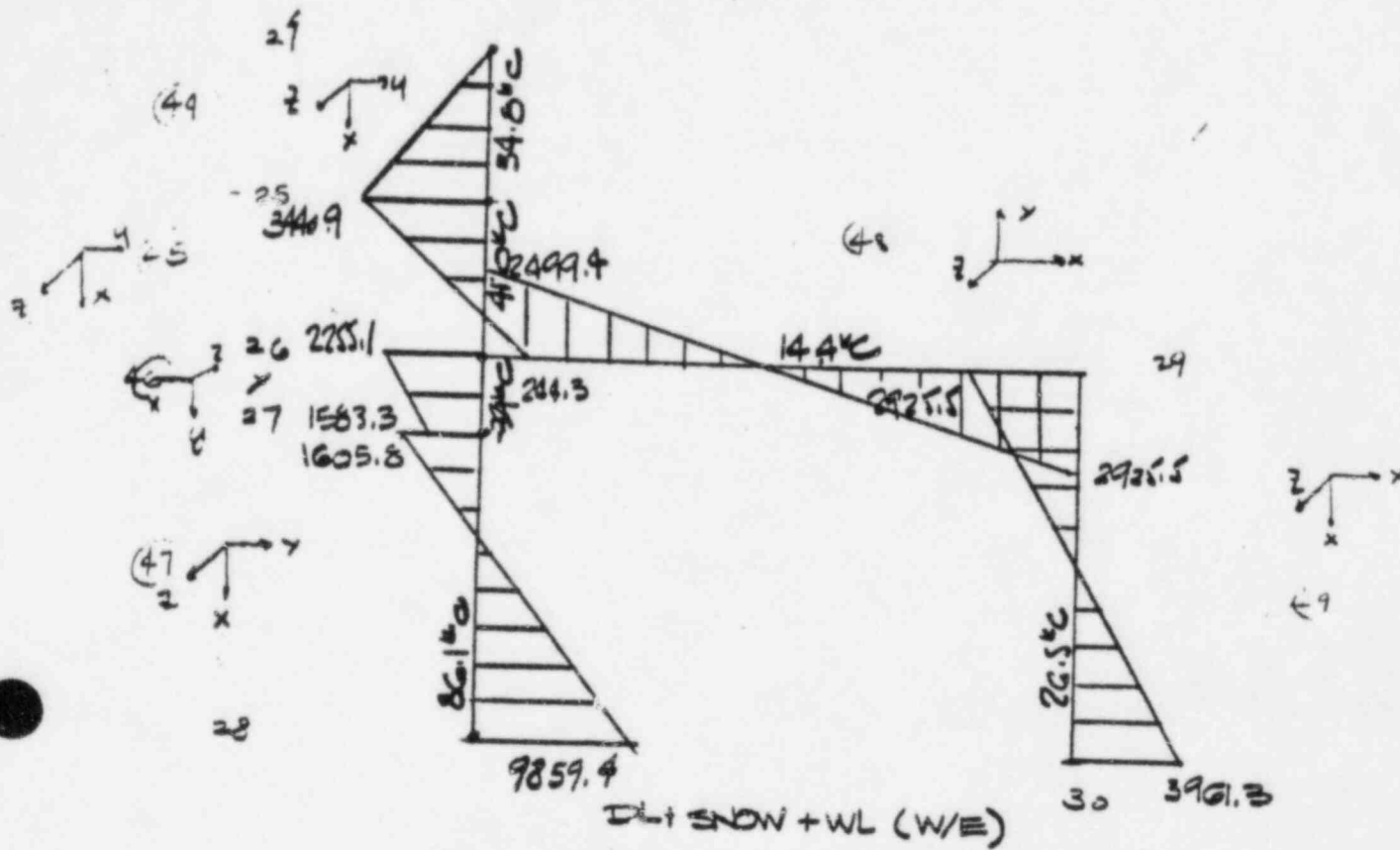
DATE 7/28/83

COM. BY/DATE PH 11/16/83

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

WIND LOAD COMBINATIONS

TURBINE BLDG



SUBJECT SEP TOPIC II. 2 LAI 82251.09

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

SHEET NO. 20 OF 57

DATE 7/25/83

COMP. BY/DATE FH 11/16/83

CHK'D. BY/DATE D.B.T. 11-22-83

WIND LOAD COMBINATIONS

TURBINE BLDG

CK W36x300 COL

$K_x = \text{SAME AS } W36x260 = 1.22$

$A = 88.3 \text{ IN}^2$

$S_x = 1110 \text{ IN}^3$

$F_A = 18.79 \text{ ksi}$

$F_B = 24 \text{ ksi}$

CALC NO C-1302-151-5320-003
PAGE 32

$$f_a = 72.3/88.3 = 1.05 \text{ ksi}$$

$$f_a/F_A = 1.05/18.79 = 0.06 < 0.15$$

$$f_b = 999.1/1110 = 8.94 \text{ ksi}$$

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

CK B.U. SECTION AT BOTTOM OF TRUSS

$A = 72.6 \text{ IN}^2$

$S_x = 539.0 \text{ IN}^3$

$F_A = 14.13 \text{ ksi}$

$F_B = 22 \text{ ksi}$

CALC NO C-1302-151-5320-003
PAGE 33

$$f_a = 34.8/72.6 = 0.48 \text{ ksi}$$

$$f_a/F_A = 0.48/14.13 = 0.03 < 0.15$$

$$f_b = 3440.9/539 = 6.38 \text{ ksi}$$

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

CK W33x130 GIRDER

$A = 38.3 \text{ IN}^2$

$S_x = 408 \text{ IN}^3$

$r_x = 13.2 \text{ in}$

CALCULATE C_B FOR WL (W/E)

$$M_1 = 2499.4$$

$$M_2 = 2925.5$$

$$M_1/M_2 = 0.854$$

$$C_B = 1.75 + 1.05(0.854) + 0.5(0.854)^2 = 2.08 > 2.3$$

$$C_B = 2.3$$

$$F_b = \frac{(12,000)(2.3)(9.84)}{(29)(12)(3309)} = 23.57 \text{ ksi} \quad F_b = 22 \text{ ksi}$$

SUBJECT SEP TOPIC III-2 LAT 87251.09

CALC. NO. C-1302-151-5320-006
SHEET NO. 71 OF 57
DATE 7/27/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DST 11-22-83

WIND LOAD COMBINATIONS
TURBINE BLDG

DETERMINE ALLOWABLE AXIAL LOAD

$$L_x = 55' \quad r_x = 13.2 \text{ IN}$$

$$L_y = 29' \quad r_y = 2.39 \text{ IN}$$

$$\frac{KL}{r_x} = \frac{(55)(12)}{13.2} = 52.7$$

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

$$f_a = 144/38.3 = 0.38 \text{ ksi} \quad f_a/F_a = 0.38/7.04 = 0.05 < 0.15$$

$$f_b = 29255/406 = 7.20 \text{ ksi} \quad f_b/F_b = 7.20/22 = 0.33$$

$$0.05 + 0.33 = 0.38 < 1.00 \quad \text{OK}$$

CK W33X130 COL
A = 58.3 IN²
S_x = 406 IN³

K_x = 1.35
F_a = 18.07 ksi
F_b = 19.75 ksi

REF CALC. NO. C-1302-151-5320-003
PAGE NO. 25

$$f_a = 265/58.3 = 0.69 \text{ ksi} \quad 0.69/18.07 = 0.04 < 0.15$$

$$f_b = 3961.3/406 = 9.76 \text{ ksi} \quad 9.76/19.75 = 0.49$$

$$0.04 + 0.49 = 0.53 < 1.00 \quad \text{OK}$$

SUBJECT SEP TOPIC II: 2 LAI 82251, 09

WIND LOAD COMBINATIONS
TURBINE BLDG

CALC. NO. C-1302-151-5320-000
SHEET NO. 22 OF 51
DATE 7/28/83
COMP. BY/DATE PH H/18/83
CHK'D. BY/DATE D.B.T. 11-23-83

CK BASE PL W36 x 300

$$P = 86.1 \text{ k} \quad M = 9859.4 \text{ k-in}$$

$$b = 29 \text{ in} \quad A_s = 2 \cdot 2 \text{ in} \phi \text{ A.B.} \quad A_T (2 \text{ in} \phi) = 2.50 \text{ in}^2$$

$$d = 51 \text{ in} \quad A_s = 2 \times 2.50 = 5.00 \text{ in}^2$$

$$d' = 21 \text{ in} \quad f'_c = 3000 \text{ PSI}$$

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

TRY $j = 0.91$ $U = \frac{1}{1 - j \frac{e}{d}} = 1.538$

$$m = \frac{f_s}{f_c} \cdot \frac{n A_s U}{b d} = \frac{(9)(5)(1.538)}{(29)(51)} = 0.047$$

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

$$f_s = \frac{N}{j A_s U} \cdot \frac{e}{d} = \frac{(86.1)(2.60)}{(0.912)(5)(1.538)} = 31.9 \text{ ksi} > 22 \text{ ksi} \text{ N.G.}$$

$$f_c = \frac{f_s}{n} \cdot \frac{k}{(1-k)} = \frac{(31.9)(0.263)}{(9)(1-0.263)} = 1.265 \text{ ksi} > 1.125 \text{ ksi} \text{ N.G.}$$

ANCHOR BOLT STRESSES EXCEED ALLOWABLE
CONCRETE BEARING STRESS EXCEEDS ALLOWABLE

SUBJECT SEP TOFC II.2 LAI 82251.09

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

SHEET NO. 23 OF 57

DATE 7/28/83

COMP. BY/DATE FH 11/15/83

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

WIND LOAD CALCULATION TURBINE BLDG

CHK BASE FB W33x130

$$P = 26.5'$$

$$H = 3961.3 \text{ KN}$$

$$b = 18''$$

$$d = 45''$$

$$d' = 19.5''$$

$$A_s = 2 \cdot 14.5 \text{ A.B.}$$

$$A_s = (2)(14.5) = 29.0 \text{ in}^2$$

$$f_c = 3000 \text{ PSI}$$

$$A_T (14.5) = 190 \text{ in}^2$$

$$e = \frac{3961.3}{26.5} + 10.5 = 168.98 \quad e/d = 3.76$$

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

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

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

$$f_s = \frac{(26.5)(3.76)}{(6.906)(3.80)(1.319)} = 21.94 \text{ ksi} < 22 \text{ ksi OK}$$

$$f_c = \frac{(21.94)(0.281)}{(9)(1 - 0.281)} = 0.952 \text{ ksi} < 1.125 \text{ ksi OK}$$

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS
TURBINE BLDG

CALC. NO. C-1302-151-5320-806
SHEET NO. 24 OF 57
DATE 10/14/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE D.B.T. 11-22-83

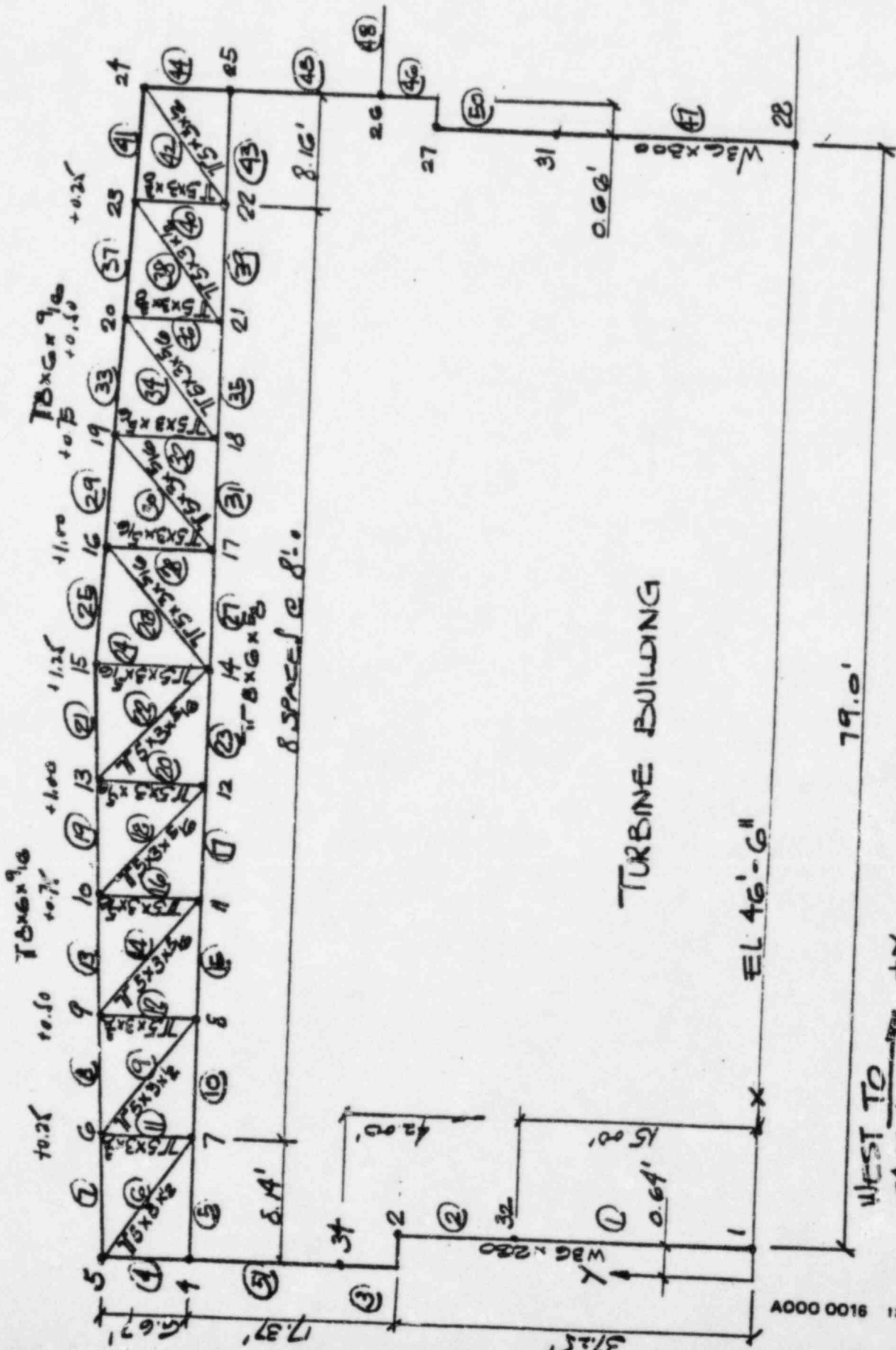
REVIEW THE INTERACTION OF ADJACENT
FRAMES BY USING THREE DIMENSIONAL
MODEL

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

SUBJECT SEP TORIC II.2 LAI 82251.09

CALC. NO. C-1301-151-1320-806
 SHEET NO. 25 OF 57
 DATE 1.2.2/83
 COMP. BY/DATE FH 11/18/83
 CHK'D. BY/DATE D.B.T. 11-22-83

