UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

N005

OCT 30 1985

Docket Nos.: 50-445
and 50-446

MEMORANDUM FOR: Chairman Palladino
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commissioner Zech

FROM: Vincent S. Noonan, Director
for Comanche Peak Project
Division of Licensing
Office of Nuclear Reactor Regulation

SUBJECT: BOARD NOTIFICATION - RECENT CORRESPONDENCE FROM CYGNA TO THE APPLICANT AND THE NRC STAFF RELATING TO COMANCHE PEAK (BOARD NOTIFICATION NO. 85-089)

This Notification is being provided to the Commission in accordance with the revised Commission's notification policy of July 6, 1984, to inform the Commission on all issues on the cases before the Commission.

By Board Notification No. 85-043 we provided you with significant Cygna correspondence with TUGCO and the NRC staff relating to Cygna's ongoing review of the design adequacy of Comanche Peak. This Board Notification is to supplement that Board Notification with similar information which we have recently received.

The first item enclosed is a letter from N. Williams (Cygna) to J. Beck (TUGCO), dated August 13, 1985. This letter transmitted the revisions to the mechanical systems, electrical/I&C, cable tray supports and conduit support Review Issues Lists (RILs). The cable tray and conduit support revisions to the RILs were made primarily to clarify Cygna's concerns. This is also true for the mechanical systems and electrical/I&C RILs; however, some new items have been added.

The second item enclosed is a letter from N. Williams (Cygna) to W. Counsil (TUGCO), dated October 9, 1985. This letter transmitted an information request to Gibbs and Hill needed to close out open issues related to the pipe stress analysis reviews.

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The parties to the proceeding are being notified by copy of this memorandum.

Vincent S. Noonan, Director
for Comanche Peak Project
Division of Licensing
Office of Nuclear Reactor Regulation

Enclosures:
1. Letter from N. Williams (Cygna) to J. Beck (TUGCO) dated August 13, 1985.
2. Letter from N. Williams (Cygna) to W. Counsil (TUGCO), dated October 9, 1985.

cc: See next page

cc: P. Bloch, ASLB
W. Jordan, ASLB
K. McCollom, ASLB
E. Johnson, ASLB
H. Grossman, ASLB
SECY (2)
EDO
OGC
OPE
ACRS (10)
Parties to the Proceeding
See next page

CYGNA
ENERGY
SERVICES
101 California Street, Suite 1000, San Francisco, CA 94111-5894 415/397-5600

August 13, 1985
84056.080

Mr. J. W. Beck
Manager - Licensing
Texas Utilities Generating Company
Skyway Tower
400 North Olive Street, L.B. 81
Dallas, Texas 75201

Subject: Review Issues List (RIL)
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Independent Assessment Program - All Phases

Reference: 1. N.H. Williams (Cygna) letter to J. W. Beck (TUGCO), "Review Issues List Transmittal," 84056.064, dated April 23, 1985

2. N.H. Williams (Cygna) letter to J.W. Beck (TUGCO), "Review Issues List Transmittal," 86056.072, dated June 21, 1985

Dear Mr. Beck:

Enclosed are revisions to the mechanical systems, electrical/I&C, cable tray supports and conduit support Review Issues Lists (RIL's). All significant changes are noted by a revision bar in the right margin.

The cable tray and conduit support revisions were primarily made to clarify Cygna's concerns. This is partly true for the mechanical systems and electrical/I&C RIL's however, some new items have been added. These additions have resulted from Cygna Project and Senior Review Team meetings held to finalize the phase 4 review checklists. At this time we do not anticipate any further significant additions to the RIL. We will however, continue to maintain the RIL until we issue the final report.

ZZZZ
1/1 See Attached

CYGNA ENERGY SERVICES

The current revisions to each discipline RIL is as follows:

Discipline	Revisions	Cygna letter reference
Pipe Stress	1	84056. 064
Pipe Supports	1	84056. 064
Cable Tray Supports	11	84056. 080
Conduit Supports	2	84056. 080
Mechanical Systems	2	84056. 080
Electrical/ I&C	2	84056. 080
Design Control	1	84056. 072

If there are any questions please call at your convenience.

Very truly yours,

N.H. Williams

N.H. Williams
Project Manager

Attachments

cc: Mr. V. Noonan (USNRC) w/attachments
Mr. S. Burwell (USNRC) w/attachments
Mr. S. Treby (USNRC) w/attachments
Mr. W. Horin (Bishop, Liberman, et al.) w/attachments
Mr. J. Redding (TUGCO) w/attachments
Ms. J. van Amerongen (TUGCO/EBASCO) w/attachments
Ms. J. Ellis (CASE) w/attachments
Mr. D. Pigott (Orrick, Herrington & Sutcliffe) w/attachments
Mr. F. Dougherty (TENERA) w/attachments
Mr. R. Ballard (Gibbs & Hill) w/attachments
Mr. R. Kissinger (TUGCO) w/attachments

MECHANICAL SYSTEMS
Review Items List

1. Component Cooling Water (CCW) System Maximum Temperature

References: 1. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-01-01 (not yet issued)

2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

3. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna), dated August 11, 1984

4. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.023, dated August 21, 1984

5. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna), dated April 11, 1984

6. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna), dated October 1, 1984

Summary: Cygna noted discrepancies between the Westinghouse stated maximum CCW system temperature of 120°F and (1) the CPSES FSAR; (2) Gibbs & Hill calculation 233-16; and (3) Gibbs & Hill calculation 229-14. These documents indicated maximums of 121.8°F, 135°F and 129.7°F, respectively. TUGCO provided documentation that showed the acceptability of the 135°F maximum temperature. Some of this documentation is dated as late as 9/28/84 indicating that TUGCO may not have been aware of the problem prior to the Cygna questions.

Status: Cygna Observation MS-01-01 was closed based on the documentation which was provided by TUGCO. However, Gibbs & Hill/TUGCO should demonstrate that when design and operating data is revised, all existing system components are reviewed to ensure that they meet the new operating conditions.

MECHANICAL SYSTEMS
Review Items List

2. CCW Surge Tank Isolation on High Radiation Signal

References: 1. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-06-01 (not yet issued)

2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.028, dated August 27, 1984

3. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated September 20, 1984

Summary: The Westinghouse functional design requirements document for the CCW system required that the surge tank be isolated by closing the vent valve on receipt of a high radiation signal. TUGCO/Gibbs & Hill removed this control function from the system radiation monitors to prevent spurious actuation caused by rising system temperature during accidents. Since the change did not address the radiation release effects of the vent remaining open, Cygna requested verification that the release would be acceptable. TUGCO performed a calculation which verified that the release was within the limits of 10 CFR 100. No generic review was conducted of other radiation monitor control function changes at CPSES.

Status: Cygna Observation MS-06-01 was closed based on the results of TUGCO calculation TNE-CA-094 dated September 19, 1984.

3. Class 5 Piping

References: 1. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-02-01 (not yet issued)

2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

3. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated August 11, 1984

4. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.023, dated August 21, 1984

5. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated September 11, 1984

MECHANICAL SYSTEMS
Review Items List

6. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated September 21, 1984

7. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated September 25, 1984

8. Communications Report between D. Wade (TUGCO) and R. Hess (Cygna) dated 9/5/84, 3:00 p.m.

9. N.H. Williams (Cygna) letter to V. Noonan (USNRC) "Open Items Associated with Walsh/Doyle Allegations," 84042.022, dated January 18, 1985

Summary: Per Gibbs & Hill, Class 5 piping is not seismically designed; it is only seismically supported to prevent it from falling on safety related equipment. TUGCO did provide documentation showing that the specific Class 5 CCW piping that was in Cygna's review scope was seismically analyzed and therefore, would remain functional as required. However, Cygna could not determine whether any similar circumstances exist in other piping systems where Class 5 piping may be required to remain functional during a seismic event.

Status: Observation MS-02-01 was closed for the CCW system based on the documentation and analyses provided. Gibbs & Hill/TUGCO should provide assurance that the use of Class 5 piping in areas where functionality is required following design basis events are analyzed for the design basis events. 2

4. Fire Doors

References:

1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

2. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated August 11, 1984

3. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.023, dated August 21, 1984

4. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated August 31, 1984

MECHANICAL SYSTEMS
Review Items List

5. Communications Report between J. Van Amerongen (TUGCO) and R. Hess (Cygna), dated 9/11/84, 11:00 a.m.

6. Communications Report between Mark Wells (TUGCO) and R. Hess (Cygna) dated 9/13/84, 11:00 a.m.

Summary: Cygna noted that the double doors between the train A & B nuclear chillers did not have a U.L. fire rating label. TUGCO stated that this had been previously noted by them and that the proper door was being installed. TUGCO could not provide documentation of how the error was noted but did supply copies of a purchase order for the correct door. Subsequent reinspection by Cygna verified the proper door had been installed. TUGCO stated that an NCR or other paper work was not initiated since the door is not safety related. The door is required to meet Appendix R requirements.

Status: TUGCO should provide assurance that the as-built Appendix R modifications are in conformance with the Appendix R design requirements and specifications.

