**Consumers Power Company**

David J VandeWalle
*Nuclear Licensing Administrator*

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-1636

September 30, 1982

Dennis M Crutchfield, Chief
Operating Reactors Branch No 5
Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-155 - LICENSE DPR-6 -
BIG ROCK POINT PLANT - SEP TOPIC
III-2, WIND AND TORNADO LOADINGS

Enclosed is Consumers Power Company response to the NRC staff request for
additional information regarding SEP Topic III-2, "Wind and Tornado Loadings",
for the Big Rock Point Plant. The attached report replies to three (3) staff
questions. Please note that the attached Appendix C, which incorporates part
of question #1 response, has been revised due to results of a recent re-evalu-
ation of the capability of the ventilation-stack to resist wind loadings, and
therefore supersedes the previous Appendix C transmitted in our August 3,
1982 correspondence.

One (1) copy of a Specification and drawing for the reinforced concrete
ventilation stack is also enclosed (questions #1 and 2).

It should be noted that the information requested by the staff on the cross-
section of the south end of the control room wall (question #3) are shown on a
security drawing which is exempt from public disclosure; therefore, the
drawing is not enclosed. However, the Systematic Evaluation Program Branch
staff indicated that such information can be retrieved from the NRC's office
of the Nuclear Material Safety and Safeguards.

A035

David J VandeWalle
Nuclear Licensing Administrator

CC   Administrator, Region III, USNRC
     NRC Resident Inspector-Big Rock Point

Attachment

oc0982-0017a142

8210060239 820930
PDR  ADOCK 05000155
P                PDR

Consumers Power Company
Big Rock Point Plant
Docket 50-155


SEP TOPIC III-2,
WIND AND TORNADO LOADINGS


21 pages

Consumers Power Company
Big Rock Point Plant
Docket 50-155


SE ' TOPIC III-2,
WIND AND TORNADO LOADINGS


21 pages

BIG ROCK POINT

SEP TOPIC III-2

WIND AND TORNADO LOADINGS

Request For Additional Information

1. Define the thickness of the shell for the ventilation stack (concrete chimney) and identify the size and location of reinforcing steel in the stack.

Answer

The thickness of the 240 ft. high ventilation stack decreases with increasing height. The following table identifies the thickness profile:

| Height Above Foundation | Thickness |
|---|---|
| 0 ft. | 8" |
| 7.8 ft. | 7 ½" |
| 16.3 ft. | 7" |
| 56.3 ft. | 6 ½" |
| 116.3 ft. | 6" |
| 236.3 ft. | 6" |
| 240.0 ft. | 5 ½" |

The size and location of the reinforcing steel in the stack is shown on Custouis Construction Co., Inc. Drawing No C-1-279-61 enclosed.

Subsequent to our responses to SEP Topic III-2, Wind and Tornado Loadings, dated August 3, 1982 and to a later NRC request for additional information dated August 30, 1982, we have re-evaluated the resistance of the 240 ft.

concrete chimney against wind and tornado loadings. A recently located
ustouis Construction Co., Inc. drawing shows the "as built" reinforcement
for the stack, whereas our original evaluation (discussed in our response
dated August 3, 1982) used steel ratios found in the vendors design cal-
culations (design ratios were 10% to 25% less than the "as built" ratios).

The results of our recent re-evaluation indicate that the 240 ft. concrete
chimney has a capacity to resist the wind loading from a 200 mph tornado.
This loading is greater than the one calculated in our original response
due to the different steel ratios used.

Because of our re-evaluation above, you will find enclosed a revised
Appendix C for our response dated August 3, 1982. This revision reflects
the "as built" steel ratios for the concrete chimney.

2. Provide a copy of Bechtel Specification No. 3159 C-21 Reinforced Concrete
Chimney (Ventilation Stack).

### Answer

Enclosed is a copy of Bechtel Specification No. 3159-C-21.

3. List the drawings which show the cross-section (dimensional and material
data) for the south masonry wall of the control room.

## Answer

The south wall of the control room consists of a 1/2-inch thick steel plate cover over a partition wall which contains two windows and a door. Details of this wall are shown on a drawing located in the security files of Consumers Power Company, which are confidential and not to be released for public scrutiny.