WIND LOAD COMBINATIONS TURBINE BLDG



TURBINE BUILDING

WEST TO EAST WIND +X

COL LINES 2-10 TYPICAL

CT SEP TOPIC II-2 LAI 82251.09

CALC. NO. C-1302-K1-5310-006

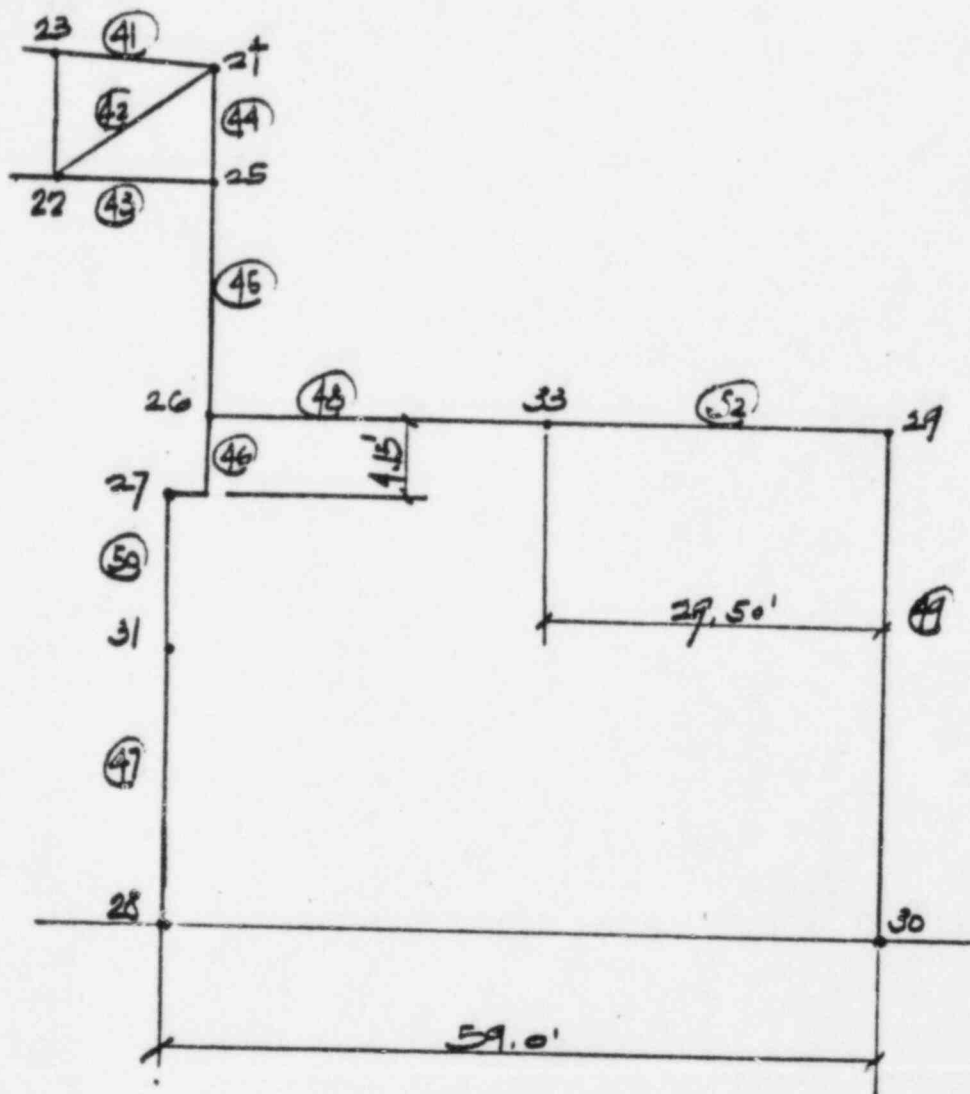
SHEET NO. 26 OF 57

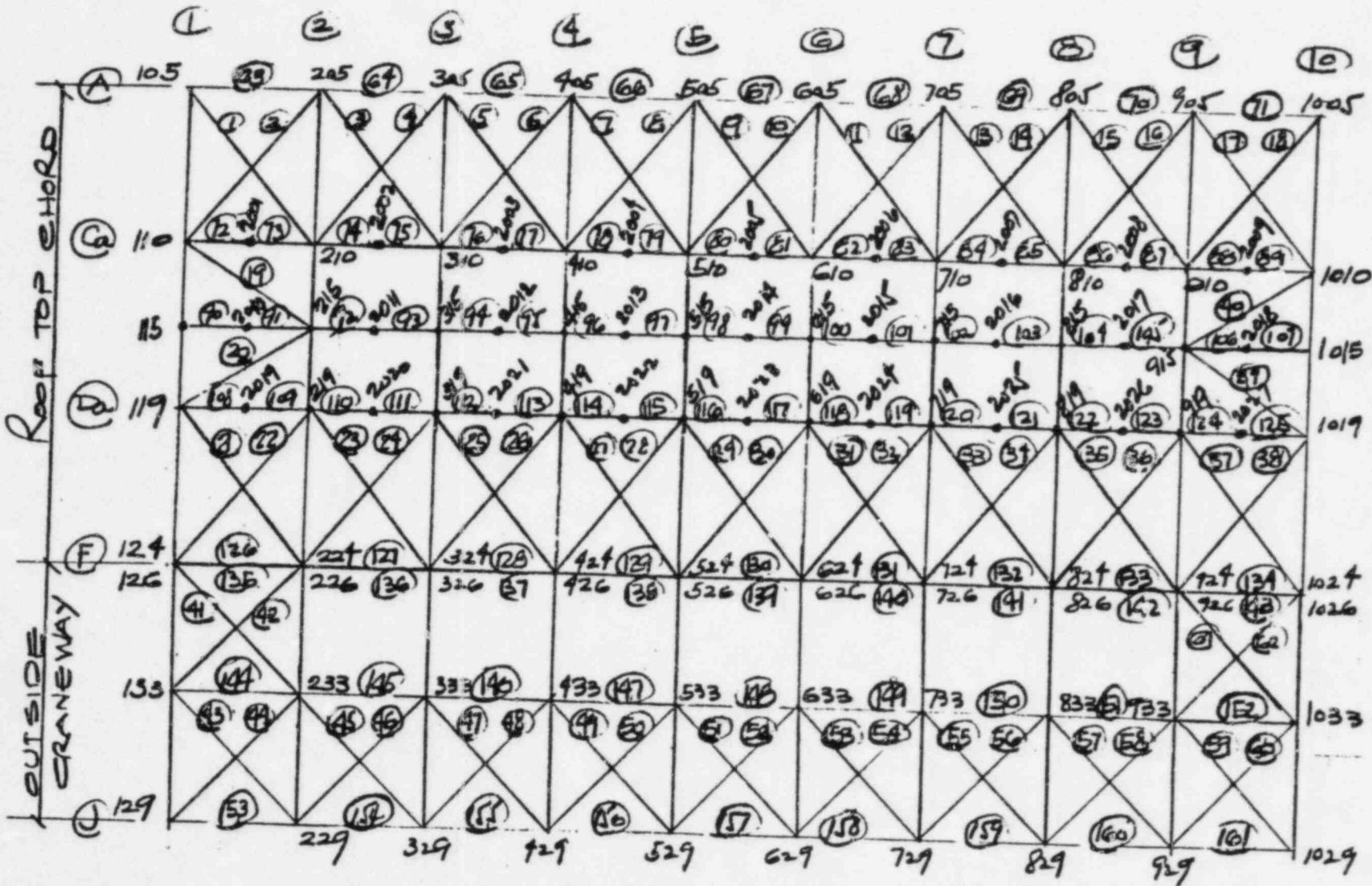
DATE 10/3/83

COMP. BY/DATE FH 11/18/83

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

WIND LOAD COMBINATIONS TURBINE BLDG





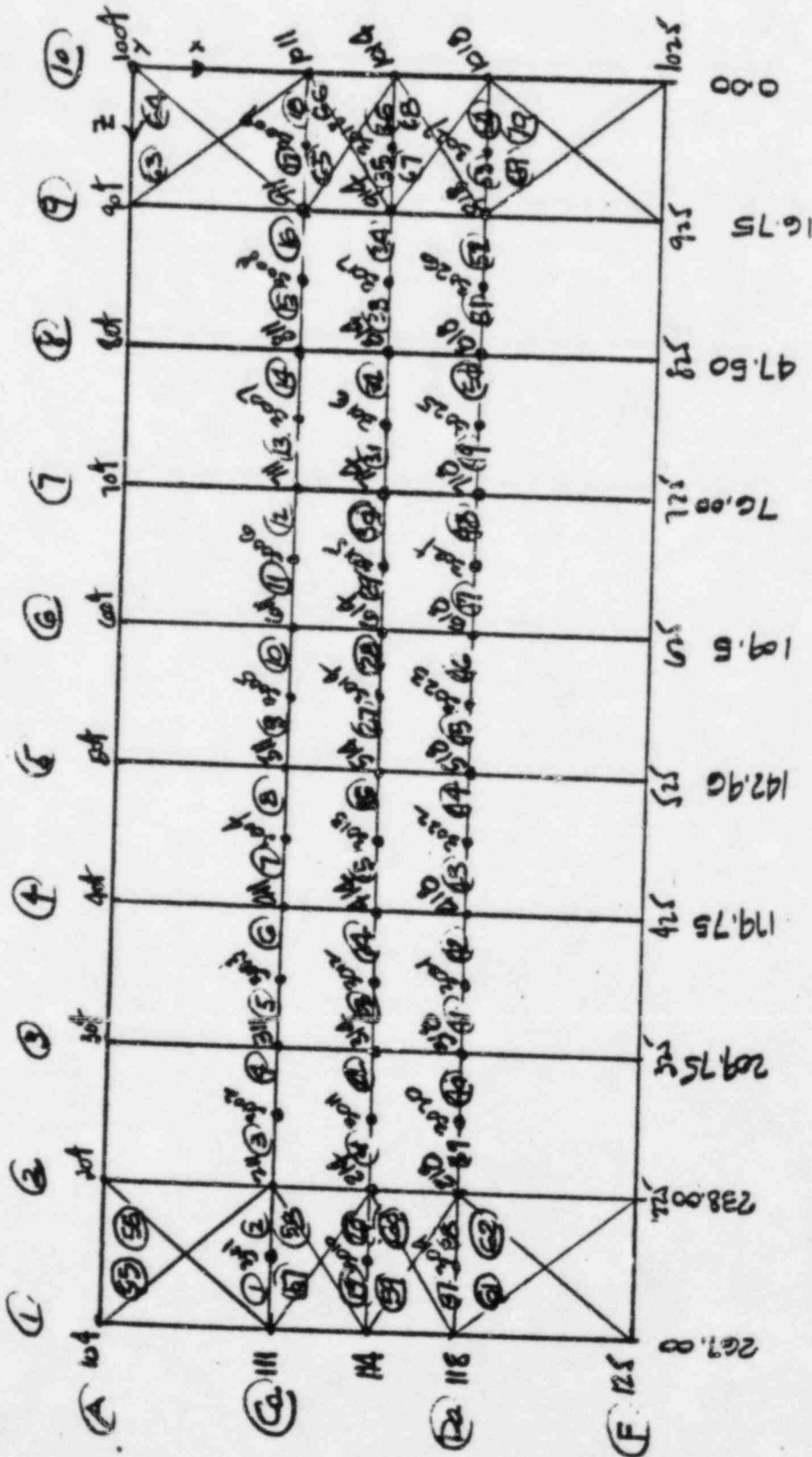
PREFIX ALL MEMBER NUMBERS 2000 +

ROOF TOP CHORD HORIZONTAL TRUSS
AND OUTSIDE CRANEWAY HORIZONTAL TRUSS

ECT SEP TOPIC II.2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. 1302-151-5320-004
SHEET NO. 28 OF 57
DATE 10/2/83
COMP. BY/DATE PH W/18/83
CHK'D. BY/DATE D.B.T. 11/22/83