5. <u>Single Failure - Reactor Coolant Pump Thermal Barrier</u>

References:

1. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-02-02 (not yet issued)

2. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Potential Finding PFR-01 (not yet issued)

3. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

4. Communications Report between D. Wade (TUGCO) and R. Hess (Cygna) dated 8/17/84, 8:30 a.m.

5. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated August 24, 1984

MECHANICAL SYSTEMS
Review Items List

6. Communications Report between D. Wade (TUGCO) and N. Williams (Cygna) dated 8/30/84, 3:30 p.m.

7. Communications Report between D. Wade (TUGCO) and R. Hess (Cygna) dated 9/5/84, 3:00 p.m.

8. D.H. Wade (TUGCO) letter to N.H. Williams (Cygna), CPPA-40961, dated September 18, 1984

9. D.H. Wade (TUGCO) letter to N.H. Williams (Cygna), CPPA-41237, dated October 3, 1984

10. N.H. Williams (Cygna) letter to S. Burwell (USNRC), 84056.032, dated October 9, 1984

11. Communications Report between D. Wade (TUGCO) and N. Williams (Cygna) dated 10/11/84, 5:00 p.m.

12. N.H. Williams (Cygna) letter to S. Burwell (USNRC), 84056.035, dated October 22, 1984

13. E.P. Rahe, Jr., (Westinghouse) letter to R.C. DeYoung (USNRC), NS-EPR-2938, dated July 13, 1984

14. T.R. Puryear (Westinghouse) letter to J.T. Merritt, Jr. (TUGCO), WPT-7436, dated July 23, 1984

Summary: Cygna expressed a concern that if the single temperature controlled isolation valve on the outlet of the reactor coolant pump thermal barrier should fail to close subsequent to a rupture of the thermal barrier, then low pressure portions of the CCW system would be over pressurized and reactor coolant could be released outside containment. Westinghouse also notified the NRC and TUGCO of a similar problem with CCW systems they designed. TUGCO informed Cygna that they were filing a 50.55E report with the NRC on this issue and that they would investigate the generic implications of this finding. Cygna submitted two letters on this subject to the NRC and TUGCO in accordance with our review procedures for a Definite Potential Finding. Cygna has not received any of the TUGCO documents which evaluate this issue nor has Cygna performed any additional investigation or review on this issue.

MECHANICAL SYSTEMS
Review Items List

Status: Observation MS-02-02 was upgraded to Potential Finding PFR-01. Subsequently, references 10 and 12 were sent to the NRC in accordance with Cygna's procedures for processing a Definite Potential Finding. TUGCO should provide evidence that other systems do not possess a similiar set of attributes which could potentially result in a common mode failure. TUGCO should provide Cygna with the 50.55E report to insure that the report addresses Cygna concerns.

6. Missing Valve Sizing Calculations

References:
1. Telecopy from N.H. Williams (Cygna) to R.E. Ballard (G&H) dated 5/9/85
2. Transcript of Texas Utilities CPRT Meeting Cygna Energy Services dated 5/21/85 (NRC/I & E Meeting)

Summary: Cygna requested equipment and valve sizing calculations along with pressure drop and flow calculations for the CCW system at the beginning of the review. Sizing calculations for the CCW surge tank relief valve, vent valve and vacuum breaker were not provided by G&H. Cygna performed an assessment of the adequacy of these components based on normal system operation and accepted the design based on Cygna's calculations. Subsequent evaluation of various scenarios, such as in-leakage to the system, caused Cygna to again request the sizing calculations and/or design bases from G&H. This data has not been received by Cygna. At the present time it appears that the relief valve and vent valve may be undersized to meet current demands. However, until the original sizing calculations are reviewed, it cannot be determined if they were properly sized during the initial design. 2

Status: Cygna is awaiting design documentation requested from G&H in Ref. 1

7. CCW Surge Tank Sizing and Design Basis

References:
1. G&H calculation 229-12 rev. 1 "CCW Surge Tank" dated 1/4/79
2. Transcript of Texas Utilities CPRT Meeting Cygna Energy Services dated 5/21/85 (NRC/I&E Meeting)

MECHANICAL SYSTEMS
Review Items List

Summary: The referenced G&H calculation does not address in-leakage to the CCW system caused by failures in systems cooled by the CCW system. This calculation also does not address or justify the surge tank design pressure of 10 psig versus the higher design pressure (150 psig) of the CCW piping and components. Cygna raised these issues in relation to the failure of the reactor coolant pump thermal barrier but they also apply to postulated failures of other heat exchanger tubes or leakage from other components served by the CCW system which operate at higher pressure than the CWW system. Since the surge tank is common to both safeguards loops of the CCW system, its integrity is critical to the system meeting its safety function. 2

Status: This generic issue of in-leakage should be addressed along with the resolution of Mechanical RIL Item 5.

8. <u>CCW Pump Motor Sizing</u>

References:
1. CCW Pump Specification 2323-MS-11 Revision 2 dated 12/10/74
2. Electric Motors Specification 2323-ES-1D Revision 4 dated 11/10/76
3. Communicatons report dated 7/31/85 between J. Oszewski/R. Hess (Cygna) and J. Irons (G&H)

Summary: The pump motor data supplied to the motor vendor in specification 2323-ES-1D listed the motor horsepower as 1000 hp and provided a torque-speed curve for the pump with the discharge valve closed. The pump is actually started with the discharge valve open for most modes of operation. The valve open condition is normally a more limiting design condition for pump motor current draw and accelerating time. Therefore, the pump motor may not be sized correctly for all service conditions. If the pump accelerating time is significantly longer than specified, it may impact the emergency diesel generated loading sequence. 2

Status: Open for additional G&H design data requested by CYGNA in Ref. 3.

MECHANICAL SYSTEMS
Review Items List

9. CCW Surge Tank Vent/Relief Single Failure

References:
1. Transcript Texas Utilities CPRT Meeting Cygna Energy Services dated 5/21/85 and 5/22/85 (NRC/I&E Meeting)
2. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-02-01 (not yet issued), Mechanical Systems Review Items List, Item Number 3
3. Cygna Phase 4 Final Report, TR-84056-01, Revision 0, Observation MS-02-02 (not yet issued), Mechanical Systems Review Items List, Item Number 5

Summary: During the technical review Cygna assessed the capability of the surge tank vent-relief/vacuum breaker combination to meet single failure criteria. This assessment was based on the relief valve and vacuum breaker being passive devices with no external operators. Subsequent discussions with the project Senior Review Team and the NRC has lead to a re-evaluation of this assessment. These components should now be considered active components since mechanical movement is required for their proper operation. Since both the power supply and position indication for the vent valve are not safety-related it cannot be relied upon as a backup for the relief valve and vacuum breaker under accident conditions. Based on this re-evaluation, the vent and relief capability of the CCW surge tank is not considered to meet the single failure criteria. In addition, references 2 and 3 also relate to the application of the single failure criteria to the design of the CCW system and therefore lead to questions relating to application of this criteria by G&H in the overall design process. 2

Status: The system/component FMEA must be re-evaluated to address these valves as active components. Cygna understands that G&H/TUGCO are presently reviewing the vent and relief capability of the CCW surge tank.

ELECTRICAL
(Power and I&C)
Review Items List

1. Instrumentation Pressure/Temperature Ratings

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

2. L.M. Poppelwell (TUGCO) letter to N.H. Williams (Cygna) dated August 11, 1984

Summary: Two instances were noted by Cygna where the pressure temperature ratings for instruments installed in the Component Cooling Water System (CCW) were lower than the maximum pressure or temperature of the system as indicated in the Gibbs & Hill analyses. The instruments in question were later shown to be qualified for the higher design conditions or protected by interlocks. Cygna reviewed a total of 24 CCW instruments and these were the only two pressure-temperature discrepancies noted.

Status: Gibbs & Hill/TUGCO should provide evidence that when design and operating data is revised, all existing system components are reviewed to ensure that they meet the new operating conditions. Statistically, two instances out of 20 may indicate the need for further review.

2. Cable Tray Thermolag Fire Protection

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.010, dated July 30, 1984

2. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna) dated August 11, 1984

3. N.H. Williams (Cygna) letter to J.B. George (TUGCO), 84056.024, dated August 21, 1984

4. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna) dated September 4, 1984

5. Communications Report between J. Van Amerongen (TUGCO) and R. Hess (Cygna), dated 9/11/84, 11:00 a.m.

ELECTRICAL
(Power and I&C)
Review Items List

Summary: During the Cygna walkdown of July 16-20, 1984, it was noted that cable tray section T130ACA43 was not covered with Thermolag fire protection material. Cygna reinspected the area in August/September and the proper material was installed. However, the documentation supplied by TUGCO for the removal and reinstallation of the fire lag insulation indicates that the work was completed and signed off on 7/14/84. This is prior to the Cygna walkdown. While the reinspection showed the tray to be properly covered, the documentation is not consistent with the noted sequence of events.

Status: Closed

3. Temperature Indicator X-TI-4837 Not Installed

References: 1. Cygna Phase 1 and 2 Final Report, TR-83090-01, Revision 0, Observation WD-07-02

Summary: During the walkdown of the Spent Fuel Pool Cooling System, it was noted that a temperature indicator was not installed. Further investigation revealed that some instrumentation is not installed by construction in order to prevent it from being damaged by additional construction activities. When the system is turned over for operation, a set of instruments is provided for final installation.

Status: Closed.

4. Incorrect Cable Identification Number

References: 1. Cygna Phase 1 and 2 Final Report, TR-83090-01, Revision 0, Observation WD-07-03

Summary: One of six cable identification tags checked during the walkdown had an incorrect unit identification number on the tag. An additional 32 safety related cable identification tags were checked and found to be correct. Since the only discrepancy was in the unit number, no safety impact was involved and the observation was closed as an isolated error.

ELECTRICAL
(Power and I&C)
Review Items List

Status: Closed.

5. System Short-Circuit Currents

References

1. Communications report between P. Lalaji (Gibbs and Hill) and J. Oszewski, K. Zee (Cygna), Dated 8/1/85, 10:30 A.M.

2. Comunications report between P. Lalaji (Gibbs and Hill) and K. Zee (Cygna), dated 8/6/85, 3:30 pm.

3. N.H. Williams (Cygna) letter to J. Redding (TUGCO), 84056.081, dated 8/13/85.

Summary

Gibbs and Hill short-circuit calculations IV-3 and IV-4 were reviewed by Cygna as part of the IAP. It was noted during the review that the design margin between the equipment rating and the calculated short-circuit current is less than 2% on several 480V buses. In addition, several non-conservative assumptions were used in the G&H calculations: 2

- Cable impedances based upon 75°C are used to reduce the short-circuit currents when actual operating temperatures will probably be less.
- The subtransient reactance assumed for large 480V loads is 25% when typical values are less than 17%.
- The 480V short-circuit calculation is based upon a maximum available momentary symmetrical 6.9KV short-circuit current of 36,000A when calculated values are 38,000A.
- The 6.9KV short-circuit calculation is based upon grid capacities determined in 1974.
- The diesel generator's short-circuit contribution during breaker interrupting is based upon the transient reactance only.

