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# TEXAS UTILITIES GENERATING COMPANY

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May 17, 1984

Director of Nuclear Reactor Regulation
Attention: Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446
SEISMIC AND DYNAMIC QUALIFICATION
REFRIGERATION COMPRESSOR UNIT

REF: TXX-3678 of June 10, 1983 - submittal of additional seismic and dynamic qualification information

Dear Sir:

In attachment (15) to the referenced letter a detailed response was provided to some specific staff concerns that related to the Control Room Air Conditioning (CRAC) compressor-motor assembly. This response described the acceptability of the seismic analysis of these assemblies based on an isolator spring mounting arrangement with a 3/4 inch minimum clearance gap. Field implementation of this mounting arrangement has presented alignment problems. Therefore, a new rigid mounting arrangement has been approved. Attached in a discussion that justifies the acceptability of this new mounting arrangement with respect to seismic qualification. The attached discussion replaces the mounting discussion previously submitted in attachment (15) of the referenced letter.

Respectfully,

J S Marshall for
H. C. Schmidt

DRW/grr

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JUSTIFICATION FOR RIGID MOUNTING CONFIGURATION OF
THE CONTROL ROOM AIR CONDITIONING COMPRESSOR-MOTOR ASSEMBLY

The following discussion pertains to the modification of the existing soft mounting system of the compressor-motor assembly into a rigid one. It is assumed that a new mounting system will be designed such that it totally by-passes the existing spring/grommet/gasket combination, and provides a direct rigid connection between the floor and the assembly. The two aspects of this modification are the following:

1. EFFECT ON NORMAL OPERATION

Ideally, a perfectly balanced rotating machinery would not create any vibrations or shocks, regardless of its mounting conditions. In reality, machinery of the type considered here-in would generate periodic forces resulting from two possible causes: (A) Impact from reciprocating parts and (B) centrifugal forces from eccentrically rotating masses.

Both of these forces have a periodicity related to the speed of operation of the equipment. Depending on the flexibility of the foundation system on which the machinery rests, these forces may generate a vibratory motion of the equipment of varying amplitude.

For a simple case of a rigid body of mass M representing the equipment, and a spring of stiffness K representing its supports, the resulting amplitude of motion for the two cases of forcing is:

Case A

$$X = \frac{Po}{K} \frac{1}{\sqrt{\left[1 - \left(\frac{f}{f'}\right)^2\right]^2 + \left(2c\frac{f}{f'}\right)^2}} \qquad (1)$$

Case B

$$X = \frac{M'e}{M} \frac{\left(\frac{f}{f'}\right)^2}{\sqrt{\left[1 - \left(\frac{f}{f'}\right)^2\right]^2 + \left(2c\frac{f}{f'}\right)^2}} \qquad (2)$$

Where Po is the amplitude of the periodically applied force, f is the angular speed of operation, f' is the natural frequency of the equipment/foundation system, e is the eccentricity of the net unbalanced mass M' rotating at the operating speed, and c is the ratio of actual damping to critical damping of the system.

Although these expressions apply to a single degree of freedom system such as a mass vibrating in one direction, for a multiple degrees of freedom case corresponding to a combination of rigid body motion in three directions, the resulting amplitudes would be a linear combination of these expressions, therefore, these expressions can be used for discussion purposes.

Also, it must be noted that equations (1) and (2) represent the amplitude of displacement of the equipment. Since in a sustained vibration (steady state), the motion has the same periodicity as the forcing function, the velocity and acceleration of the resulting motion can be obtained by multiplying the displacement amplitudes by $2\ f$ and $(2\ f)^2$ respectively.

The effect of changing the mounting stiffness from a flexible system to a rigid one is equivalent to increasing the values of K and f', everything else remaining unchanged. This results, for both equations (1) and (2), in a reduction of the displacement amplitude X, and consequently, a reduction of the velocity and acceleration amplitudes. At the limit, as K and f become infinitely large, the response amplitudes approach zero. Therefore, the modification from a soft support to a rigid support system would be beneficial for the overall operating condition of the equipment.

## 2. EFFECT ON SEISMIC CONDITION

A rigid system is always considered to be desirable under seismic conditions. A system whose fundamental frequency is greater than 33 cps will be subjected to zero period accelerations (ZPA), whereas a flexible system such as the compressor - motor assembly in its presently supported condition will be subjected to higher accelerations corresponding to floor response spectrum ordinates for the frequencies of the different modes of vibration. Even though for a very soft mounting with a fundamental frequency in the neighborhood of 1 cps the floor response acceleration would fall below the ZPA value, higher modes would, in this case, contribute with larger accelerations. In addition, large displacements would be expected from a soft mounted system, which could be detrimental to the overall operation of the system considering alignment and connection to other components of the assembly. Restraining devices which would be required for reducing the amplitude of motion would in turn cause impact loads. It must also be recognized that the springs provided with the original skid are only capable of lowering the fundamental frequency of the system to approximately 3 cps.

## 3. CONCLUSION

In conclusion, it is apparent that a rigidly mounted unit is beneficial from the viewpoints of both normal operation and seismic loads. The design of the modified support as shown on Drawing No. B587-1100, Sheet 2, Rev. CP-1 provides a rigid support such that the fundamental frequency of the assembly is greater than 33 cps. Therefore, based upon the above discussion, the modified system will be subjected to smaller operational and seismic loads than the original system which was qualified per Gibbs & Hill Report No. DMI-1R dated July 1983.