PREFIX ALL MEMBER NUMBERS 3000+

BOTTOM CHORD HORIZONTAL TRUSS

ST SEP TOPIC II.2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BUDG

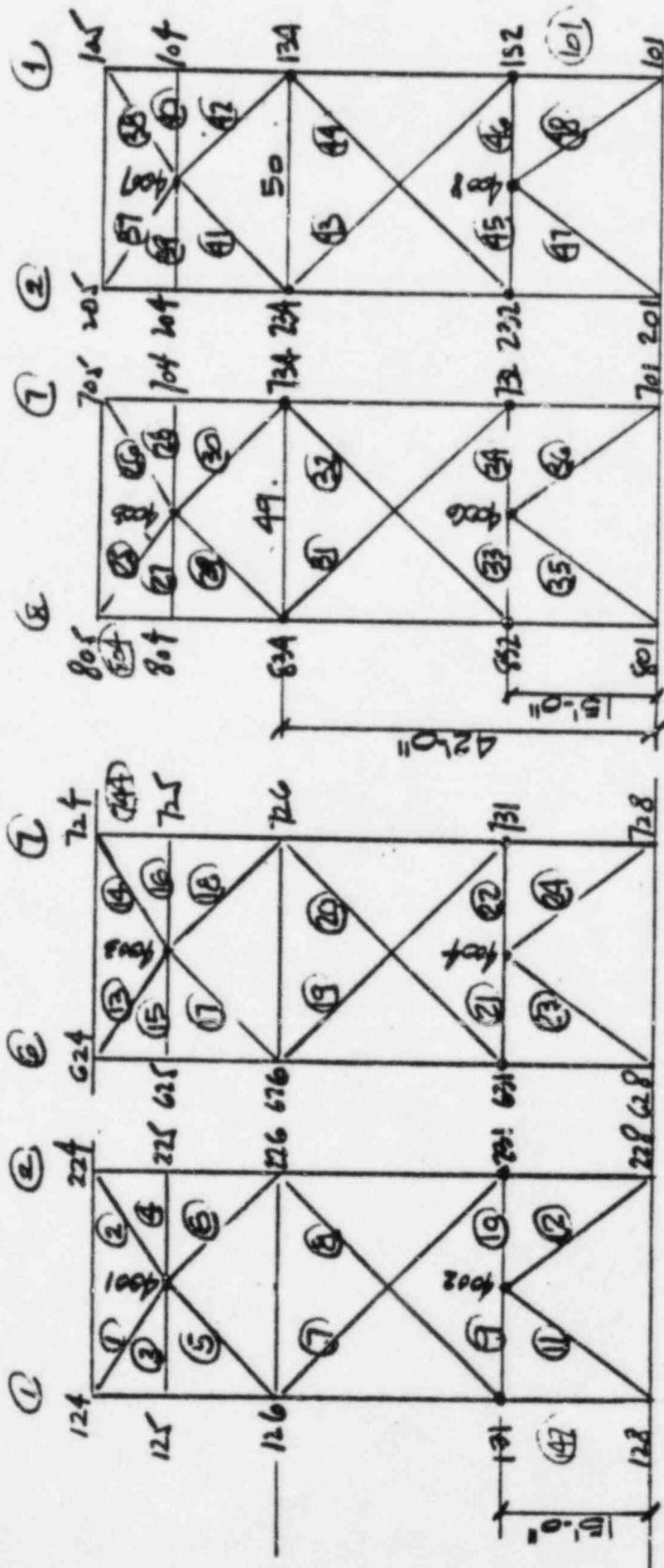
CALC. NO. C-1201-151-5320-006

SHEET NO. 29 OF 57

DATE 10/3/83

COMP. BY/DATE PH 11/8/83

CHK'D. BY/DATE D.B.T. 11/22/83



COL LINE A

COL LINE F

VERTICAL FRAMES @ COL LINES A & F

PREFIX ALL MEMBER NUMBERS 5000+

CT SEP TOHC III-2 LAI 82251.09

WINIA LOAO COMBINATION! TURBINE DDG

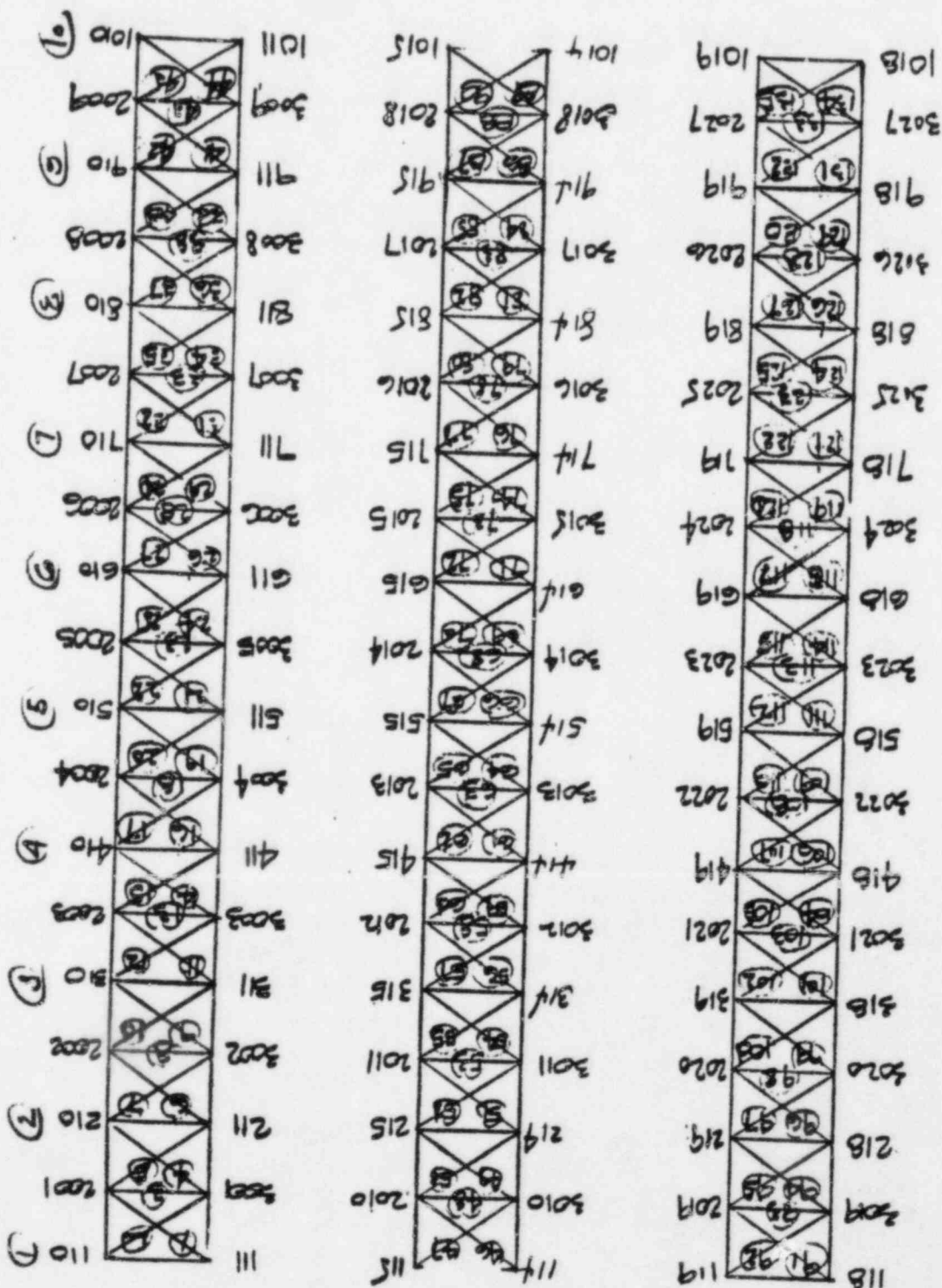
CALC. NO. C-1302-151-5320-006

SHEET NO. 30 OF 57

DATE 10/31/83

COMP. BY/DATE. PH 11/15/83

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

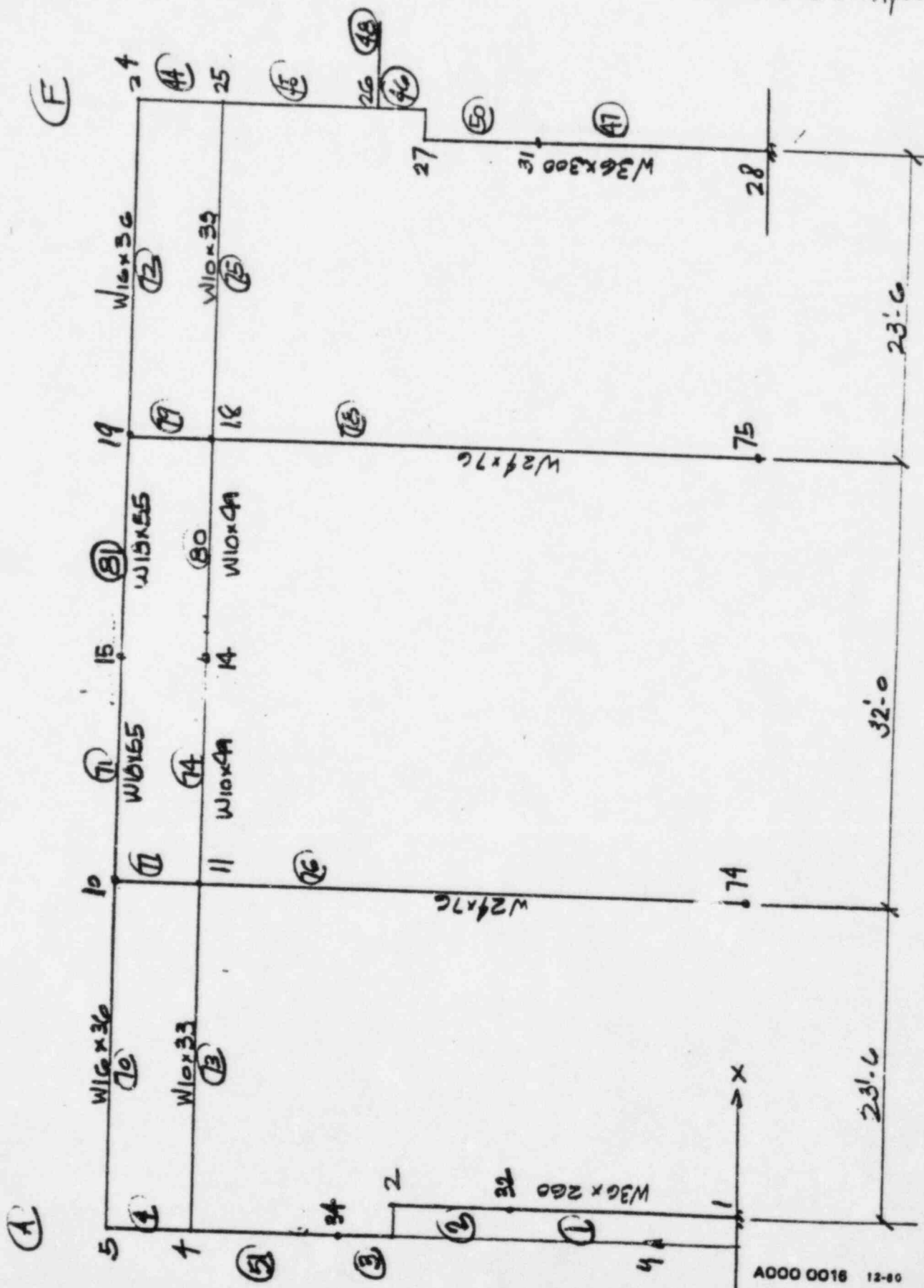


Roof Vertical Truss
PREFIX MEMBER NUMBERS 4000+

SEP TOPIC III.2 LAT 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C1302-151-5320-006
SHEET NO. 31 OF 57
DATE 10/3/83
COMP. BY/DATE R 11/10/83
CHK'D. BY/DATE D.B.T. 11/22/83



SUBJECT EXX TOPIC III.2 LAT 82251.09

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

SHEET NO. 32 OF 57

DATE 10/12/83

COMP. BY/DATE PH 11/18/83

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

WIND LOAD COMBINATION TURBINE BLDG

BASED ON 3-D FRAME ANALYSIS

W36 X 260 COL. DL + SNOW + WL COMBINATIONS

CHECK ANCHOR BOLTS - FIND CRITICAL COLUMN

MEMBER LOADING	101 134	201 135	301 135	401 135	501 135	601 135	701 135	801 135	901 135	1001
P	31.9	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	672.2	652.1	614.7	565.8	476.9	375.4
LOADING	1 3 4	1 3 5	DL + SNOW + WL (E/W)	DL + SNOW + WL (W/E)						