ELECTRICAL
(Power and I&C)
Review Items List

Status: Open pending discussion with Gibbs & Hill based upon their review of Ref. 3.

6. AC Distribution System Voltages

References:
1. Communications report between P. Lalaji (Gibbs and Hill) and J. Oszewski, K. Zee (Cygna), Dated 8/1/85, 10:30 A.M.
2. Comunications report between P. Lalaji (Gibbs and Hill) and K. Zee (Cygna), dated 8/6/85, 3:30 pm.
3. N.H. Williams (Cygna) letter to J. Redding (TUGCO), 84056.081, dated 8/13/85.

Summary: The Gibbs and Hill system voltage calculations III-7 and III-8 were reviewed by Cygna as part of the IAP. It was noted during the review that certain operating conditions will result in bus voltages below the specified operating range. During conditions as discussed in paragraph 8.3.1.1.1 of the FSAR concurrent with normal grid voltage variations, the voltage on the safety buses is more than 10% below the rated voltage of the connected loads. During minimum loading conditions, the 480V bus voltages are more than 10% above the rated voltage of the connected load. The source of the assumed grid voltage variations is not indicated in the G&H calculation. 2

The G&H calculations studied the starting of 6.9KV motors, but did not study the starting of 480V loads.

Status: Open pending discussion with Gibbs & Hill based upon their review of Ref. 3.

ELECTRICAL
(Power and I&C)
Review Items List

7. Overcurrent Protection

References: 1. Communications report between P. Lalaji (Gibbs and Hill) and J. Oszewski, K. Zee (Cygna), Dated 8/1/85, 10:30 A.M.

2. Comunications report between P. Lalaji (Gibbs and Hill) and K. Zee (Cygna), dated 8/6/85, 3:30 pm.

3. N.H. Williams (Cygna) letter to J. Redding (TUGCO), 84056.081, dated 8/13/85.

Summary: During Cygna's review of the component cooling water pump motor overcurrent protection, the following items were noted:

- The motor thermal limit was not used to determine the maximum allowable tripping delay during stalled conditions. The setting was based only upon the acceleration time which is the minimum allowable tripping delay. 2

- The settings of transformer overcurrent devices did not consider the transformer's thermal limit - - ANSI point. Again, the maximum allowable tripping delay is based upon the thermal limit with minimum delay based upon coordination with dowstream devices.

- It was not clear that the 6.9KV safety bus feeders were coordinated with the diesel generator's short-circuit capability and protective devices.

- It appears that the primary and back-up protective devices for the reactor coolant pump motor electrical penetration conductors are connected to the same current transformer. It also appears that the breakers have a common control power source.

Status: Open pending discussion with Gibbs & Hill based upon their review of Ref. 3.

ELECTRICAL
(Power and I&C)
Review Items List

8. Cable Sizing

References: 1. Communications report between P. Lalaji (Gibbs and Hill) and J. Oszewski, K. Zee (Cygna), Dated 8/1/85, 10:30 A.M.

2. Comunications report between P. Lalaji (Gibbs and Hill) and K. Zee (Cygna), dated 8/6/85, 3:30 pm.

3. N.H. Williams (Cygna) letter to J. Redding (TUGCO), 84056.081, dated 8/13/85.

2

Summary: During Cygna's review of Gibbs and Hill calculations, it was noted that the power cables were derated for a 40°C ambient outside containment and a 50°C ambient inside containment. Paragraph 8.3.1.2.4 of the FSAR shows the long term post accident temperature inside containment as approximately 65°C.

Status: Open pending discussion with Gibbs & Hill based upon their review of Ref. 3.

CABLE TRAY SUPPORTS
Review Issues List

1. Controlling Load Case for Design

References: 1. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 5, Sheets 16-20, Revision 5

2. Communications Report between P. Huang, S. Chang (Gibbs & Hill) and J. Russ and W. Horstman (Cygna) dated November 13, 1984

3. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 5, Sheets 1-7, Revision 1

4. CPSES FSAR, Sections 3.8.3 and 3.8.4

Summary: Gibbs & Hill used the equivalent static method to design the cable tray supports. In all load cases, the equivalent static accelerations used in designing the supports for SSE events are less than 160% of the corresponding accelerations for 1/2 SSE (OBE) events. Based on this finding and citing Section 3.8.4 of the CPSES FSAR which allows a 60% increase in allowables for structural steel between OBE and SSE events, Gibbs & Hill determined that the design was governed by the OBE event (Reference 3).

To validate this conclusion, the 60% increase in allowables must be liberally interpreted to be applicable to all support components rather than applicable only to structural steel as specified in the CPSES FSAR. Catalog items such as Richmond Inserts and Hilti Kwik-bolts do not have increased allowables for SSE events. By designing these catalog components to the OBE event, the manufacturer's design factor of safety is not maintained for the SSE event.

Furthermore, for the design of structural steel, the 60% increase in allowables is acceptable for axial and strong-axis bending stresses in structural members. The 60% increase cannot be applied to certain other allowable stresses. For example, the maximum increase in base plate stresses may only be 33%, at which point the material yield

CABLE TRAY SUPPORTS
Review Issues List

is reached. A limit on maximum allowable stress is not provided in the FSAR.

These limitations were not considered in the selection of the governing seismic load case.

Status: In order to reduce the loads for SSE, Gibbs & Hill elected to use 7% damping for the cable trays at SSE, as allowed for bolted structures.

Gibbs & Hill provided tables of peak spectral accelerations for OBE at 4% damping and SSE at 7% damping (Reference 1). These tables show that for the enveloping acceleration levels, the ratio of SSE to OBE does not exceed 1.33. The reduced SSE accelerations appear to demonstrate that OBE governs for the structural steel used in support designs on a generic basis. However, for supports designed using accelerations for a specific building elevation (e.g., elevations 773', 785' and 790' in the Safeguards Building) the ratio of SSE to OBE may exceed 1.33. Therefore, SSE can potentially govern the design of the structural steel for these supports. The supports at the three elevations indicated above may require additional review.

Determination of the governing load case for catalog components depends on the determination of an acceptable safety factor for those items at the SSE load level. See Issues 3.B and 3.E for a discussion of safety factors.

2. Seismic Response Combination Method

References:
1. CPSES FSAR Section 3.7B.2.7
2. Gibbs & Hill Calculation Binder 2323-SCS-215C, Sets 2-6
3. USNRC Regulatory Guide 1.92, Revision 1

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4. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Design Review Questions," 84056.031, dated August 31, 1984

5. Gibbs & Hill calculation response to IAP Phase 2 questions, Cygna Technical File 83090.11.2.1.50

Summary:

A. Closely Spaced Modes (10% Modal Combination) in Spectral Analysis

In the response spectra analyses performed for the Working Point Deviation Study (Reference 2), Cygna noted that modal responses were not combined considering closely spaced modes as required by References 1 and 3.

B. Inclusion of Dead Load in SRSS Combination

In all Gibbs & Hill design calculations, the acceleration due to deadweight is combined with the seismic accelerations using the SRSS method. A 1.0 g deadweight acceleration is first added to the vertical seismic acceleration. The sum is then combined with the two horizontal seismic components using the SRSS method.

This issue was discovered in Phase 2 of this review. At that time, Gibbs & Hill performed a study to quantify the impact of this finding (Reference 5). Gibbs & Hill's study compares the acceleration vector magnitudes calculated with the standard combination method and with the SRSS method. For most buildings and elevations, the magnitude of the resultant acceleration using the SRSS method does not differ significantly from the resultant using the standard combination method. However, the difference in vector direction was not considered and is of greater importance, since each load direction contributes to different components of response in the cable tray supports. To properly assess the impact of this combination method, the critical response should be evaluated instead of the magnitude of the acceleration applied to the support. 11

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Reference 4 discusses a Cygna study on the effects of aspect ratios for frame types within the review scope. The study results indicated the increases in resultant loads by combining the dead load with the seismic SRSS may be larger than those predicted by Gibbs & Hill.

Status: A. Gibbs & Hill has revised the working point analyses to account for closely spaced modes in accordance with Reference 3. For a discussion of other discrepancies in the working point deviation study, see Review Issue 12.

B. TUGCO/Gibbs & Hill should consider the effects of the worst case frame aspect ratio on the results of the SRSS study.

3. Anchor Bolt Design

References:

1. Gibbs & Hill calculations, "Evaluation of Detail 1, single-bolt connection," Cygna Technical File 84056.11.1.259
2. Gibbs & Hill Calculation Binder SCS-212C, Set 7, Sheet 4-11, Revision 0
3. Gibbs & Hill calculations, "Justification of the adequacy of 1" Richmond Inserts for the effects of prying action," Cygna Technical File 84056.11.1.219
4. Brown & Root Procedure CEI-20, "Installation of Hilti Drilled-In Bolts", Revision 9.
5. Hilti, Inc., "Architects & Engineers Anchor and Fastener Design Manual"
6. TUGCO SDAR CP-80-12, "Reduced Allowable Loads for Hilti Kwik-bolts"

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7. TUGCO Instructions CP-EI-4.0-49, "Evaluation of Thermolag Fire Barrier Material on Class 1E Electrical Raceways", Revision 1.

8. US NRC Inspection Report 50-445/81-14; 50-446/81-14, dated 10/27/81.

9. Communication Report between R.M. Kissinger (TUGCO), B.K. Bhujang et al (Gibbs & Hill) and W.R. Horstman, et al (Cygna) dated 10/10/84.