## EVALUATION OF THE 240-FOOT-HIGH STACK

The analysis of the 240-foot-high stack was performed using ACI 307-69 and ASCE paper 3269 with the following exception: in lieu of using the allowable stresses identified in the ACI code for normal wind loading, the values for the extreme tornado wind loading were:

$$\text{Maximum concrete stress} = 0.8f'_c = 2,800 \text{ psi}$$
$$\text{Maximum reinforcing steel stress} = 0.9f_y = 36,000 \text{ psi}$$

These values are consistent with the values used by D'Appolonia in analyzing the 240-foot stack under extreme earthquake loading.[C-1]

The critical sections of the stack were determined by reviewing the original calculation and were found to be 56'-4" above the base for maximum reinforcing steel stresses and at the base for maximum concrete stresses.

The following outlines the method used in analyzing the stack when subjected to a 200 mph wind:

$$P = qC_D = .00256 \ (200)^2 \ (.55)$$

$$= 56.3 \text{ lbs/ft}^2$$

In determining the stresses at 56'-4" above the base, the following information was used:

Moment at 56'-4" above the base = 6,558 ft-kips
$W$ = weight = 364 kips
$n$ = 8
$\beta$ = 0°
$\rho$ = .0058
$\rho n$ = .0466
$\alpha$ = 55°    (based upon $e/r$ = 2.77)

Stress at mean diameter of chimney shell:

$$f'_{cw} = \frac{W(1-\cos \alpha)}{2rt \left[(1-\rho)(\sin \alpha - \alpha \cos \alpha) - \rho n \ \pi \cos \alpha\right]}$$

$$= 120.8 \text{ k/ft}^2 = 840 \text{ psi} \ < \ 2,800 \text{ psi}$$

Stress at outside diameter of chimney shell:

$$f_{cw} = f'_{cw} \left[1 + \frac{t}{2r(1-\cos \alpha)}\right]$$

$$= 921 \text{ psi} \qquad < \ 2,800 \text{ psi}$$

Maximum stress in vertical reinforcement

$$f_{sw} = nf'_{cw} \left[ \frac{1+\cos\alpha}{1-\cos\alpha} \right]$$

$$= 24,800 \text{ psi} \quad < 36,000 \text{ psi}$$

In determining the stresses at the base, the following information was used:

$$
\begin{aligned}
\text{Moment} &= 13,404 \text{ ft-kips} \\
W &= \text{weight} = 597.2 \text{ kips} \\
n &= 8 \\
\beta &= 19° \\
\rho &= .01 \\
\rho n &= .08 \\
\alpha &= 65° \text{ (based upon } e/r = 2.06)
\end{aligned}
$$

Stress at mean diameter of chimney shell:

$$f_{cw}' = \frac{W(\cos\beta - \cos\alpha)}{\left[ 2rt\,(1-\rho)(\sin\alpha - \alpha\cos\alpha) - (1-\rho+\rho n)(\sin\beta - \beta\cos\alpha) - \rho n\,\pi\cos\alpha \right]}$$

$$= 235k/ft^2 = 1,632 \text{ psi} \quad < 2,800 \text{ psi}$$

Stress at outside diameter of chimney shell:

$$f_{cw} = f_{cw}' \left[ 1 + \frac{t}{2r\cos\beta\,(\cos\beta - \cos\alpha)} \right]$$

$$= 1,766 \text{ psi} \quad < 2,800 \text{ psi}$$

Maximum stress in vertical reinforcement:

$$f_{sw} = nf'_{cw} \left[ \frac{1+\cos\alpha}{\cos\beta - \cos\alpha} \right]$$

$$= 35,500 \text{ psi} \quad < 36,000 \text{ psi}$$

The foundation was checked for 200 mph wind as follows:

Total load on the soil (including stack, foundation, soil, and buoyancy) = 1,970 kips

Moment at the bottom of the foundation = 15,557 ft-kips

Since $\frac{M}{W} = \frac{15,557}{1,970} = 7.9$ ft is larger than 1/6 of the base, dimension (5.72 ft) full surface contact does not exist.

Maximum soil pressure is determined by: (C-2)

$$P = \left\{ \frac{2W}{3a\ (b/2-e)} \right\} = 5.84 \ k/ft^2$$

Where

p = soil pressure
W = weight = 1,970 kips
a = width
b = length
e = M/W

The maximum allowable soil pressure for loadings including wind or seismic, in accordance with the original design criteria [C-3] is 5 k/ft$^2$ x 1.33 = 6.65 k/ft$^2$, which is greater than the calculated maximum soil pressure.