COLUMN LINE 5

$$P = 80.6 \text{ K} \quad M = 678.2 \text{ K}'$$

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

$$e/d = 122.0/47 = 2.60$$

$$\text{Try } j = 0.91$$

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

$$m = g = \frac{n A_s l}{6 d} = \frac{(9)(5.00)(1.538)}{(26)(47)} = 0.057$$

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

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

$$f_s = \frac{N}{j A_s l} \frac{e}{d} = \frac{(80.6)(2.60)}{(0.905)(5.00)(1.538)} = 30.11 \text{ ksi} > 22 \text{ ksi} \quad \text{NG}$$

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

CT. SEP TOPIC III-2 LAJ 82251.09

CALC. NO. C-1302-151-(320-006)
SHEET NO. 33 OF 57
DATE 10/19/83
COMP. BY/DATE FH 11/18/83
CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS TURNING BLDG

CHECK COL LINE 4

$P = 77.8^k$ $M = 657.9^k'$

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

TRY $\gamma = 0.91$ $\phi = 1.535$ $m = \gamma = 0.0565$ $k = 0.284$ $\gamma = 0.905$

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

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

CHECK COL LINE 6

$P = 78.2^k$ $M = 652.1^k'$ SAY SAME AS 4

CHECK COL LINE 7

$P = 66.5^k$ $M = 614.7^k'$

$e = 131.9$ $e/d = 2.81$

TRY $\gamma = 0.90$ $\phi = 1.471$ $m = \gamma = 0.054$ $k = 0.279$ $\gamma = 0.907$

$f_s = \frac{(66.5)(2.81)}{(0.907)(5.00)(1.471)} = 27.93^k \text{ psi} > 22^k \text{ psi}$

$f_c = \frac{(27.93)(0.279)}{(9)(1 - 0.279)} = 1.209^k \text{ psi} > 1.125^k \text{ psi}$

CHECK COL LINE 3

$P = 70.9^k$ $M = 611.6^k'$ SAY SAME AS 7

CHECK COL LINE 2

$P = 75.3^k$ $M = 573.0^k'$

$e = 112.3"$ $e/d = 2.389$

TRY $\gamma = 0.90$ $\phi = 1.604$ $m = \gamma = 0.059$ $k = 0.290$ $\gamma = 0.903$

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

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

CALC. NO. CP22-151-5320-006
 SHEET NO. 34 OF 57
 DATE 10/18/83
 COMP. BY/DATE PH W/10/83
 CHK'D. BY/DATE DIST 11/22/83

PROJECT SEP TOWER II-2 LAT 82251.09

WIND LOAD COMBINATIONS TURBINE BUDG

CHECK COL LINE 9
 $P = 61.6 \text{ k}$ $M = 470.9 \text{ k}$
 $e = 113.9$ $e/d = 2.423$
 TRY $j = 0.91$ $c = 1.001$ $m = 7 = 0.0590$ $k = 0.219$ $j = 0.904$

$$f_s = \frac{(61.6)(2.423)}{(0.904)(5.00)(1.001)} = 20.62 \text{ ksi} < 22 \text{ ksi}$$

$$f_c = \frac{(20.62)(0.289)}{(7)(10.289)} = 0.932 \text{ ksi} < 1.125 \text{ ksi OK}$$

ICT SEP TOPIC II.2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 35 OF 57
DATE 10/14/83
COMP. BY/DATE FH 11/15/83
CHK'D. BY/DATE D.B.T. 11/24/83

BASED ON 3D FRAME ANALYSIS
W 36X200 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 M = 736.4 e = 109.6 e/d = 2.150
TRY j = 0.91 u = 1.734 m = g = 0.0528 R = 0.329 j = 0.890

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

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

COLUMN LINE 4

P = 98.5 M = 720.2 SAY SAME AS COL LINE 5

COLUMN LINE 6

P = 106.7 M = 715.0 SAY SAME AS COL LINE 5

COLUMN LINE 3

P = 25.7 M = 282.2 e = 152.8 e/d = 2.995
TRY j = 0.91 u = 1.436 m = g = 0.0457 R = 0.255 j = 0.915

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

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

ECT... SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE BLDG.

BASED ON 3-D FRAME ANALYSIS
 W133x130 COL DL + SNOW + WL COMBINATIONS
 CHECK ANCHOR BOLTS - FIND CRITICAL COL

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

MEMBER LOADING	149	249	349	449	549	649	749	849	949	1049
	134	134	134	134	134	134	134	134	134	134
P	20.1	25.3	25.7	21.8	21.0	28.1	26.4	28.2	22.6	17.2
M	242.3	264.9	282.2	247.6	304.7	297.1	278.7	256.7	226.8	217.1

$$e = \frac{304.7 \times 12}{29} + 19.5 = 145.6"$$

$$e/d = 145.6/45 = 3.24$$

$$\text{TRY } \phi = 0.91 \quad \phi = \frac{1}{(1 - \frac{0.91}{3.24})} = 1.391$$

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

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

$$\phi = 1 - \frac{0.288}{3} = 0.904 \approx 0.91 \text{ OK}$$

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

$$f_o = \frac{(19.87)(0.388)}{(9)(1 - 0.288)} = 0.893 \text{ ksi} < 1.125 \text{ ksi OK}$$

SUBJECT SEP TONE III-2 LAI 82251.09

WIND LOAD COMBINATIONS

TURBINE PLOG

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	
Ⓐ	OK OK	24.83 OK	27.93 1.229	29.23 1.283	29.11 1.324	29.23 1.283	27.93 1.229	OK OK	OK OK	OK OK	BOLT CONC
Ⓔ	OK OK	OK OK	OK OK	27.78 1.543	27.78 1.513	27.78 1.513	OK OK	OK OK	OK OK	OK OK	BOLT CONC
Ⓜ	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 = $22 \times \frac{4}{3} = 29.33 \text{ ksi}$

CONC = $1.125 \times \frac{4}{3} = 1.5 \text{ ksi}$

STRESSES AS NOTED ABOVE EXCEED THE CURRENT ALLOWABLE STRESS CRITERIA

BOLT = 22 ksi

CONC = 1.125 ksi

ECT SEP TOPIC III-2 LAI 82251.09

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

WIND LOAD COMBINATIONS TURBINE BLDG

BASED ON 3-D FRAME ANALYSIS
W36x760 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	464.8	643.4	642.4	694.0	717.1	692.9	647.3	596.9	500.6	381.3

DESIGN CASE

COLUMN LINE 5

$$P = 40.0$$

$$M = 717.1 \times 12 = 8605 \text{ k-in}$$

$$e = \frac{M}{N} = \frac{8605}{40} + 2 = 236.1 \text{ in}$$

$$e/d = 236.1 / 47 = 5.76$$

TRY $j = 0.91$

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

$$m = f \cdot \frac{\pi A_i}{6d} = \frac{(9)(5.00)(1.188)}{(26)(47)} = 0.0437$$

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

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

$$f_s = \frac{N}{j A_{si}} \frac{e}{d} = \frac{(40.0)(5.76)}{(0.915)(6.00 \times 1.188)} = 42.39 \text{ ksi} > 22 \text{ ksi} \quad \underline{\text{NG}}$$

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

SUBJECT SEP TOPIC III.2 LAS 02251.09

WIND LOAD COMBINATION! TURBINE BLDG

COL LINE 4

$$P = 39.0^k \quad M = 694^k' \quad C = \frac{694 \times 12}{39.0} + 21 = 234.5' \quad q_d = \frac{234.5}{47} = 4.99$$

$$\text{TRY } J = 0.91 \quad i = \frac{1}{\left(1 - \frac{0.91}{4.99}\right)} = 1.223$$

$$m = g = \frac{(9)(5.00)(1.223)}{(26)(47)} = 0.0455$$

$$k = 0.258 \quad J = 0.914$$

$$f_s = \frac{(39.0 \times 4.99)}{(0.914)(5.00)(1.223)} = 34.84^k \quad > 22^k$$

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

COL LINE 6

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

COL LINE 3

$$P = 36.1^k \quad M = 692.4^k \quad C = \frac{692.4 \times 12}{36.1} + 21 = 213.5' \quad q_d = 4.543$$

$$\text{TRY } J = 0.910 \quad i = 1.250 \quad m = g = 0.046 \quad k = 0.261$$

$$J = 0.913 \quad \text{OK}$$

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

$$f_c = \frac{(28.74 \times 0.261)}{(9)(1 - 0.261)} = 1.428^k \quad \sim 1.125^k \quad \text{OK}$$

COL LINE 7

$$P = 49.0^k \quad M = 673^k \quad C = 179.5' \quad q_d = 3.820$$

$$\text{TRY } J = 0.910 \quad i = 1.313 \quad m = g = 0.04635 \quad k = 0.266$$

$$f_s = \frac{(49.0)(3.820)}{(0.910)(5.00)(1.313)} = 31.29^k \quad > 22^k \quad \text{NG}$$

$$f_c = \frac{(31.29)(0.266)}{(9)(1 - 0.266)} = 1.260^k \quad > 1.125^k \quad \text{NG}$$

ECT SEP TOPIC II.2 LAE 12251.09

WIND LOAD COMBINATION TURBINE BLDG

CALC. NO. C-1302-151-5320-006
SHEET NO. 40 OF 57
DATE 10/12/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DIST 11/22/83

COL LINE 2

$P = 37.4^k$ $M = 63.4^k'$ $e = 217.8''$ $e/d = 4.634$
TRY $J = 0.01$ $i = 1.244$ $m = g = 0.0458$ $R = 0.260$
 $J = 1 - \frac{0.001}{0.01} = 0.913$ 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 $J = 0.10$ $i = 1.206$ $m = g = 0.0444$ $R = 0.257$
 $J = 0.914$ 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 $J = 0.01$ $i = 1.283$ $m = g = 0.0472$ $R = 0.264$
 $J = 0.912$ 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 $J = 0.01$ $i = 1.332$ $m = g = 0.0491$ $R = 0.268$ $J = 0.911$

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

$$f_c = \frac{(21.81)(0.268)}{(9)(1 - 0.268)} = 1.887^{ksi} < 1.125^{ksi} \text{ OK}$$

CT SEP TOPIC III.2 LAI 82251.09

CALC. NO. C-1302-151-5320-0060
SHEET NO. 41 OF 57
DATE 10/14/83
COMP. BY/DATE PH 11/18/83
CHK'D. BY/DATE DBT 11/14/83

WIND LOAD COMBINATIONS TURBINE BLDG

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

$$P = 47.1 \text{ K} \quad M = 596.4 \text{ K-ft} \quad e = 173.5 \quad e/d = 3.691$$

$$\text{TRY } J = 0.910 \quad C = 1.327 \quad m = g = 0.0489 \quad k = 0.268 \quad j = 0.911$$

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

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

ECT SEP TOPIC II-2 LAI 82251.09

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

WIND LOAD COMBINATIONS TURBINE BLDG

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 IS	247 IS	347 IS	447 IS	547 IS	647 IS	747 IS	847 IS	947 IS	1047 IS
P	54.6	58.3	59.2	66.6	66.1	74.6	81.6	81.9	54.3	41.8
M	574.4	668.0	714.3	764.8	785.7	763.9	710.7	656.4	562.6	484.9
		✓	✓	✓	✓	✓	✓	✓		

COLUMN LINE 5

$$P = 66.1 \text{ K} \quad M = 785.7 \text{ K}'$$

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

$$e/d = 163.6/51 = 3.209$$

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

$$m = 8 - \frac{(9)(5.00)(1.396)}{(29)(51)} = 0.0425$$

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

$$j = 1 - \frac{0.252}{3} = 0.916 \sim 0.91 \text{ OK}$$

$$f_s = \frac{(66.1)(3.209)}{(0.916)(5.00)(1.396)} = 33.15 \text{ ksi} > 22 \text{ ksi}$$

$$f_c = \frac{(33.18)(0.252)}{(9)(1 - 0.252)} = 1.241 \text{ ksi} > 1.12 \text{ ksi}$$

ECT SEP TOPIC III.2 LAR 82251.09

WIND LOAD COMBINATION

TURBINE BLOCK

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 11/24/83

CHECK COL LINE 4

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

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

$$e/d = 158.8/51 = 3.114$$

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

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

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

$$j = \frac{1 - 0.253}{3} = 0.016 \sim 0.91 \quad OK$$

$$f_s = \frac{(66.6)(3.114)}{(0.016)(5.00)(1.413)} = 32.05 \text{ ksi} > 22 \text{ ksi}$$

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

CHECK COL LINE 6

$$P = 74.6^k \quad M = 763.9^k'$$

$$e = \frac{763.9 \times 12}{74.6} + 21 = 143.9"$$

$$e/d = 143.9/51 = 2.821$$

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

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

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

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

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

SUBJECT SEP TOPIC II-2 LAT 82251.07

CALC. NO. C-1302-451-5320-006
SHEET NO. 44 OF 57
DATE 10/12/83
COMP. BY/DATE FH 11/6/83
CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS TURBINE PILES

CHECK COL LINE 3

$P = 59.2^k$ $M = 74.3^k'$

$e = \frac{74.3 \times 12}{59.2} + 21 = 165.8$
 $e/d = 165.8/51 = 3.25$

$w/d = 0.9$ $c = \frac{1}{(1 - \frac{e}{3.25})} = 1.383$

$m = 2 = \frac{(9)(0.277)(1.383)}{(29)(51)} = 0.053$

$k = 0.277$ $j = 0.908$ OK

$f_s = \frac{(59.2)(3.25)}{(0.908)(6.25)(7.395)} = 24.40^k > 22^k$ N.G.