Summary: A. Frame Connection Point and Anchor Bolt Pattern Centroid Eccentricity

In the design for the anchor bolts, Gibbs & Hill did not properly account for the eccentricity between the frame connection point to the base angle and the anchor bolt pattern centroid. The moment due to the eccentricity may cause the base angle to rotate about its longitudinal axis, resulting in: (1) a compressive force along the toe of the angle section and (2) additional tension in the anchor bolt(s).

In response to Cygna's request for an evaluation of the additional bolt tension loads, Gibbs & Hill provided calculations (Reference 1) to justify not considering the effect of this eccentricity. These calculations consider two specific connection details shown on Gibbs & Hill Drawing 2323-S-0903, "Detail 1" using one Hilti Super Kwik-bolt and "Detail 1-Alternate" using two Hilti Super Kwik-bolts.

The reactions from support frame types B-2 and A-4 were selected as the basis for the "Detail 1" and "Detail 1-Alternate" worst case applied loading, respectively. Gibbs & Hill has not provided any justification for assuming that the B-2 and A-4 designs represent the worst case loading or frame geometry.

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In the analysis, Gibbs & Hill assumes that the moment introduced by the eccentricity between the vertical load application and centerline of bolt pattern can be reduced by a horizontal force couple consisting of anchor bolt shear force and tray longitudinal (axial) force. The validity of this assumption depends on the capacity of the tray attachment clamps to transfer longitudinal forces as discussed in Review Issue 18. Furthermore, the mathematical model used in the Reference 1 analysis assumes that the lower end of the hangar is restrained from translation in the tray longitudinal direction. However, the tray is not attached to the end of the hanger for trapeze type supports. It is attached to a beam spanning the two hanger members, and additional out-of-plane translation of the bottom end of the hanger is possible due to the flexibility of the beam section between the hanger centerline and the tray location.

The resolution of this generic issue requires an evaluation of the worst case load and geometry for all applicable supports. The geometries considered should include the effects of any generic change documents such as those for the base angle anchor bolt edge distance (CMC 1970) and the use of shims under base plates (CMC 1969).

B. Safety Factor on Hilti Expansion Anchors at SSE Levels

Gibbs & Hill's cable tray support designs employed a safety factor of 4.0 for Hilti expansion anchors for the 1/2 SSE load level. As discussed in Issue 1, the 1/2 SSE event was assumed governing for support designs without consideration of the reduced factor of safety on Hilti expansion anchors. The safety factor will range from 2.5 to 3.0 for the SSE event, depending on the installed location in the plant.

C. Inconsistent Application of ACI 349-76, Appendix B

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Gibbs & Hill has used the provisions of Reference 1 to qualify several designs. Examples include the qualification of anchorages for Detail "11" (Gibbs & Hill Drawing 2323-S-0905, Reference 2) and the use of code provisions as justification for the factors of safety used for Richmond Inserts. However, the designs do not comply with other sections of ACI 349-76, Appendix B. For example, Section 3.7.3 requires a safety factor of 6.0 for single expansion anchor connection designs. Cygna believes that the philosophy of the entire code appendix should be considered prior to employing selected portions of the code.

D. Factor of Safety on Richmond Inserts

Gibbs & Hill's cable tray support designs employed a safety factor of 3.0 for Richmond Inserts for the 1/2 SSE load level. As discussed in Issue 1, the 1/2 SSE event was assumed governing for support designs without consideration of the reduced factor of safety on Richmond Inserts. The safety factor may be as low as 1.8 for the SSE event. See Item C, above, for a discussion of ACI 349-76 as it has been applied to Richmond inserts.

E. Richmond Insert Design

Prying action was not considered in the original design of Richmond Insert connections for cable tray supports. To qualify those connections which use Richmond Inserts, Gibbs & Hill performed calculations which reference the results of the Richmond Insert testing program (Reference 3). These calculations showed that Richmond Inserts were not the controlling anchorage type, but rather that the Hilti expansion anchors were the limiting case. Cygna has the following comments regarding these calculations:

1. The calculations do not account for the instances where the allowable values for 1" diameter Richmond Inserts taken from Gibbs &

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Hill Specification 2323-SS-30 (Ta = Va = 11.5 kips) were used without the prying factor. This situation could occur whenever a CMC changed the edge distances and the span of a base angle. Although Gibbs & Hill has stated that their engineers were instructed to include the prying factor, Cygna could not locate any supporting documentation.

2. The original design calculations for concrete connections using Richmond Inserts employed allowable values of tension (Ta = 10.1 k) and shear (Va = 9.5 kips). With the issuance of Gibbs & Hill Specification 2323-SS-30, restrictions were placed on certain Richmond Insert allowables. Decreases in allowable tensions and shears were provided for Richmond Inserts in cluster arrangements, Richmond Inserts embedded in the sides of concrete beams, and Richmond Inserts used in spacings less than those originally considered in Gibbs & Hill designs. Since these restrictions were imposed after the original design of the Richmond Insert connections was completed, Cygna is concerned that cable tray supports installed using Richmond Insert clusters or Richmond Inserts in the sides of concrete beams may not have been evaluated for the required reduction in allowables. In discussions with TUGCO, Cygna was told that the Richmond Inserts in clusters were reserved for pipe whip restraints. Authorization to attach to these clusters should have been obtained from the responsible TUGCO group and a corresponding evaluation of the installation should have been performed. However, Cygna could not

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locate any TUGCO Quality Control documentation detailing these controls.

F. Connection Designs

The cable tray support designs provide for the use of angles or plates at base connections. The installation specifications also provide for various anchor bolt spacing and member placement tolerances. However, the use of these tolerances may produce concrete attachments which are outside the original design limits. Gibbs & Hill has not fully evaluated the effects of all possible installation tolerances on the base member stresses or the anchorages.

Cygna's Phase 2 Observations CTS-00-05 and CTS-00-07 respectively addressed the design of base connections for Detail "E" supports with three-directional loadings and Details "A-D" base plate designs (drawing number 2323-E1-0601-01-S). Due to the tolerances described above, these support connection designs must also be reviewed to assure that the above concerns are addressed.

G. Justification of Prying Factor

Gibbs & Hill designs globally used a factor of 1.5 to account for the effects of base angle flexibility on anchor bolt tensile loads. The value of this factor is dependent on the applied load, bolt pattern geometry, and angle thickness. No documented justification existed for the use of this factor.

H. Detail 1 Tolerances

General note 14d on Gibbs & Hill drawing 2323-S-0901 and note 2 on Detail 1 of Gibbs & Hill drawing 2323-S-0903 allow the substitution of Richmond Inserts for Hilti expansion anchors. This may result in a mixed connection of Richmond Inserts and Hilti expansion anchors. The minimum Hilti anchor spacing is 15" while the minimum Richmond Insert spacing is 16". For base connections subject to moments,

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the tensile load in each anchor is calculated by dividing the applied moment by the minimum bolt spacing. By substituting a Richmond Insert for a Hilti expansion anchor at the Hilti spacing, the tensile load in the Richmond Insert may be greater than the previously calculated load. The effect of this substitution on Richmond Insert tensile loads has not been considered in the cable tray support designs.

I. Base Angle Boundary Condition Assumptions

For trapeze type supports, Gibbs & Hill has assumed that the hanger connections employing two-bolt base angles are free to rotate about the strong axis of the hanger. Since both the welds between the hanger and its base angle and the base angle itself have significant flexural stiffness, this assumption requires that the connection allow the calculated rotation without base connection failure. Gibbs & Hill has not justified such connection behavior. (See Issue No. 26)

J. Installation of Expansion Anchors in Diamond Cored Holes

Section 3.1.4.2.3 of Reference 4 discusses the reinstallation of an expansion bolt in an empty but "pre-used" holes. Paragraph (a) of that sections states

> "The bolt being replaced has been removed from the concrete using a Diamond core bit of the same nominal outside diameter as the replacement expansion bolt. The replacement bolt shall be one diameter size larger than the bolt being removed."

The Hilti publication "Architects and Engineers Design Manual" (Reference 5) addresses the bit type used in drilling holes for Hilti Kwik and Super Kwik-bolts. On page C-4, Note 6a states:

> "All of the technical information pertaining to Kwik-Bolts herein (e.g., pullout and shear data) was

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accomplished using HILTI masonry carbide bits. Before installing the Kwik-Bolt using another means of drilling (e.g., Diamond Core), contact your local HILTI Field Engineer for advice and proper procedures."

On page C-1 (Reference 5) a footnote to the installation process description states:

"To obtain maximum published holding values, use only HILTI carbide bits."

In discussions with Hilti, Inc., Cygna learned that Hilti expansion anchors installed in core-bored holes will provide ultimate strengths that are less than those published in the Hilti Design Manual. Primarily, the strength reduction is due to the diameter of the core bore bit itself. It has been Hilti's experience that core bore bits are intentionally supplied at a larger diameter than the nominal size to account for the progressive reduction in bit diameter over its life. Thus, at the initial bit usage, the bit diameter will be larger than that required for the bolt hole. It is this hole oversize which causes the reduction in expansion anchor capacity. 11

In order to avoid any such strength reductions, careful control on the bolt hole diameter must be established. Control may be established by measuring the core bit diameter or the hole diameter. Cygna has not observed any QC procedures which impose such control.

Additionally, Cygna did not observe any procedures which require craft or QC to document which expansion bolts were installed in diamond cored holes.

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K. Reduced Allowable Loads for 1" Diameter Hilti Kwik-bolts

Based on expansion anchor capacity tests performed by Hilti Inc. in 1980, Hilti Inc. issued a letter giving reduced ultimate capacities for 1" diameter Kwik-bolts. In response to this letter, TUGCO issued a Significant Deficiency Analysis Report (SDAR) (Reference 6) to evaluate the effect of the reduced anchor bolt capacities for support installations at CPSES. The resolution of this SDAR was to accept all existing designs employing 1" diameter Kwik-bolts by allowing a reduced safety factor of 3.41, and require that all future design efforts use the reduced capacity. The USNRC accepted this resolution (Reference 8).