Factor of safety (FS) against overturning:

$$FS = \left\{ \frac{1,970\ (24.27/2)}{15,557} \right\} = 1.54 \ < 1.5$$

# APPENDIX C

## References

C-1 D'Appolonia Report Volume IV Appendix E "Seismic Safety Margin Evaluation, Reinforced Concrete Stack"

C-2 F.S. Merritt, Standard Handbook for Civil Engineers, 2nd edition

C-3 Design Criteria, Big Rock Point Plant - Consumers Power Company, Job 3159 (Civil, Structural, Architectural)

# REQUISITION
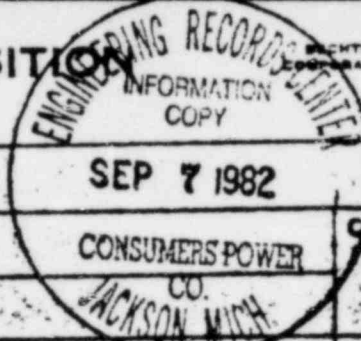
BECHTEL CORPORATION · POWER AND INDUSTRIAL DIVISION

**MATERIAL:** CONCRETE VENTILATION CHIMNEY

**ATTACHMENTS:** SPECIFICATION NO. 3159 C-21

DWGS. C-315, C-316, SK-1060

**COST CODE** 7.142

**REQUIRED FOR:** CONSUMERS POWER COMPANY - BIG ROCK POINT PLANT

**MATERIAL REQUIRED AT JOB SITE NOT LATER THAN** See Below

**SHOP INSPECTION:** REQUIRED ☐   NOT REQUIRED ☒

**FURNISH AND DELIVER TO:** BECHTEL CORPORATION, c/o CONSUMERS POWER COMPANY, CHARLEVOIX, MICHIGAN

| ITEM NO. | QUANTITY AND UNIT | DESCRIPTION | |
|---|---|---|---|
| 1 | 1 lot | Design and erect a 240' reinforced concrete chimney. | |
| | | Design of foundation. (Concrete and concrete testing to be supplied by the Contractor). | |
| | | Appurtenances to include embedded material, platform, ladder to platform, port and sleeve for probe. | |
| | | | |
| 2 | 1 lot | Additive item - Aircraft obstruction lighting and ladder from probe port platform to top of chimney. | |
| | | | |
| | | Time Schedule: | |
| | | Design calculations and preliminary drawings shall be submitted within three weeks after award of subcontract. | |
| | | Construction to begin July 15, 1961 and to be completed on or before September 30, 1961. Any requests for revising the time schedule shall be submitted in writing with the proposal. | |

**SUBCONTRACTOR:** CUSTODIS CONSTRUCTION CO., INC., 221 WEST MONROE St., CHICAGO 3, ILLINOIS

**VENDOR:** C. C. MOORE & CO. ENGINEERS, INC., 450 MISSION STREET, SAN FRANCISCO 5, CALIF.

| △ | DATE | REVISIONS | APPROVALS | | |
|---|---|---|---|---|---|
| △ | 8/23/61 | Issued for Contract Item No. 2 | WB | BMC | |
| △ | 7/27/61 | Issued for Bids Item No. 2 | WB | | |
| △ | 5/19/61 | Issued for Contract Item No. 2 | WB | BMC | |
| △ | 4/19/61 | Issued for Contract Item No. 1 only | WB | BMC | |
| △ | 3/10/61 | Issued for Bids | WB | BMC | |

**JOB NO.** 3159

**REQUISITION NO.** 3159 C-21

**REV.** 4

**SHEET** 1 **of** 2 **SHEETS**

# REQUISITION

| ITEM NO | QUANTITY AND UNIT | DESCRIPTION |
|---|---|---|

3   lot   Furnish labor, materials and equipment necessary to paint
the top 140 ft. of the chimney in accordance with the
directions set forth in "Obstruction Marking and Lighting"
issued by Civil Aeronautics Administration. The painting
shall consist of seven bands of international orange and
white. Each band shall be 20 ft. in height. The top and
bottom band shall be international orange.

The presence of objectionable alkalinity in the concrete
shall be checked by using pink litmus paper or by phenolphthalein
indicator solution. If surface condition is found to be
alkaline, treat with a solution of 5% phosphoric acid and
2% zinc chloride in water and allow to dry 24 hours.
[illegible] rinse [illegible] with water. Any
glazed areas shall be rubbed with pumice stone or carborundum
brick.

Paint System   First Coat - Ford's Paint & Varnish - PVA
CI2 Sealer
Second Coat - [illegible]
The paint manufacturer's specifications shall be followed.

The [illegible] before painting as applied hereto shall be
furnished [illegible] 30 days after [illegible] are issued. No
[illegible] shall be applied in damp weather when the ambient
temperature is below [illegible] or when the temperature is expected
[illegible]

REQUISITION NO. [illegible]

REV 4

SHEET 2 OF 2 SHEETS