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

CHECK COL LINE 7

$P = 59.0^k$ $M = 710.7^k'$

~ SAME AS COL LINE 3

CHECK COL LINE 2

$P = 58.3^k$ $M = 668^k'$

$e = \frac{668 \times 12}{58.3} + 21 = 158.5$
 $e/d = 158.5/51 = 3.108$

$w/d = 0.91$ $c = \frac{1}{(1 - \frac{e}{3.108})} = 1.414$

$m = 2 = \frac{(9 \times 5.00)(1.414)}{(29)(51)} = 0.0438$

$k = 0.253$ $j = 0.916$ OK

$f_s = \frac{(58.3)(3.108)}{(0.916)(5.00)(1.414)} = 27.98^k > 22^k$ N.G.

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

CHECK COL LINE 8

$P = 59.9^k$ $M = 656.4^k'$

~ SAME AS COL LINE 2

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLADE

CHECK COLUMN LINE 1

$$P = 54.6^k \quad M = 574.4^k' \quad e = 147.2 \quad e/d = 2.887$$

$$\text{TRY } j = 0.91 \quad L = 1.460 \quad m = \gamma = 0.0444 \quad k = 0.257 \quad j = 0.914$$

$$f_s = \frac{(54.6)(2.887)}{(0.914)(5.00)(1.460)} = 23.62^k \quad > 22^k$$

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

CHECK COLUMN LINE 9

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

$$\text{TRY } j = 0.91 \quad L = 1.469 \quad m = \gamma = 0.0447 \quad k = 0.258 \quad j = 0.914$$

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

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

CHECK COLUMN LINE 10

$$P = 49.8^k \quad M = 484.9^k' \quad e = 137.8 \quad e/d = 2.703$$

$$\text{TRY } j = 0.91 \quad L = 1.5075 \quad m = \gamma = 0.0459 \quad k = 0.260 \quad j = 0.913$$

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

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

SUBJECT SEP TOPIC II.2 LAT 82251.09

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

SHEET NO. 46 OF 57

DATE 10/14/83

COMP. BY/DATE PH 11/18/83

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

WIND LOAD COMBINATIONS TURBINE BARS

BASED ON 3D FRAME ANALYSIS

W33X120 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	28.8	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.

PROJECT SEP TOPIC II:2 LAF 82251.09

 CALC. NO. C-1302-151-5320-086
 SHEET NO. 47 OF 57
 DATE 10/12/83
 COMP. BY/DATE FH 11/16/83
 CHK'D. BY/DATE DBT 11/22/83

WIND LOAD COMBINATIONS TURBINE RUN

 SUMMARY MAXIMUM ANCHOR BOLT AND CONCRETE
 BEARING OVERSTRESS BASED CURRENT CRITERIA

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	
Ⓐ	OK	31.51 ^{ksi}	22.74 ^{ksi}	34.84 ^{ksi}	42.31 ^{ksi}	34.84 ^{ksi}	31.29 ^{ksi}	30.24 ^{ksi}	24.50 ^{ksi}	OK	LDG 14 BOLT CONC
	OK	1.191	OK	1.346	1.612	1.346	1.260	1.161	OK	OK	
Ⓕ	23.62 ^{ksi}	27.98 ^{ksi}	29.40 ^{ksi}	32.05 ^{ksi}	33.15 ^{ksi}	31.20 ^{ksi}	24.40 ^{ksi}	27.98 ^{ksi}	23.05 ^{ksi}	OK	LDG 15 BOLT CONC
	OK	OK	OK	1.206	1.241	1.205	OK	OK	OK	OK	
Ⓖ	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	LDG 14 BOLT CONC
	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	

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

$$\text{BOLT} = 22 \times 4/3 = 29.33 \text{ ksi}$$

$$\text{CONC} = 1.125 \times 4/3 = 1.50 \text{ ksi}$$

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

$$\text{BOLT} = 22 \text{ ksi}$$

$$\text{CONC} = 1.125 \text{ ksi}$$

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

SUBJECT SEP TOPIC III-2 LAI 82251.09

CALC. NO. C-1302-151-5320-004
 SHEET NO. 48 OF 57
 DATE 10/14/83
 COMP. BY/DATE PH 11/18/83
 CHK'D. BY/DATE DBT 11/24/83

WIND LOAD COMBINATIONS TURBINE BDR

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 @	ACTUAL MAX LD	MEMBER NO'S
DIAGONAL T 5x3x2	T 161.7 C 97.0	84.8 11.4	C 9 38 42 } OK
DIAGONAL T 5x3x2	T 103.7 C 59.3	41.5 6.6	14 18 22 26 30 34 } OK
VERTICAL T 5x3x2	T 123.7 C 94.0	8.0 53.0	11 12 36 40 } OK
VERTICAL T 5x3x2	T 103.7 C 74.7	68.8 25.1	16 20 24 28 32 } OK
TOP CHORD T 8x6x9	T 320.6 C 290.2	26.4 135.7	7 8 13 19 21 25 29 } OK 33 37 41
BOT CHORD T 8x6x5	T 354.4 C 292.6	129.2 56.1	5 10 15 17 23 27 31 } OK 35 39 43

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

CALC. NO. 49 OF 57
SHEET NO. 49 OF 57
DATE 10/14/83
COMP. BY/DATE FH M/18/83
CHK'D. BY/DATE DBT 11/22/83

SUBJECT SEP DRC III-2 LAI 82251.09

WIND LOAD COMBINATIONS
TURBINE BLDG

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

MEMBERS 501 502 503 504

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

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

PREVIOUSLY EXAMINED CASE WAS MORE CRITICAL
THEREFORE COL IS OK

MEMBERS 544 545 546 547

$$M_{BASE} (MAX) = 735.7^k \cdot 9428^k \quad < 2D = 9919^k$$

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

PREVIOUSLY EXAMINED CASE WAS MORE CRITICAL
THEREFORE COLUMN IS OK

MEMBERS 549

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

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

$$\frac{1}{2} \cdot \frac{29}{38.3} = 0.76^k$$

$$\frac{0.76}{12.07} = 0.0642 < 0.15$$

$$\frac{1}{2} \cdot \frac{3656}{400} = 9.00^k$$

$$\frac{9.00}{17.75} = 0.456$$

$$0.0642 + 0.455 = 0.497 < 1.00 \quad OK$$

SUBJECT SEP TOPIC III-2 LAI 82251.09

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

SHEET NO. 49A. OF 57

DATE 11-23-83

COMP. BY/DATE D.B.T. 9-15-83

CHK'D. BY/DATE F.N. 11/23/83

WIND LOAD COMBINATIONS
(TURBINE BLDG.)TO DETERMINE PULL-OUT VALUE OF ANCHOR BOLTS.

FROM AISC SPEC 1.5.2.1 & ASTM A307

 $F_t = 20 \text{ KSI}$ & $F_u = \text{YIELD STRESS} = 36 \text{ KSI}$

YIELD CAPACITY

$$T = F_u \times A_T = 36 \times 2.50 = 90 \text{ KSI}$$

$$\text{BOND STRENGTH} = \pi D L (250)$$

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

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

$$= 64.5 \text{ K}$$

BEARING ON THE HOOK

$$= \phi F_c' d H$$

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

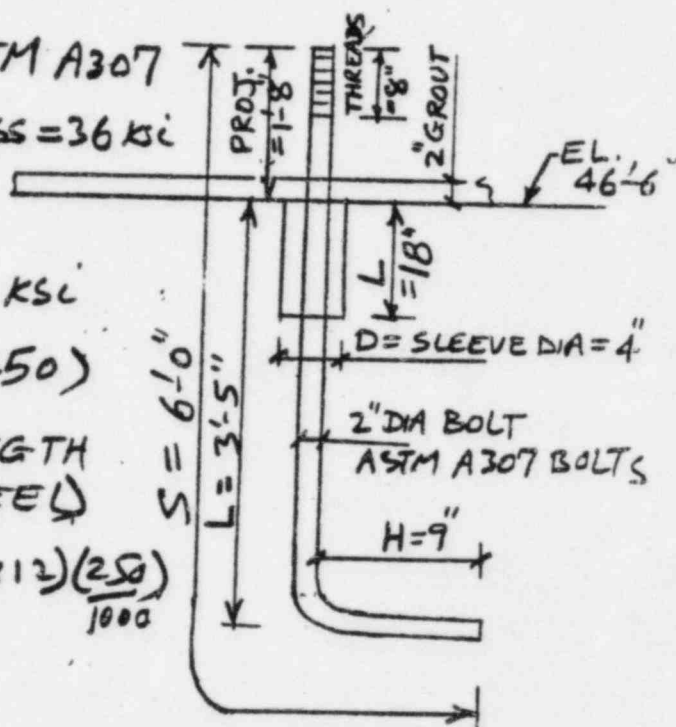
$$= 37.8 \text{ K}$$

ULTIMATE PULLOUT CAPACITY BASED ON EMBEDMENT

$$= 64.5 + 37.8 = 102.3 \text{ K} > 90 \text{ K}$$

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.



WIND LOAD COMBINATIONS TURBINE BLDG

FROM COMPUTER OUTPUT "HAREKEZ"

- BASE MOMENT AT COLUMNS A.4, B & G IS FIXED AT ANCHOR BOLT YIELD MOMENT CAPACITY
- LOADING IS FOR TL + 80MPH WL IN TX 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	7123				7773	7167	6012	4573
	✓	✓	✓				✓	✓	✓	

CHECK col A.7

$$e = \frac{7773}{53} + 21 = 167.7' \quad e/d = 3.567$$

$$w/d = 0.92 \quad i = 1.3475 \quad m = g = 0.04962 \quad k = 0.269 \quad \delta = 0.910$$

$$f_3 = \frac{(53)(3.567)}{(0.910)(5.0)(1.3475)} = 30.83 \text{ ksi}$$

$$f_0 = \frac{(30.83)(0.269)}{(9)(1 - 0.269)} = 1.26 \text{ ksi}$$

col A.3

$$e = \frac{7123}{36} + 21 = 235.5' \quad e/d = 5.011$$

$$w/d = 0.92 \quad i = 1.2249 \quad m = g = 0.0451 \quad k = 0.2586 \quad \delta = 0.914$$

$$f_3 = \frac{(36)(5.011)}{(0.914)(5.0)(1.2249)} = 32.22 \text{ ksi}$$

$$f_0 = \frac{(32.22)(0.2586)}{(9)(1 - 0.2586)} = 1.25 \text{ ksi}$$

COL A-2

$$e = \frac{7371}{39} + 21 = 210.07 \quad e/d = 4.4371$$

$$w/d = 0.92 \quad L = 1.2599 \quad m = g = 0.0464 \quad k = 0.262 \quad j = 0.913$$

$$f_s = \frac{(39)(1.9697)}{(0.913)(5)(1.2599)} = 30.31 \text{ ksi}$$

$$f_c = \frac{(30.31)(0.262)}{(9)(1-0.262)} = 1.196 \text{ ksi}$$

COL A-8

$$e = \frac{7167}{29} + 21 = 268.1 \quad e/d = 5.705$$

$$w/d = 0.92 \quad L = 1.1923 \quad m = g = 0.0439 \quad k = 0.256 \quad j = 0.915$$

$$f_s = \frac{(29)(5.705)}{(0.915)(5)(1.1923)} = 30.33 \text{ ksi}$$

$$f_c = \frac{(30.33)(0.256)}{(9)(1-0.256)} = 1.160 \text{ ksi}$$

COL A-9

$$e = \frac{6012}{35} + 21 = 192.77 \quad e/d = 4.1015$$

$$w/d = 0.92 \quad L = 1.2892 \quad m = g = 0.0475 \quad k = 0.264 \quad j = 0.912$$

$$f_s = \frac{(35)(4.1015)}{(0.912)(5)(1.2892)} = 24.42 \text{ ksi OK}$$

$$f_c = \frac{(24.42)(0.264)}{(9)(1-0.264)} = 0.973 \text{ ksi OK}$$

COL A-1

$$e = \frac{5502}{36} + 21 = 173.8 \quad e/d = 3.699$$

$$w/d = 0.91 \quad L = 1.3263 \quad m = g = 0.04884 \quad k = 0.267 \quad j = 0.911$$

$$f_s = \frac{(36)(3.699)}{(0.911)(5)(1.3263)} = 22.04 \text{ ksi OK}$$

$$f_c = \frac{(22.04)(0.267)}{(9)(1-0.267)} = 0.892 \text{ ksi OK}$$

SUBJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. 52 OF 57
SHEET NO. 52 OF 57
DATE 11/8/83
COMP. BY/DATE PH 11/18/83
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