The review of cable tray supports for the addition of Thermolag, for cases where the cable tray load with Thermolag exceeds the design load in any segment Reference 7, section 3.2.2.1, paragraph (b) states:

> "All hangers shall then be evaluated for actual loads. During this evaluation, all pertinent design changes shall be taken into account. Consideration shall be given to use of actual tolerances, weld undercut-undersize, 1" diameter Hilti Kwik-bolt revised criteria and actual field 'as-built' configuration"

Based on a review of calculations performed by Gibbs & Hill evaluating a cable tray support considering the added weight of Thermolag and a discussion with TUGCO/Gibbs & Hill (Reference 9), TUGCO/Gibbs & Hill indicated that the calculations under discussion should use the original (unrevised) Hilti Kwik-bolt allowables since the calculations reviewed an existing design. This is not consistent with the requirements of Reference 7.

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Status: A. Gibbs & Hill should revise the mathematical model to include the beam flexural stiffness in the anchor bolt forces study and also provide justification for the selection of loadings used for base angle and anchor bolt analyses.

B. Cygna has collected data on the issue of the Hilti expansion anchor factor of safety and is evaluating it internally. Gibbs & Hill, however, should provide a supporting evaluation.

C. TUGCO/ Gibbs & Hill should provide justification for the use of the selected Appendix B sections of ACI 349-76.

D. Cygna has not found sufficient justification for the safety factor of 1.8 for Richmond Inserts under emergency/faulted (SSE) conditions.

E. Cygna requires verification that controls on the use of Richmond Insert allowables and the inclusion of a prying factor were in place and enforced by all responsible groups.

F. Gibbs & Hill should provide assurance that the installation tolerances are properly accounted for in the base connection designs.

G. Gibbs & Hill should provide technical justification for the global usage of a prying factor of 1.5 for base angles.

H. Gibbs & Hill should provide technical justification for the allowed bolt substitution.

I. Gibbs & Hill should provide technical justification for the assumption of a pinned connection for two-bolt base connections and the connection for $L\text{-}A_1$ type supports.

J. TUGCO should provide technical justification on the acceptability of expansion anchors installed in core bored holes. 11

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K. TUGCO/Gibbs & Hill should provide documentation indicating that all designs performed after the issuance of Reference 6 consider the reduced capacities for the anchor bolts as applicable.

4. Design of Compression Members

References:

1. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 1
2. Gibbs & Hill Calculation B'nder 2323-SCS-215C, Sets 2-6
3. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.022, dated August 17, 1984, question 4
4. Timoshenko and Gere, "Theory of Elastic Stability," 2nd Edition, pages 99 and 100

Summary:

A. In the design of compression members for trapeze type support frames, Gibbs & Hill did not consider the entire unsupported length of the channels when they calculate the slenderness ratios (Reference 1, Sheets 11 and 18 for support types A_4 and B_4, respectively). If the correct unsupported lengths as well as pinned end conditions are assumed, the slenderness ratio of these members for bending about their weak axis will exceed 200. AISC Specification Section 1.8.4. specifies that the limit for compression members per is 200.

In order to reduce the slenderness ratios below 200, Gibbs & Hill performed calculations to show that k = 0.8 (Reference 1, Sheets 128-146, Revision 3, and Reference 2). These calculations assumed that rotational restraint is provided by the clip angle used to attach the hanger to the bottom of the slab. Additionally, since the compressive load is applied at several points over the length of the member, the allowable axial

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stress was increased based on the buckling analysis of columns with multiple, discrete axial loads (Reference 4).

Cygna has analyzed one- and two-bolt clip angles under compressive loading and determined that it is reasonable to assume partial rotational fixity for weak axis bending of the attached hanger. However, the assumption that the tray provides lateral bracing to the frame has not been validated (see Review Issue 18 for a discussion of tray clamps). Cygna believes that it is acceptable to consider the effective increase in allowable axial loads based upon a multiple load application. However, the increase is a function of the applied loads, and must be calculated individually for each support configuration and load case.

B. In calculating the slenderness ratio of the compression members for trapeze-type supports, Gibbs & Hill did not check the effectiveness of the in-plane sidesway restraint for the various support designs. 11

C. In the design of the compression member for cantilever type supports (e.g., SP-7, Details E, F, G, and H on drawing 2323-E1-0601-01-S, etc.) Gibbs & Hill has used the distance from the face of the concrete to the centerline of the cable tray as the cantilever length. A value of k = 1.0 was used in calculation of the minor axis slenderness ratio, rather than the actual value of k = 2.0 for cantilevers. A value of k = 1.0 is based on the assumption that the tray will provide lateral bracing at the clamp location. The validity of this assumption pending on the resolution of Review Issue 18. 11

D. For the trapeze type of supports, Gibbs & Hill has not considered the effect of weld under cut on the section properties of compression members at the point where in-plane braces are attached to the channel web. As shown 11

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in the Working Point deviation study (Reference 2), high stresses exist in the region of the brace attachment and may increase if the reduced section properties are considered.

E. The design of compression members assumed that the applied axial load was parallel to the member axis. Gibbs & Hill installation specifications 2323-SS-16b allows an installation tolerance of 2 degrees from plumb to vertical members. Cygna was unable to locate calculations considering the effect of this tolerance.

Status: Items A through C are open pending further discussion with Gibbs & Hill/TUGCO regarding the systems concept (also see Review Issue 10) and its application to the design of cable tray supports, as well as compliance with the AISC specification (also see Review Issue 14) and resolution of the tray clamp adequacy (also see Review Issue 18). Gibbs & Hill should provide technical justification for the effectiveness of sidesway restraint as described in Item C and for using the unreduced section properties as described in Item D.

5. Vertical and Transverse Loading on Longitudinal Type Supports

References:

1. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 2
2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.025, dated August 21, 1984, questions 3 and 4
3. R.E. Ballard (Gibbs & Hill) letter to N.H. Williams (Cygna), GTN-69437, dated September 10, 1984, with attached calculations

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4. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 5

Summary: Longitudinal trapeze type supports (e.g., L-A_1, L-A_4, L-C_4, etc.) were assumed to act independently of the transverse supports (see Reference 4). Calculations for these longitudinal supports (Reference 1) consider only longitudinal loads in the design of frame members and anchor bolts. Since these supports are rigidly connected to the cable trays with "heavy duty clamps", a tributary tray mass will be associated with these supports. It is Cygna's belief that these supports must be designed for vertical and possibly transverse seismic loads similar to the transverse supports (References 2 and 3).

Status: Gibbs & Hill should consider these effects and ensure acceptability of this assumption on a generic basis.

6. Support Frame Dead and Inertial Loads

References: None

Summary:

A. Out-of-plane inertial loads were not considered in the design of two-way cable tray supports. Such loads should, as a minimum, be considered in the design of base connections and anchorages. Assuming that tray clamps are able to transmit the loads from the two-way supports to the cable trays, out-of-plane inertial loads from the two-way supports must also be considered in the member design of longitudinal supports (also see Review Issue 18).

B. Gibbs & Hill did not consistently consider support dead loads. The support design calculations considered support weight in one of the following ways: (a) support weight was not considered, (b) support weight was considered as an additional load in the tray (usually this value was given as 5 psf), or (c) the

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support weight was calculated by considering the actual weight of each of the support's frame members.

Method (b) also led to other problems in the support design. Initially, the tray unit weight was considered as 35 psf. When the "effective" support weight of 5 psf was added to the cable tray unit weight the result was a total assumed tray design load of 40 psf. At a later point in time when design changes were issued against the supports, the designer reduced the design weight from 40 psf to 37.5 psf to remove some "conservatism" from the design loads in order to qualify the support. By doing so, the designer removed some portion of the support weight. 11

Status: A. Gibbs & Hill should provide technical justification for ignoring out-of-plane inertial support loads.

B. Gibbs & Hill should provide technical justification for not including support dead loads or not considering 100% of the support dead loads.

7. Design of Angle Braces Neglecting Loading Eccentricity 4

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.025, dated August 21, 1984, questions 3 and 4

2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.027, dated August 27, 1984, question 2

3. AISC Specification, 7th Edition, Sections 1.15.2 and 1.18.2.4

4. Gibbs & Hill calculation "Cable tray support type SP-7 with brace. Brace eccentricity calculations." Cygna Technical File 84056.11-1.228

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5. Gibbs & Hill calculation "Verify the adequacy of brace L3x3x3/8 of the governing support Case C_3." Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 1, Revision 1, dated 11/16/84

6. Gibbs & Hill calculation "Justify the use of two L3-1/2x3-1/2x3/8 angles to take the appropriate load and moment individually in the longitudinal tray supports at the lower brace." Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 2, Revision 6, dated 9/15/84

Summary:

A. Longitudinal cable tray supports typically use angle sections as bracing to resist the longitudinal loads (e.g., SP-7 with brace, L-A_1, L-A_4, etc). For the member design, loads were assumed to produce only axial stresses. The induced bending stresses due to eccentric end connections were not considered. Neglecting these flexural stresses can result in members which are underdesigned. For certain longitudinal supports, double angles are required. The design assumes that the angles behave as a composite member. However, no intermittent filler plates are provided as required by AISC Specification Section 1.18.2.4. Thus, the double angles must be considered to act independently.

B. Transverse and longitudinal cable tray supports typically use angle sections as in-plane braces to resist transverse loads and provide bracing points on the vertical members (e.g., A_3, A_4, B_3, B_4, L-A_4, etc). For the member design, loads were assumed to produce only axial stresses. The induced bending stresses due to eccentric end conditions were not considered. Though it is not explicitly stated in the AISC Specifications, it is standard practice (Reference 3, Sheet 3-59) to consider the bending stresses due to end connection eccentricity and check the interaction ratio considering the principal axes section moduli.

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C. Single longitudinal braces are typically connected to the frame by welding along the legs of the angle. Some brace designs provide welding on only one angle leg at one end of the brace; while, at the other end of the brace, welding is provided on the other angle leg. Such end conditions may lead to failure by twist buckling.

Status:

A. Gibbs & Hill provided calculations which considered end eccentricities as well as independent action for each angle in double-angle brace designs (Reference 6). Case L-B_4 was assumed to provide enveloping brace loads. Calculations (Reference 4) were also provided for support type SP-7 with brace, which has a single angle brace. Cygna believes that the approach is acceptable, however, Gibbs & Hill should provide justification for the enveloping cases.

B. Gibbs & Hill provided a calculation (Reference 5) which considered eccentric load application for in-plane braces. By reviewing the results of the working point deviation study, Gibbs & Hill found that Case C_3 had the highest brace loads. See Review Issue 12 for a discussion of the working point deviation study.

C. Cygna has evaluated the possibility of twist-buckling on single-angle braces and determined that it can result in a significant reduction in member capacity.

8. Dynamic Amplification Factors (DAF) and Ratios between Continuous Tray Support Reactions and Tributary Tray Support Reactions

References: 1. Gibbs & Hill Report, "Justification of the Equivalent Static Load Method Using a Factor of 1.0 Times Peak Spectrum Acceleration for the Design of Cable Tray Supports; Comanche Peak Units 1 and 2."

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2. Communications Report between J. Jan (Gibbs & Hill), G. Bjorkman (Cygna) dated October 4, 1984, 4:00 p.m.

3. Communications Report between J. Jan, P. Huang, J. Pier (Gibbs & Hill), N. Williams, G. Bjorkman (Cygna) dated September 13, 1984, 3:00 p.m.

4. Communications Report between J. Jan, J. Pier (Gibbs & Hill), G. Bjorkman (Cygna) dated October 12, 1984, 10:00 a.m.

5. Communications Report between J. Jan (Gibbs & Hill), G. Bjorkman (Cygna) dated October 18, 1984

6. Communications Report between J. Jan, et. al. (Gibbs & Hill), H. Levin (TERA), R. Kissinger, et. al. (TUGCO), N. Williams, et. al. (Cygna) dated October 31, 1984

7. CPSES, FSAR, Section 3.7B.3.5.

Summary: Gibbs & Hill performed cable tray support designs using an "equivalent static analysis" to account for seismic loads. The tray dead load on a support was calculated by the tributary span method. The seismic load was the product of the tray dead load and the peak spectral acceleration for the given buildings elevation. A dynamic amplification factor (DAF) was not included as required by reference 7 (see also Issue 25.A).

In response to Cygna's request for an evaluation of the required DAF, Gibbs & Hill performed a study (Reference 1) to justify a DAF=1.0. Based upon discussions between Cygna and Gibbs & Hill (References 2, 3, 4, 5, and 6) 1.14 was established as an appropriate DAF. Several limitations apply to the use of this factor, based upon these assumptions, such as:

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- Equal support spacing was assumed on the given tray run.
- The DAF calculated is the ratio of the dynamic support reaction to the equivalent static reaction for a continuous beam finite element model.

An additional factor to be considered is the ratio of the static reaction for a continuous beam to the reaction calculated by the tributary span method. This ratio is in the range of 1.10 to 1.25 for beams with two to four continuous spans. △11

Status: Since Cygna's walkdown documented the use of non-uniform spans, Gibbs & Hill must justify using DAF=1.14 for designing the supports of cable trays with non-uniformly supported spans. All supports originally designed for DAF=1.0 should be reevaluated for a factor equal to the multiplication of the newly established DAF (1.14 minimum) and the ratio between the continuous tray support reaction and tributary tray support reaction.

9. Reduction in Channel Section Properties Due to Clamp Bolt Holes

References:

1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray and Conduit Support Review Questions," 84056.015, dated August 6, 1984, Attachment B, question 2

2. Gibbs & Hill letter GTN-69371, dated 8/23/84, Calculation SCS-111C, Set 8, Sheets 34-39

3. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, 7th Edition. △11

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Summary: Per the AISC Specification (Reference 3), Section 1.10.1:

> Riveted and welded plate girders, cover-plated beams and rolled or welded beams shall in general be proportioned by the moment of inertia of the gross section. No deduction shall be made for shop or field rivet or bolt holes in either flange, except that in cases where the reduction of the area of either flange by such holes, calculated in accordance with the provisions of Sect. 1.14.3, exceeds 15 percent of the gross flange area, the excess shall be deducted.

Cygna has found instances where the areas of bolt holes, used for the tray clamp bolts, exceeded 15 percent of the gross flange area, and the required reduction in moment of inertia had not been considered in the design calculations. Cygna requested an evaluation of the effect of the reduction in channel section properties due to clamp bolt holes in Reference 1. Gibbs & Hill provided a response in Reference 2.

The response did not to consider the following items:

A. Cable trays may be placed anywhere in the beam span (for example, see CMC 2646).

B. The case for cantilevered supports where one tray is close to the wall and other trays are located further out from the wall.

C. The effect of DCA 17838, which provides bolt hole gage tolerances, and allows the use of 3/4" diameter holes for 5/8" diameter bolts.

D. All unused flange holes are not required to be plug-welded and may be present in high moment regions. (See Note 15 on Gibbs & Hill Drawing 2323-S-0901, Revision 4.)

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Status: Gibbs & Hill should provide technical justification for their response.

10. System Concept

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.031, dated August 31, 1984, Attachment A, question 2

2. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), dated September 28, 1984 with attached calculations

Summary: In order to justify certain design assumptions questioned by Cygna, documentation was provided indicating that Gibbs & Hill had assumed that the cable tray and supports act as a system. As part of this "systems" approach, the following behavior was assumed:

A. The moments introduced by the eccentricities between the load application points and the member resistant centroid were balanced by load couples between adjacent supports. More specifically, for longitudinal supports using composite beams (e.g., SP-7 with brace, Detail 8, drawing 2323-S-0903, etc.), the development of torsion in the beam due to longitudinal loading eccentricity is prevented due to the development of flexure in the cable tray. This tray moment is subsequently balanced by a vertical load coupled between adjacent supports. 11

Similarly, the torsion in the beam and the weak axis bending in the hanger due to the vertical load placement eccentricities as well as the bending moment in the beam due to the transverse load placement eccentricities are all balanced by either vertical or tranverse load couples between adjacent supports.

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Such moment transfers as described above are only possible if full rotational and translational compatability exists between the cable tray and support beam. Gibbs & Hill assumes that the compatability is provided by the heavy duty and friction types of tray clamps. See Review Issue 18 for a discussion of Cygna's concerns relative to the clamp behavior.

B. In the design of trapeze support hanger members for compression loads, the trays provide lateral bracing at points along the length of the hanger (also see Review Issue 4).

C. For trapeze type supports, the longitudinal and transverse support systems act independently. Therefore, the longitudinal supports are designed for longitudinal loads only, i.e., no transverse or vertical load contribution is considered (also see Review Issue 5).

D. Additional tensile forces introduced by rotation of the base angles about the bolt pattern axis is minimized by the hanger attachment to the tray (also see Review Issue 3).

E. For trapeze type supports, out-of-plane seismic inertial loads from two-way support frames (self-weight excitation) are resisted by the longitudinal supports. However, as discussed in Review Issue 6, these inertial loads have not been considered in Gibbs & Hill's design of longitudinal supports.

Status: Items A through E have not been fully justified considering the hardware. Cygna is concerned that Gibbs & Hill's use of a "systems" concept may not be consistent with the actual behavior of the clamps used in the field.

11. Validity of NASTRAN Models

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References: 1. Gibbs & Hill Calculation Binder 2323-SCS-215C, Sets 2-6

2. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 3, Sheets 234-243, Revision 9

3. Gibbs & Hill Calculation Binder DMI-13C, Set 1

Summary: Cygna has questioned the validity of the NASTRAN models used in the Gibbs & Hill generic studies, e.g., working point deviation study (Reference 1) and the qualification of Detail D_1 (References 2 and 3). The models assume a row of one support type, all having identical configuration and spans. This will influence the system frequencies and seismic response. Such models may not be representative of an actual installation where a mixture of support types and spans is used.

Status: Further justification is required prior to applying the results of these studies throughout the plant.

12. Working Point Deviation Study

References: 1. Gibbs & Hill Calculation Binder 2323-SCS-215C, Sets 2-6

2. Gibbs & Hill Calculation Binder 2323-SCS-216C, Sets 1-5

3. AISC Specification for the Design, Fabrication and erection of Structural Steel for Buildings, 7th edition. 11

Summary: A. Gibbs & Hill's working point study (References 1 and 2) does not fully consider the effects of change documentation and previously approved design deviations. Cut-off elevations were established using an assumed cri-

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tical case of 8'-6" spans, enveloping frame dimensions and maximum permissible working point deviations. Frames below the cut-off elevations were not checked for compliance with the study parameters. Frames above the cut-off elevation were analyzed on a case-by-case basis but did not consider the effects of change notices. The allowable working point deviations resulting from the study were to be used by QC to accept installed supports. Since changes to any one of the above assumed parameters may effect the acceptability of the study, QC's check of working point deviations alone will not assure support acceptability.

B. The effects of vertical and transverse loads on longitudinal support frames were not considered in the working point study (also see Review Issue 5).

C. The portion of the study that evaluated longitudinal trapeze supports only checked member stress interaction as specific in Section 1.6.1 of Reference 3. No evaluation was made to ensure that the connections, base angles and anchor bolts are also adequate. 4

D. Questionable modeling assumptions

1. Instead of modeling a longitudinal support in the tray run, one end of the tray was assumed to be fixed. The effect of this tray boundary condition on the system response was not justified. 11

2. The analysis assumed a single two-foot tray per beam and did not assess the impact of more realistic multiple tray loadings.

3. Eccentricities were not properly modeled (also see Review Issue 10). 11

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4. The assumption of tray attachment fixity to the support was not justified.