$$e = \frac{8122}{60} + 21 = 156 \quad e/d = 3.066$$

$$w/j = 0.91 \quad z = 1.4220 \quad u = g = 0.04327 \quad k = 0.254 \quad j = 0.915$$

$$f_s = \frac{(60 \times 3.066)}{(0.915 \times 5 \times 1.4220)} = 28.27 \text{ ksi OK}$$

$$f_c = \frac{(28.27)(0.254)}{(9)(1-0.254)} = 1.070 \text{ ksi OK}$$

COL F.4

$$e = \frac{7974}{61} + 21 = 151.7 \quad e/d = 2.975$$

$$w/j = 0.91 \quad z = 1.4407 \quad u = g = 0.0438 \quad k = 0.255 \quad j = 0.915$$

$$f_s = \frac{(61 \times 2.975)}{(0.915 \times 5 \times 1.4407)} = 27.53 \text{ ksi}$$

$$f_c = \frac{(27.53)(0.255)}{(9)(1-0.255)} = 1.047 \text{ ksi OK}$$

COL F.6

$$e = \frac{7859}{57} + 21 = 158.9 \quad e/d = 3.115$$

$$w/j = 0.91 \quad z = 1.4127 \quad u = g = 0.04298 \quad k = 0.250 \quad j = 0.917$$

$$f_s = \frac{(57)(3.115)}{(0.917)(5)(1.4127)} = 27.41 \text{ ksi}$$

$$f_c = \frac{(27.41)(0.250)}{(9)(1-0.250)} = 1.015 \text{ ksi OK}$$

PROJECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURKINE BLDG

COL F-3

$$e = \frac{7566}{54} + 21 = 161.1 \quad e/d = 3.159$$

$$w/y = 0.01 \quad z = 1.4046 \quad m = g = 0.0427 \quad k = 0.255 \quad \gamma = 0.916$$

$$f_s = \frac{(54)(3.159)}{(0.916)(5)(1.4046)} = 26.52 \text{ ksi}$$

$$f_c = \frac{(26.52)(0.255)}{(9)(1-0.255)} = 0.998 \text{ ksi}$$

COL F-7

$$e = \frac{7367}{68} + 21 = 129.3 \quad e/d = 2.536$$

$$w/y = 0.92 \quad z = 1.5693 \quad m = g = 0.04775 \quad k = 0.265 \quad \gamma = 0.912$$

$$f_s = \frac{(68)(2.536)}{(0.912)(5)(1.5693)} = 24.10 \text{ ksi}$$

$$f_c = \frac{(24.10)(0.265)}{(9)(1-0.265)} = 0.965$$

COL F-2

$$e = \frac{7048}{64} + 21 = 131.1 \quad e/d = 2.571$$

$$w/y = 0.92 \quad z = 1.5572 \quad m = g = 0.04738 \quad k = 0.264 \quad \gamma = 0.912$$

$$f_s = \frac{(64)(2.571)}{(0.912)(5)(1.5572)} = 23.17 \text{ ksi}$$

$$f_c = \frac{(23.17)(0.264)}{(9)(1-0.264)} = 0.924 \text{ ksi}$$

COL F-8

$$e = \frac{6839}{55} + 21 = 145.3 \quad e/d = 2.8499$$

$$w/y = 0.92 \quad z = 1.4767 \quad m = g = 0.04493 \quad k = 0.258 \quad \gamma = 0.914$$

$$f_s = \frac{(55)(2.8499)}{(0.914)(5)(1.4767)} = 23.22 \text{ ksi}$$

$$f_c = \frac{(23.22)(0.258)}{(9)(1-0.258)} = 0.897 \text{ ksi}$$

ECT SEP TOPIC III-2 LAI 82251.09

WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. C-132-151-5320-006
SHEET NO. 54 OF 57
DATE 11/8/83
COMP. BY/DATE FH 11/15/83
CHK'D. BY/DATE DBT 11/22/83

COL F.1

$$e = \frac{6297}{29} + 21 = 192.46 \quad G_d = 3.578$$

$$w/y = 0.9 \quad i = 1.346 \quad m = g = 0.4096 \quad k = 0.248 \quad j = 0.917$$

$$f_s = \frac{(29)(3.578)}{(0.917)(5)(1.346)} = 22.61 \text{ ksi} \quad \text{say OK}$$

$$f_c = \frac{(22.61)(0.248)}{(9)(1.0.248)} = 0.829 \text{ ksi}$$

SUBJECT SEP TOPIC III-2 LAF 82251.09
WIND LOAD COMBINATIONS TURBINE BLDG

CALC. NO. 6-1704-151-5220-006
 SHEET NO. 55 OF 57
 DATE 11/8/83
 COMP. BY/DATE PH 11/18/83
 CHK'D. BY/DATE DBT 11/21/83

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	24	25	22	17
M	2896	3117	3270	3418	3485	3393	3185	2943	2627	2519

COL F.B

$$e = \frac{3485}{29} + 19.5 = 139.67 \quad e/d = 3.104$$

$$w/\gamma = 0.91 \quad z = 1.4148 \quad m = g = 0.0786 \quad k = 0.326 \quad \gamma = 0.891$$

$$f_s = \frac{(29)(3.104)}{(0.891)(5)(1.4148)} = 14.44 \text{ ksi OK}$$

$$f_c = \frac{(14.44)(0.326)}{(9)(1 - 0.326)} = 0.776 \text{ ksi OK}$$

SUBJECT SEP TOPIC III-2 LAI 8228.09

WIND LOAD COMBINATIONS TURBINE BURG

CALC. NO. 56 OF 57
 SHEET NO. 56 OF 57
 DATE 11/15/83
 COMP. BY/DATE PH 11/15/83
 CHK'D. BY/DATE DBT 11/22/83

**SUMMARY MAXIMUM ANCHOR BOLT AND CONCRETE
 BEARING OVERSTRESS BASED ON CURRENT CRITERIA**

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Ⓐ	OK OK	31.31 OK	32.22 1.25	OK OK	OK OK	OK OK	30.83 1.26	30.53 1.26	OK OK	OK OK
Ⓔ	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
Ⓜ	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.

SEP TOPIC II-2 LAI 82251.09

WIND LOAD COMBINATIONS

CALC. NO. C-1302-151-1220-0000
 SHEET NO. 57 OF 57
 DATE 10/25/83
 COMP. BY/DATE PH 11/18/83
 CHK'D. BY/DATE D.B.T. 11/22/83

WIND LOADS ON CONCRETE FRAME

① COMPARE SHEAR @ ELEV 46'-0" FOR
TORNADO VS. EARTHQUAKE

$$\text{TORNADO SHEAR @ 80 mph } P = 16.4 \text{ psf}$$

$$P (\text{TOTAL}) = (16.4)(1.3) = 21.3 \text{ psf}$$

$$\text{EFFECTIVE AREA} = (269.7)(62.7) = 16,935 \text{ s.f.}$$

$$\text{WIND SHEAR} = (0.0213)(16,935) = 360 \text{ k @ 80 MPH}$$

SEISMIC SHEAR FOR SSE

$$\text{REF 13 PAGE 36 OBE SHEAR @ EL 46'-0" @ 8k 23.6k}$$

$$\therefore \text{OBE GOVERNS OVER DESIGN WIND}$$

WIND WILL NOT GOVERN FRAME DESIGN
 SINCE SEISMIC SHEAR ACCUMULATES MORE
 RAPIDLY THAN WIND SHEAR WITHIN THE
 CONCRETE PORTION.

② CHECK COMPONENTS - WALL

$$\text{WIND WALL PRESSURE} = 16.4 \times 0.8 = 13.1 \text{ psf}$$

REF DWG 4019 SECTION C-C

WALL REINF #8 @ 12"

$$d = 30 - (2 + 2) = 26 \text{ in}$$

$$\text{SPAN} = 23'-0"$$

FOR MOST CRITICAL CONDITION, ASSUME
 SIMPLE SPAN

$$M = (0.0131)(23)^2 / 8 = 0.866 \text{ k}$$

$$M_u = (0.866)(1.4) = 1.21 \text{ k}$$

$$F_{AVAIL} = \frac{(12)(33.5)^2}{12,000} = 1.122$$

$$K_{REQ} = \frac{1.21}{1.122} = 1.08$$

$$f = 0.79 / (12)(33.5) = 0.0020$$

$$K_u \text{ AVAIL } \approx 80 > K_{REQ} \therefore \text{OK}$$

ATTACHMENT III

TURBINE BUILDING ROOF: WIND LOAD ANALYSIS

TURBINE BUILDING ROOF WIND LOAD

PROBLEM

OYSTER CREEK SEP TOPIC II-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	FURLIN	TRUSS (5)	DECK	FURLIN	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	0.47 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 COMPIN 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 FAL THE DECKING / PURLIN CONNECTION THEREBY RELASING THE DECKING AND RELIEVING PRESSURE AND ANY FURTHER PURLIN DEFORMATION. DECKING WOULD BE

SUBJECT O.C. SEP TOPIC II:2

SHEET NO. 2 OF 13

DATE 2/16/83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE T.H.C. 4/05/83

TURBINE BUILDING ROOF WIND LOAD

- 5) CARRIED UP AND AWAY FROM THE TURBINE BUILDING WITHOUT POSING A HAZARD TO ITS CONTENTS. 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. SEPTOPIC II-2

SHEET NO. 22 OF 13

DATE 1-19-84

COMP. BY/DATE PH 1-19-84

CHK'D. BY/DATE HC 1/23/84

TURBINE BUILDING ROOF WIND LOAD

CONCLUSIONS (CONT'D)

CAPACITY OF ELEMENTS IN ACCORDANCE WITH
ALLOWABLE STRESS LEVELS OF KUREG 3 & 4

	VELOCITY	DEPRESSURIZATION
PURLINE	134 MPH	0.22 PSF
ROOF TRUSS	235 MPH	0.69 PSI
DECK	275 MPH	0.94 PSI

SUBJECT... P. G. SELF REVIEW TOPIC II-2

CALC. NO. ... 3 ... OF ... 13

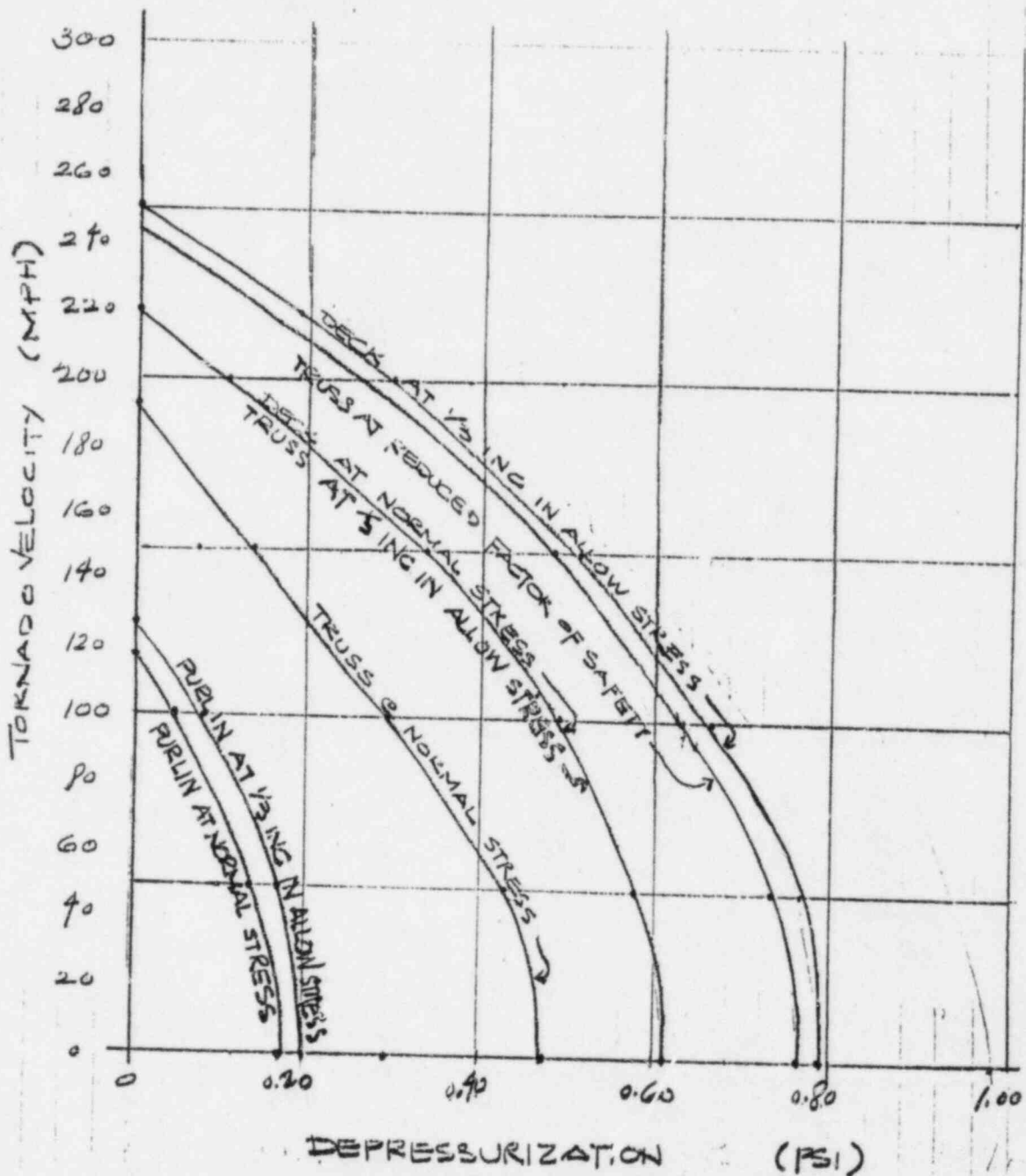
SHEET NO. ... 3 ... OF ... 13

DATE ... 2-22-83

COMP. BY/DATE P.H. 3/11/83

CHK'D. BY/DATE T.H. 4/6/83

1. TURBINE BUILDING ROOF WIND LOAD



TURBINE BUILDING ROOF COMPONENT CAPACITY
AT VELOCITY / PRESSURE COMBINATIONS

SUBJECT 0.0 SEP REVIEW TOPIC III-2

TURBINE BLDG ROOF WIND LOAD

FILE NO. 100-100000-100000

SHEET NO. 4 OF 13

DATE 2.15.83

COMP. BY/DATE PH. 3/11/83

CHK'D. BY/DATE T.H.C. 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' SF
RIGID INSULATION - CELLULAR GLASS
BUILT UP ROOFING - 4 FLY WITH GRAVEL