5. The run configuration selected may not represent an actual installation (also see Review Issue 11).

6. The base angle modeling assumed a simply supported beam for two bolt base connections. In reality, the concrete reactions (prying actions) provide flexural restraint to the base angle. (See also Issue 26)

7. Excitation in the longitudinal tray direction was not considered.

8. The out-of-plane translational degrees of freedom were retrained on trapeze type supports.

E. Gibbs & Hill did not check all support components when determining the controlling support element. For example, support type E_4 was assumed to be limited by the load capacity of the Hilti expansion anchors. Cygna's review indicated that the actual governing component was the Richmond Inserts which were not checked by Gibbs & Hill.

F. Working Point Loca..un for Two-Bolt Brace Connections on Longitudinal Supports.

The working point location does not coincide with the actual line of action of the brace load for two-bolt brace connections, e.g., Details "F" and "G" on Gibbs & Hill drawing 2323-S-0903, and the brace concrete attachments for support types L-A_1 through L-A_4, L-B_1, L-B_2, L-B_4, L-C_1, L-C_2 and L-C_4 on Gibbs & Hill drawing 2323-S-0902. These offsets may induce larger tensile loads

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in the anchorages than originally considered in the designs. Additionally, these connections were not evaluated as part of the working point deviation evaluation.

G. Several support types, within Cygna's review, have specified allowable working point deviations without any supporting calculations.

1. Detail N (Gibbs & Hill drawing 2323-E1-0601-01-S) Gibbs & Hill calculation binder 2323-SCS-216C, Set 3, Sheet 5 indicates an allowable deviation of 9" ± 3" for brace connection to beam. Calculations are not included.

2. Detail V (Gibbs & Hill drawing 2323-E1-0601-01-S) Gibbs & Hill calculation binder 2323-SCS-216C, Set 3, Sheet 5 indicates "Low Stress, Brace Working Point Deviation of 6" is acceptable". Calculations are not included.

H. Several support types, within Cygna's review, have specified allowable working point deviations based on similarity to standard support types.

1. Detail J (Gibbs & Hill drawing 2323-E1-0601-01-3) is qualified by similarity to case B_3.

2. Detail 11 (Gibbs & Hill drawing 2323-S-0905) is qualified by similarity to Detail 8 (Gibbs & Hill drawing 2323-S-0903).

The calculations for case B3 and Detail 8 (Gibbs & Hill calculation binders 2323-SCS-215C, sets 2 and 4) indicate that these support types will be overstressed for the allowed working point deviation. Case-by-case evaluations of case B_3 and Detail 8 supports were performed to determine if all as-designed supports were acceptable. The support types which had been qualified by similarity were not

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included in these case-by-case reviews, hence there is no assurance that they are not overstressed also.

I. The Working Point Deviation Study evaluates several support types by grouping them with an enveloping support of similar configurations. Reference 1, Set 2 evaluates cases A_3, B_3 and C_3 considering case C_3 to envelope the others, and cases A_4, B_4 and C_4 considering case C_4 to envelope the others. For each analysis, the enveloping case is found to be overstressed, and a case-by-case as-designed review of supports of that type is conducted. The enveloped cases are not all included in the case-by-case reviews and a separate evaluation is not performed to show design adequacy of the other support types on a generic basis.

Status: To assure support acceptability Gibbs & Hill/TUGCO should justify the modeling assumptions, the applicability of the analysis results for global support qualification, and the use of working point deviations by QC.

13. Reduced Spectral Accelerations

References:

1. Gibbs & Hill calculations, "Analysis of Alternate Detail 1"
2. Gibbs & Hill Calculation Binder SCS-101C, Set 3, Sheet 247, Revision 9
3. Gibbs & Hill Calculation Binder SCS-215C, Set 4
4. Gibbs & Hill Calculation Binder SCS-101C, Set 2, Sheets 131 & 132, Revision 5.

Summary: For the qualification of the supports discussed below, Gibbs & Hill used reduced spectral accelerations based on a calculated support-tray system frequency.

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A. For the analysis of transverse supports, such as type A_4 which was used in analysis of Alternate Detail 1 (Reference 1), a reduced acceleration was used. This acceleration is based on a calculated frequency which is to the right of the spectral peak. The study assumes a tray weight of 35 psf and tray spans of 8'-6". Use of this study's results will not be valid in installations where either of the above parameters have been exceeded without considering the effect on frequency.

B. Similarly, for longitudinal supports (e.g., type SP-7 with brace [Reference 3], L-A_1 [Reference 2], etc.) the frequency will decrease due to tray weights exceeding 35 psf or longitudinal spans exceeding 40'-0". In addition, the frequency calculations did not include the effect of the axial frequency of the tray.

C. The flexural stifness of the base angle supporting the brace of the longitudinal supports was not considered in frequency calculation (References 3,4). Significant reduction in support frequency can be resulted from the flexural deformation of the base angle.

D. The actual cable tray runs use a mixture of support types and variable spans. Gibbs & Hill's frequency analyses assume that all supports are of the same type and spaced evenly. Therefore, the calculated fundamental frequencies are model specific and cannot be extended over the plant population.

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Status: Additional discussion between Cygna and Gibbs & Hill is required.

14. Non-Conformance with AISC Specifications

References: 1. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, 7th Edition

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2. CPSES, FSAR, Sections 3.8.3.2 and 3.8.4.2.

Summary: Reference 2 commits to designing the cable tray supports in accordance with Reference 1. Gibbs & Hill has not properly considered the requirements of Reference 1 as discussed below.

A. Unbraced length for axial buckling:

Section 1.8.4 (Reference 1) requires that kl/r be less than 200 for compression members. Depending on the approach selected for the resolution of Review Issue 4, this requirement may not be met. For example, if the friction type clamp cannot provide adequate restraint in the longitudinal direction, the K value should be taken as 2.0 for trapeze type and cantilever type supports. Consequently, Kl/r=257 for a 5'-9" C6x8.2 hanger or beam.

B. Unbraced length for lateral torsinal buckling:

Section 1.5.1.4.6a (Reference 1) requires that Equation 1.5-7 be used to calculate the allowable bending stress for channels. In the denominator, "l" is the unbraced length of the compression flange. Cygna found the following instances where the AISC Specifications were not considered or were improperly applied:

1. The Working Point Deviation Study uses 22 ksi for the allowable flexural stress without checking Equation 1.5-7. Since the frame heights are on the order of 144", an allowable flexural stress of 15 ksi is calculated by Equation 1.5.7.

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2. Detail SP-7 and similar supports consider "l" to be the distance from the base attachment to the tray centerline and not to the outside tray rail where the load is applied. Use of the larger distance will result in lower allowable bending stresses.

C. Reductions in the section properties of beams due to bolt holes in their flanges per Section 1.10.1 (Reference 1), were not considered (see Review Issue 9).

D. Double angle braces are designed as composite members while no lacing is provided per Section 1.18.2.4. (Reference 1) (also see Review Issue 7).

E. Eccentric connections, Section 1.15.2 (Reference 1). This section requires that any axial members not meeting at a single working point be designed for the eccentricities. Examples of designs where this specification section applies use the single angle braces, (type SP-7 with brace, L-A1, etc). The gusset plates connected to these braces must also be designed for the eccentricities.

F. Section 1.23.4 (Reference 1) allows bolt holes to be 1/16" larger than the nominal bolt diameter. The bolt holes for anchor bolts in base plates/angles (per Gibbs & Hill Drawing 2323-S-0903) and for tray clamps (per DCA 17838, Revision 8) are specified as 1/8" larger than the nominal bolt diameter. Therefore, the bolt holes in Gibbs & Hill's designs should be considered oversized and should be treated as such in bearing connection calculations.

Status: Technical justification for not complying with the AISC Specifications should be provided by TUGCO/Gibbs & Hill.

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15. Member Substitution

References: 1. Communications Reports between R.M. Kissinger (TUGCO) and J. Russ (Cygna), dated January 17, 1985, 8:15 a.m. and 3:45 p.m.

2. CMC 69335, Revision 1, dated 9/21/82.

3. Gibbs & Hill Drawing 2323-S-0901, Revision 4

Summary: A. Note 9 on Gibbs & Hill Drawing 2323-S-0901, Revision 4, states:

"Structural members shown on drawing numbers 2323-S-900 series may be substituted by one step heavier shape of the same size."

This note allows craft to substitute a member from one series with a member from another series, e.g., an American Standard Channel (C) for a Miscellaneous Channel (MC) or vice versa, as long as the substituted shape is heavier than, but of the same depth as the original member. Cygna is concerned that this note allows the use of substitute sections which are heavier, but have lower section moduli.

At a later date, Reference 2 was issued, providing the following clarification:

"Structural members shown on drawing numbers 2323-S-900 series may be substituted by a member of the same size and next heavier shape determined by the material on site. The next step heavier shape will be governed by sections as shown in AISC Manual of Steel Construction. Examples are shown on sheet 2 of 2."

The examples shown on sheet 2 of Reference 2 include the substitution of a C4x7.25 for a C4x5.4, a C6x10.5 for a

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C6x8.2, etc. This clearly indicates that the substitution should be of the same series as the specified member.

Cygna's concern is what types of substitutions were performed by the craft and accepted by the QC inspectors during the time between the issuance of Reference 3 and Reference 2. Cygna was unable to locate any requirements for documenting member substitutions.

B. Within Cygna's walkdown scope, support number 6654 (also see Review Issue 20) was reviewed and found to be an example of Cygna's concern as discussed above. The design required an MC6x12 and the installed member was a C6x13 which has a smaller section modulus ($S = 5.80\ in^3$ for a C6x13 compared to $S = 6.24\ in^3$ for an MC6x12). For the other supports listed in Review Issue 20, the required MC6x12's were substituted with C6x8.2's, a substitution not permitted by this note.

Status: TUGCO/Gibbs & Hill should provide justification of such substitutions and the requirements for documentation of the substitutions.