ASSEMBLY WEIGHT

ROOFING	5.5 #/sq'
INSULATION	0.7 #/sq'
DECKING	2.9 #/sq'
	<u>9.1 #/sq'</u> TOTAL

DECK SECTION PROPERTIES - REF ROBERTSON CAT.
+S = 0.398 IN²
-S = 0.380 IN²
MATERIAL = ASTM A446 F_y = 33 ksi

CONSIDER SIMPLE SPAN - CRITICAL CASE

AT BASIC ALLOWABLE STRESS OF 20 ksi

$$M_{\text{ALLOW}} = f_s \cdot (20)(0.380)/12 = 0.633 \text{ k'} \\ = 633 \text{ FT-LB}$$

$$M = wL^2/8$$

$$w = 8M/L^2 = (8)(0.633)/8^2 = 0.079 \text{ k'/ft} \\ = 79 \text{ #/ft}$$

NET ALLOWABLE UPLIFT

$$\begin{array}{r} 79 \text{ #/ft DECK CAPACITY} \\ 9.1 \text{ #/ft ASSEMBLY WEIGHT} \\ \hline 88.1 \text{ #/ft} \end{array}$$

$$\rightarrow 0.61 \text{ PSI}$$

EQUIVALENT WIND VELOCITY

FLAT ROOF SHAPE FACTOR = 0.7

EQUIVALENT HORIZ PRESS = 88.1/0.7 = 125.8

$$V = \sqrt{\frac{125.8}{0.00256}} = 221.6 \text{ MPH}$$

SUBJECT O.C. SEP REVIEW TOPIC II-2

SHEET NO. 5 OF 13

DATE 2-15-83

COMP. BY/DATE P.H. 3/11/83

CHK'D. BY/DATE T.H.K. 4/6/83

TURBINE BLDG ROOF WIND LOAD

CHECK DECK UPLIFT CAPACITY WITH $\frac{1}{3}$ INCREASE IN ALLOWABLE STRESS

$$w = (4/3)(79.0) = 105.3 \text{ \#/ft}^2$$

$$\frac{9.1}{114.4} \text{ \#/ft}^2 \text{ NET UPLIFT}$$

$$\hookrightarrow 0.79 \text{ PSI}$$

EQUIVALENT WIND VELOCITY

$$V = \sqrt{\frac{114.4/0.7}{0.00256}} = 252.7 \text{ MPH}$$

TURBINE BUILDING PURLINS

16831 - SPAN VARIES 36'-9 1/2" MAX @ 8' 9"

$$S = 47.2 \text{ IN}^3 \quad r_T = 1.39 \text{ IN}$$

$$L_U = 7.1 \text{ FT} \quad b/2t_f = 6.5 \quad C_b = 1.0$$

$$L/r_T = (12)(36.79)/1.39 = 317.6 > \sqrt{\frac{510 \times 10^3}{F_y}} = 119$$

$$F_b = \frac{170000}{(317.6)^2} = 1.68 \text{ KSI} \quad F_b = \frac{(12000)(5.525)(0.44)}{(36.79)(12)(16)} = 4.1$$

GOVERNS -

$$M = (4.13)(47.2)/12 = 16.24 \text{ K'}$$

$$w = (16.24)(8)/(36.79)^2(8) = 0.012 \text{ K/ft}^2 \uparrow$$

$$12 \text{ \#/ft}^2 \uparrow$$

TOTAL UPLIFT CAPACITY

$$\text{BM WGT } 3/8 = 3.9 \text{ \#/ft}^2$$

$$\text{DECK ASS'T } 9.1$$

$$\text{UPLIFT CAPACITY } \frac{12.0}{25.0} \text{ \#/ft}^2$$

$$\hookrightarrow 0.174 \text{ PSI}$$

SUBJECT O.C. SEP REVIEW TOPIC II-2

1 TURBINE BLDG ROOF WIND LOAD

SHEET NO. 0 OF 13

DATE 2-15-83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE T/C 2/10/83

EQUIVALENT VELOCITY

$$V = \sqrt{\frac{25.07}{0.00256}} = 118 \text{ MPH}$$

CHECK UPLIFT CAPACITY WITH 1/3 INCREASE IN ALLOWABLE STRESS

$$w = 4/3 \times 12 = 16.0$$

$$\begin{array}{r} 9.1 \\ 3.9 \\ \hline 29.0 \text{ \#/ft} \end{array}$$

→ 0.20 PSI

EQUIVALENT WIND VELOCITY

$$V = \sqrt{\frac{29/0.7}{0.00256}} = 127.2 \text{ MPH}$$

CHECK PURLIN END CONNECTION CAPACITY

$$\text{PURLIN END REACTION} = \frac{(12)(8)(36.79)(1/2)}{1000} = 11.76$$

PURLINS FRAME OVER TOP OF ROOF TRUSSES
ALLOW FOR (2) 3/4" A325 BOLTS FROM
BOTTOM FLANGE OF PURLIN TO TRUSS
TOP CHORD.

CAPACITY OF A325 BOLT IN TENSION

$$P_T = 19.4 \text{ K/BOLT}$$

$$19.4 \times 2 = 38.8 \text{ K} > R = 11.76 \text{ K}$$

CONNECTION OK FOR 1/3 INC IN
ALLOWABLE STRESS BY OBSERVATION.

SUBJECT ... O.G. SEP REVIEW TOPIC III-2

✓ TURBINE BLDG ROOF WIND LOAD

CALC. NO. 4-1507-151-0000-001

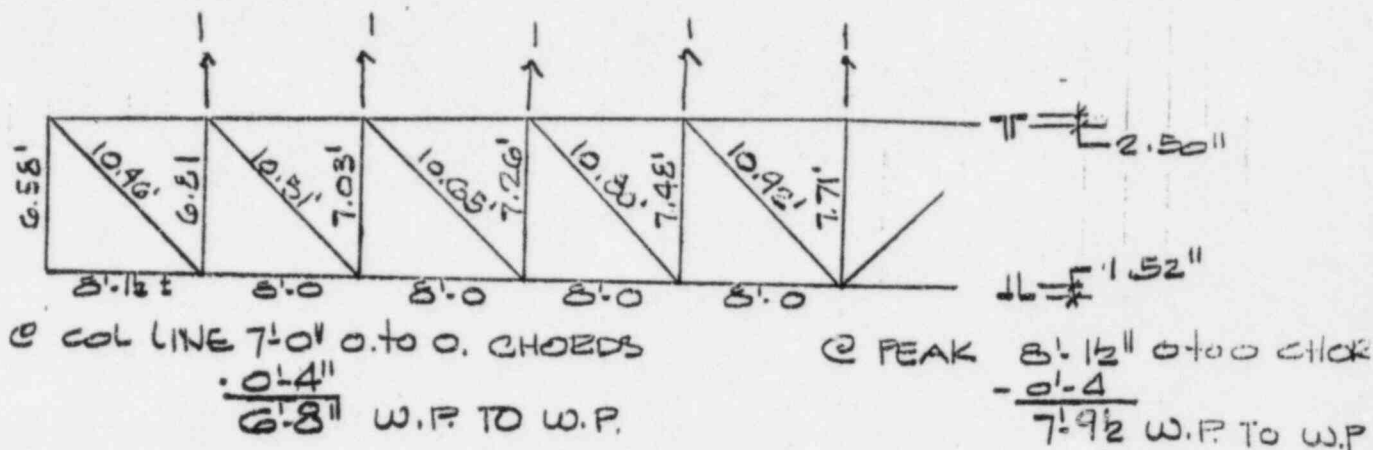
SHEET NO. 7 OF 13

DATE 2-16-83

COMP. BY/DATE P.H. 3/11/83

CHK'D. BY/DATE T.H. 4/6/83

ROOF TRUSS CAPACITY

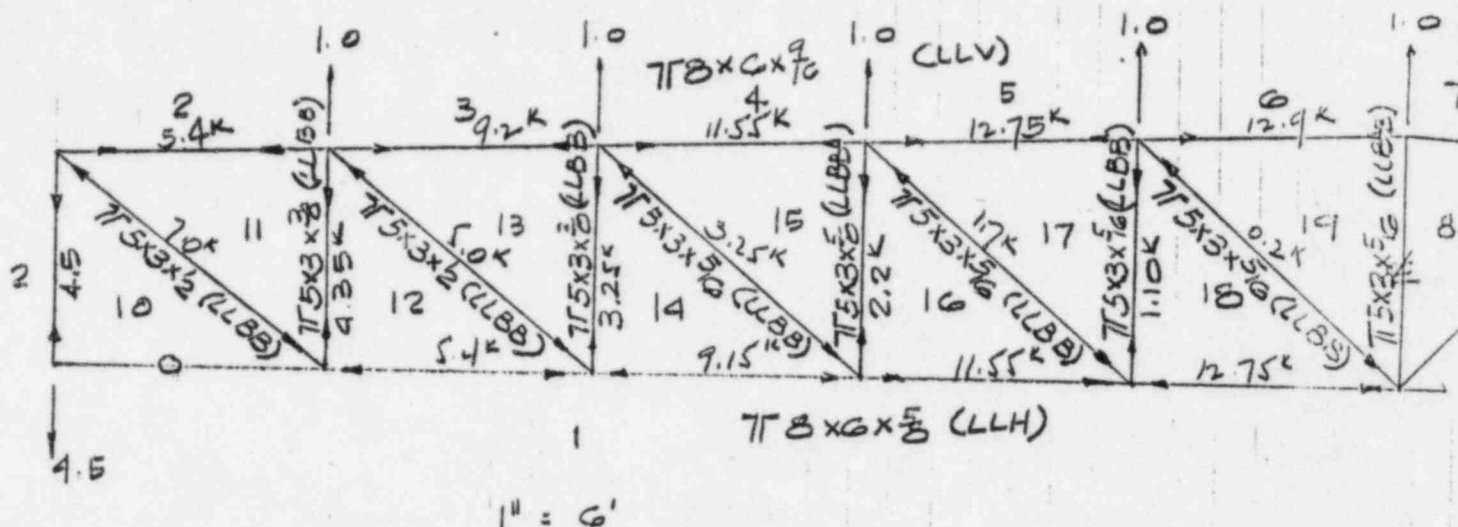


$$\text{ROOF SLOPE} = 13 \frac{1}{2}'' / 40'-1 \frac{1}{2}'' = 0.336'' / 12''$$

ANALYZE TRUSS FOR UNIT LOADS AT PANEL POINTS
 AND ISOLATE CRITICAL MEMBER

TURBINE BLDG ROOF WIND LOAD

REV 1



SUBJECT Q.C. SEP REVIEW TOPIC III-2

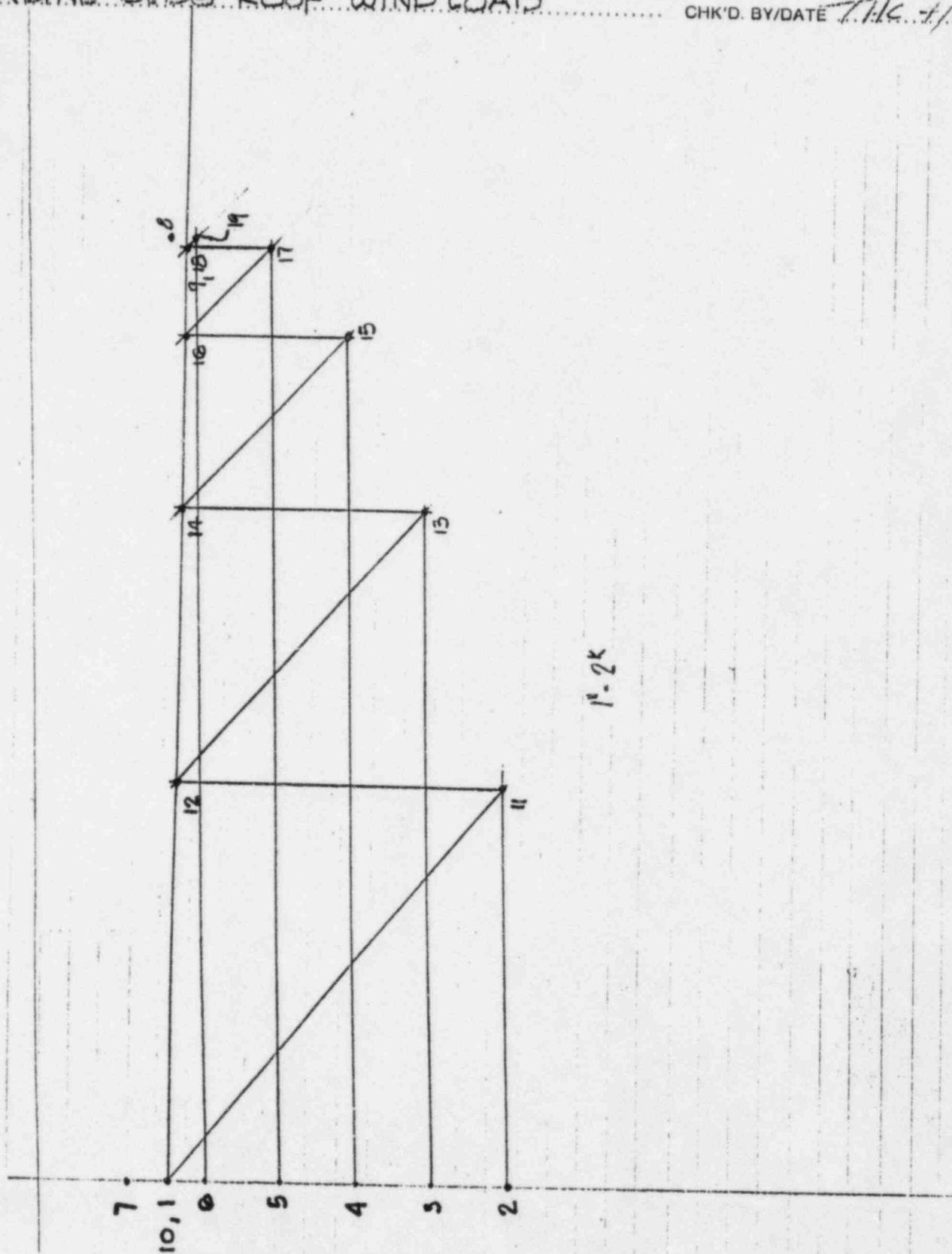
SHEET NO. 9 OF 13

DATE 2-16-83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE T/K 4/4/83

TURBINE BLDS ROOF WIND LOAD



SUBJECT O.C. SEP REVIEW TOPIC III-2

CALC. NO. C-1304-151-2230-001

SHEET NO. 10 OF 13

DATE 2-16-83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE TNC 9/6/83

TURBINE BLDG. ROOF WIND LOAD

REV 1

$$\begin{aligned} \text{TF } 5 \times 3 \times 2 \quad \text{TF} \quad A &= 2 \times 3.75 = 7.50 \text{ in}^2 \\ L_x = L_y &= 10.46' \quad r_x = 1.59'' \\ I_y &= (2)(2.53) + (3.75)(0.75 + 3 \times 2)^2(2) = 11.75 \text{ in}^4 \\ r_y &= (11.75/7.50)^{1/2} = 1.25'' \\ KL/r_y &= (10.46)(12)/1.25 = 100.4 \\ F_a &= 12.93 \text{ ksi} \\ P &= (7.50)(12.93) = 97.0 \text{ k C} \end{aligned}$$

$$\begin{aligned} \text{TF } 5 \times 3 \times 3/8 \quad A &= 2 \times 2.40 = 4.80 \text{ in}^2 \\ L_x = L_y &= 10.65' \quad r_x = 1.61'' \\ I_y &= (2)(1.75) + (2.40)(0.68 + 3 \times 2)^2(2) = 7.12 \text{ in}^4 \\ r_y &= (7.12/4.80)^{1/2} = 1.22'' \\ KL/r_y &= (10.65)(12)/1.22 = 104.8 \\ F_a &= 12.36 \text{ ksi} \\ P_{\text{ALLOW}} &= (12.36)(4.80) = 59.3 \text{ k C} \end{aligned}$$

$$\begin{aligned} \text{TF } 5 \times 3 \times 3/8 \quad A &= 2 \times 2.86 = 5.72 \text{ in}^2 \\ \text{ALLOW FOR (1) } 15/16'' \phi \text{ HOLE } A_{\text{NET}} &= 5.72 - (15/16)(3/8)(2) = 5.02 \\ P_{\text{ALLOW}} &= (5.72)(22) = 125.8 \text{ k T} \\ P_{\text{ALLOW}} &= (0.85)(5.02)(0.5)(58) = 123.7 \text{ k GOVERNS} \\ \text{TF } 5 \times 3 \times 5/16 \quad A &= 2 \times 2.40 = 4.80 \text{ in}^2 \\ \text{ALLOW FOR (1) } 15/16'' \phi \text{ HOLE } A_{\text{NET}} &= 4.80 - (15/16)(5/16)(2) = 4.21 \\ P_{\text{ALLOW}} &= (4.80)(22) = 105.6 \text{ k} \\ P_{\text{ALLOW}} &= (4.21)(0.85)(0.5)(58) = 103.7 \text{ k GOVERNS} \end{aligned}$$

CHECK % UTILIZATION OF EACH SECTION

TF 8x6x9/16 TOP CHORD	12.9/238 = 5.4	0.045, 0.037 Δ PH 1/19
TF 8x6x5/8 BOT CHORD	12.75/292.6	0.044
TF 5x3x2 DIAGONAL	7.0/97.0	0.072 ←
TF 5x3x5/16 DIAGONAL	1.7/59.3	0.029
TF 5x3x3/8 VERTICAL	4.35/123.7	0.0352
TF 5x3x5/16 VERTICAL	1.10/103.7	0.0106

DIAGONAL TF 5x3x2 GOVERNS.

ALLOWABLE PANEL POINT LOAD = 97/7 = 13.86 k ↑

ADD TRUSS WEIGHT FOR NET ALLOWABLE

SUBJECT O.C. SEP REVIEW TOPIC III-2

CALC. NO. 44774
SHEET NO. 11 OF 13
DATE 2-16-83
COMP. BY/DATE PH. 3/11/83
CHK'D. BY/DATE T.H.G. 4/2/83

TURBINE BLDG. ROOF WIND LOAD

TRUSS WEIGHT @ ONE PANEL POINT

8'	TF 8x6x	9	@ 51.4 #/FT	=	411.2
8'	TF 8x6x	5	@ 57.0	=	456.0
7.03'	TF 5x3x	3	@ 19.6	=	137.8
5.25'	TF 5x3x	2	@ 25.6	=	134.4
5.33'	TF 5x3x	1	@ 16.4	=	87.4
					<u>1226.8 #</u>
					SAY 1.22K

NET ALLOWABLE PANEL POINT LOAD

$$\begin{array}{r} 13.86 \\ 1.22 \\ \hline \end{array}$$

15.08 K = PURLIN REACTION (TOTAL OF 2)

PURLIN LENGTHS = 36'-9 1/2' AND 33'-5 1/2'

$$\text{CONTRIB LGTH} = \frac{36.79 + 33.46}{2} = 35.13'$$

$$w = \frac{15.08}{(35.13)(3)} = 0.054 \text{ K/ft}$$

54 #/ft	ROOF LOADING
9.1 #/ft	ROOF ASSY WEIGHT
3.9 #/ft	PURLIN WGT
<u>67.0 #/ft</u>	
	→ 0.47 PSI

EQUIVALENT VELOCITY

$$V = \sqrt{\frac{67.0 / 0.7}{0.00256}} = 193.3 \text{ MPH}$$

DETERMINE WITH 3 INC. IN ALLOW STRESS

$$(54 \times 43) + 13.0 = 85 \text{ #/ft}$$

$$\rightarrow 0.59 \text{ PSI}$$

$$V = \sqrt{\frac{85 / 0.7}{0.00256}} = 217.8 \text{ MPH.}$$

SUBJECT O.C. SEP. REVIEW TOPIC II-2

CALC. NO. 47006-11-02-1

SHEET NO. 12 OF 13

DATE 2-16-83

COMP. BY/DATE PH. 3/11/83

CHK'D. BY/DATE THE 4/6/83

TURBINE BLDE ROOF WIND LOAD

CALCULATE THE REDUCTION IN FACTOR OF SAFETY TO HAVE A CAPACITY OF 240 MPH

$$w = 0.00256 (240)^2 = 147.4 \text{ #/ft}^2$$

$$\begin{array}{r} \times 0.7 \\ 103.2 \text{ #/ft}^2 \uparrow \text{ ON ROOF} \\ - 13.0 \text{ #/ft}^2 \text{ ROOF WGT} \\ \hline 90.2 \text{ #/ft}^2 \text{ NET} \end{array}$$

$$\text{PURLIN REACTION} = \frac{(90.2)(8)(35.13)}{1000} = 25.34^K$$

$$R_{\text{DIAGONAL}} = (25.3)(7) = 177.1^K$$

F.S. FROM COLUMN FORMULA

$$F.S. = (53) + \frac{3(KL/r)}{8C_c} - \frac{(KL/r)^3}{8C_c^3}$$

$$\begin{array}{l} C_c = 126 \\ KL/r = 100.4 \end{array}$$

$$F.S. = 1.90$$

$$P_{ULT} = 1.90 \times 97.0 = 184.3 > 177.1^K$$

$$F.S. = 184.3 / 177.1 = 1.04 \text{ AT 240 MPH TORNADO}$$

SUBJECT O.C. SEP. REVIEW TOPIC III-2

CALC. NO. G-1302-151-6320-001

SHEET NO. 13 OF 13

DATE 3/11/83

COMP. BY/DATE PH 3/11/83

CHK'D. BY/DATE TH 4/4/83

TURBINE BLDG. ROOF WIND LOAD

CHECK CAPACITY OF ROOF DECK ATTACHMENT TO FURLINS.

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" & FUSION WELDS

- OUTSIDE EDGE AT 1ST, 3RD & 5TH LOW CORRUGATION
- JOINTS AT 1ST, 3RD & 5TH LOW CORRUGATIONS
- INTERMEDIATE SUPPORTS AT 2ND & 4TH LOW CORRUGATIONS

RIDDLE 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.

$W = 1540/8 = 192.5 \text{ #/ft}$ THIS IS GREATER THAN THE DECK BENDING CAPACITY AND WILL NOT GOVERN.

SUBJECT 06 SEP REVIEW TOPIC III-2

CALC. NO. 132 OF 13
SHEET NO. 132 OF 13
DATE 1-19-84
COMP. BY/DATE FH 1/10/84
CHK'D. BY/DATE THE 1/22/84

TURBINE BUILDING ROOF WIND LOAD

CHECK CAPACITY OF PURLIN @ $F_B = 1.6 S$
AS PER NUREG 3.8.4

REF PG 5

$$W = 1.6 \times 12 = 19.2 \text{ PSF UPLIFT CAPACITY}$$

TOTAL WIND UPLIFT CAPACITY

$$3.0 + 9.1 + 19.2 = 32.2 \text{ PSF}$$

EQUIVALENT VELOCITY

$$V = \sqrt{\frac{32.2/0.7}{0.00256}} = 134 \text{ MPH}$$

$$\text{DEFRESSURIZATION } 32.2/144 = 0.22 \text{ PSI}$$

CHECK CAPACITY OF TRUSS @ $F = 1.6 S$
AS PER NUREG 3.8.4

REF PG 11

$$W = 54 \times 1.6 + 13.0 = 99.4 \text{ PSF} = 2.69 \text{ PSI}$$

$$V = \sqrt{\frac{99.4/0.7}{0.00256}} = 235 \text{ MPH}$$

CHECK CAPACITY OF ROOF DECK @ $F = 1.6 S$
AS PER NUREG 3.8.4

REF PG 4

$$W = 79 \times 1.6 + 9.1 = 135.5 \text{ PSF} = 0.94 \text{ PSI}$$

$$V = \sqrt{\frac{135.5/0.7}{0.00256}} = 275 \text{ MPH}$$

$$\frac{1.6}{1.33} = 1.203$$

$$\sqrt{1.203} = 1.097$$

$$\begin{array}{l} 0.801 \times 1.203 = .96 \text{ PSI} \sim .94 \text{ PSI} \\ 0.20 \times 1.203 = .24 \text{ PSI} \sim .24 \text{ PSI} \\ 0.59 \times 1.203 = .71 \text{ PSI} \sim .71 \text{ PSI} \\ 253 \times 1.097 = 277 \text{ MPH} \sim 275 \text{ MPH} \\ 127 \times 1.097 = 139 \text{ MPH} \sim 134 \text{ MPH} \\ 218 \times 1.097 = 239 \text{ MPH} \sim 235 \text{ MPH} \end{array}$$