16. Weld Design and Specifications

References:
1. N.H. Williams (Cygna) letter to V. Noonan (USNRC), "Response to NRC Questions," 83090.023, dated March 8, 1985
2. Communications Report between Chang and Huang (Gibbs & Hill) and Horstman, Russ and Williams (Cygna) dated October 27, 1984
3. Communications Report between Chang and Huang (Gibbs & Hill) and Horstman, Russ and Williams (Cygna) dated November 13, 1984

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4. Communications Report between Chang and Huang (Gibbs & Hill) and J. Russ (Cygna) dated November 17, 1984

5. Communications Report between R. M. Kissinger (TUGCO) and J. Russ (Cygna), dated November 30, 1984

6. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.041, dated February 12, 1985

Summary: Cygna has discovered the following problems with the weld designs for cable tray supports.

A. The design drawings are missing the weld details for several support types as described in Reference 1, Attachment C.

B. Per discussions with Gibbs & Hill/TUGCO (References 2, 3, 4 and 5), Cygna has noted that the weld sizes shown on the assembly drawings differ from those shown on the design drawings and those that were assumed in Gibbs & Hill calculations.

C. Eccentricities were not considered in weld connections.

1. Detail SP-7 with brace and similar connections require a partial penetration groove weld at the gusset plate/beam connection. The design calculations did not consider the eccentric load transfer from the brace member. The eccentricity of the brace loads results in a weld stress in excess of the allowable. 11

2. Weld designs for base angle connections never considered the eccentricities of the applied loads from the connecting members.

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D. The weld designs did not consider the thickness of the connected parts. Gibbs & Hill's weld designs assumed that the full weld throat would be developed without considering the thickness of the connected member. For example, the weld size for support designs employing C6x8.2 channels with a fillet weld crossing the web of the channel is limited to the 0.2 inch web thickness. Gibbs & Hill designs specified a 5/16" fillet weld size and did not reduce the throat to account for the minimum material thickness. Cases where this may be a problem include: Details E, F, G, H, J and K on Gibbs & Hill Drawing 2323-E1-0601-01-S, SP-7 using an L6x4x3/4 base angle and the Detail 2/2A on Gibbs & Hill drawn 2323-S-0903 as modified per CMC 58338.

E. Gibbs & Hill assumed an incorrect minimum weld length for the beam/hanger base angle connection. Gibbs & Hill assumed a distance of l-k, where l = angle leg width and k = distance from back of angle leg to end of fillet. However, because of the existence of the curve with radius, r (approximately equal to one-half the leg thickness), at the angle toe, the actual weld length is l-k-r.

Status: Items A through D are open pending response to Reference 6. Item E may require further discussion with TUGCO.

17. Embedded Plates Design

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.041, dated February 12, 1985, Attachment A, question 1

2. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna) dated April 19, 1984, page 11

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3. Communications Report between Williams, Russ and Horstman (Cygna), Kissinger and Keiss (TUGCO) and Bhujang, Huang and Chang (Gibbs & Hill) dated September 15, 1984

4. Communications Report between M. Warner (TUGCO) and N. Williams, J. Minichiello and J. Russ (Cygna) dated February 27, 1985

5. Gibbs & Hill Calculations Binder 2323-SCS-146C, Set 4, Sheet 3-9, 21.

6. Gibbs & Hill Drawing 2323-S-0919, Revision 3.

Summary:

A. Gibbs & Hill performed capacity calculations for cable tray support attachments to embedded strip plates. Cygna's review of these calculations indicates that the calculated capacities may not have considered the effect of prying action on the tension in the Nelson Studs.

B. Questions from Cygna's pipe support reviewers and cable tray reviewers on the stiffening requirements for embedded plate moment connections elicited conflicting responses from TUGCO personnel. The pipe support response indicated that attachments to embedded plates act as stiffeners for moment connections (Reference 2) while the cable tray support response indicated that any moment attachment must be stiffened or sufficiently analyzed (Reference 3).

C. Cygna has noted that calculations for cable tray supports attached to embedded plates did not consider the capacity reductions for attachment locations given in Gibbs & Hill Specification 2323-SS-30, "Structural Embedments" (Reference 1).

D. Cygna is reviewing the QC cable tray support Inspection Report forms as well as the verification procedures for attachment proximity criteria as part of the design

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process overview for possible implications relative to the field control of attachments to embedded plates.

E. Details E, F, G, and H Installations on Embedded Plates

Reference 5 is the design calculation for support Details E,F,G, and H (Gibbs & Hill drawing 2323-E1-0601-01-S) installations on embedded strip plates. One of the design inputs to these calculations is a maximum tributary tray span of 7'-6". Note 9 on Reference 6 states:

> "The supports will have a location tolerance of ± 12" in the direction parallel to the tray and ± 2" perpendicular to the tray. However, spacing between any two adjacent supports shall not exceed 9'-0" for Unit 1 and Common Areas...unless otherwise noted on the drawing."

Supports installed in accordance with this drawing note may have to resist loads due to a 9'-0" tributory span, 1'-6" greater than the design tributary span.

11

Status: TUGCO/Gibbs & Hill should provide justification for the above items.

18. Tray Clamps

References:
1. Gibbs & Hill Drawing 2323-S-0902, Revision 5
2. TUGCO Drawing TNE-S1-0902-02, Revision CP-2
3. Communication Report between T. Keiss (TUGCO) and W. Horstman (Cygna) dated November 15, 1984

Summary: Two general categories of cable tray clamps are used at CPSES. "Friction" type clamps are installed on transverse type supports (e.g., A_1, B_1, SP-7, etc.). These clamps are

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assumed to provide vertical and horizontal transverse load transfer. "Heavy duty" clamps are installed on longitudinal trapeze supports (e.g., L-A_1, L-B_1, etc.), three-way supports (e.g., SP-7 with brace, Detail 8 on drawing 2323-S-0903, etc.), and transverse supports where interferences (e.g., tray splice plates, fittings, etc.) prevent the installation of friction type clamps. Heavy duty clamps are designed to transfer vertical, horizontal transverse and longitudinal tray loads to the cable tray support beam. References 1 and 2, DCA 3464, Revision 23, DCA 6299, Revision 7, and DCA 20331, Revision 0, provide clamp configuration details.

In addition to the indicated load transfers between trays and supports, Gibbs & Hill has assumed other load transfer mechanisms in order to justify behavioral assumptions made in the support designs. For "friction" type clamps, the following assumptions have been made in order to justify the system concept (also see Review Issue 10).

- The trays will provide out-of-plane bracing to trapeze supports to reduce the buckling length of the vertical hanger members (also see Review Issue 4).

- The trays will provide lateral bracing to the compression flanges of the horizontal beams (also see Review Issue 24).

- The trays will provide out-of-plane bracing to supports to prevent frame translation which would result in increased anchor bolt tensile loads (also see Review Issue 3).

- The cable trays will transfer out-of-plane inertial loads from transverse supports to longitudinal supports on the same tray run (also see Review Issue 6).

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- The development of minor axis bending moment in the beams due to the horizontal eccentricity between the beam neutral axis and the clamp bolt is minimized by a bending moment in the cable tray (also see Review Issue 24).

- For vertical loading, the development of torsion in the beam due to the eccentricity between the clamp location and the beam shear center is prevented by flexure of the cable tray. This assumes a full moment fixity between the tray and the support beam (also see Review Issue 24).

For heavy duty clamps, all of the above assumptions are also applicable and an additional assumption is made by Gibbs & Hill.

- The development of torsion due to longitudinal loads on three-way supports using composite beam sections (e.g., SP-7 with brace, Detail 8 on drawing 2323-S-0903, etc.), is prevented by flexure of the cable tray. This assumes a full moment fixity between tray and support beam (Review Issue 24).

The assumptions described above are valid only if the clamps can provide suitable displacement and rotation compatibility between the tray and support beam. Based on a discussion with TUGCO (Reference 3), Cygna determined that installation tolerances (Reference 2, DCA 6299, Revision 7, DCA 20331, Revision 0, and CMC 93450, Revision 4) have been adopted which allow gaps between the tray side rails, the support beam and the tray clamps. In order to provide the assumed compatibility, "friction" type clamps must be cinched sufficiently to develop friction between the tray/beam and tray/clamp interfaces. The existence of gaps will preclude the development of the normal contact force require for frictional resistance.

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Status: Gibbs & Hill/TUGCO should evaluate the various clamp designs to establish their capability to provide the assumed load transfer.

19. FSAR Load Combinations

References: 1. CPSES FSAR, Section 3.8.4.3

2. Gibbs & Hill Calculation Binder SCS-103C, Set 1, Sheets 14-19

3. Gibbs & Hill Calculation Binder SCS-103C, Set 2, Sheet 32

Summary: Reference 1 defines the loads and load combinations applicable to the design of cable tray supports. Cygna's review of the cable tray support designs indicates that only dead weight and seismic inertial loads are considered.

For supports installed in the Reactor Buildings, the loads associated with a LOCA may be applicable, including pipe whip, jet impingement and thermal loads. Two support types within Cygna's review were designed for installation in the Reactor Building, Detail A (Gibbs & Hill drawing 2323-E1-0500-01-S) and Detail C (Gibbs & Hill drawing 2323-E1-0500-04-S). The design calculations for these supports, References 2 and 3, respectively, did not consider these additional loads.

Status: Gibbs & Hill/TUGCO should provide the criteria for not evaluating other possible support loadings.

20. Differences Between the Installation and the Design/Construction Drawings without Appropriate Documentation

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References:

1. Gibbs & Hill, Inc., support layout drawing 2323-E1-0713-01-S
2. Brown & Root, Inc., fabrication drawing FSE-00159
3. American Institute of Steel Construction, Inc., Manual of Steel Construction, 7th Edition
4. Gibbs & Hill support layout drawing 2323-E1-0601-01-S
5. Gibbs & Hill support layout drawing 2323-E1-0700-01-S
6. Gibbs & Hill cable tray support design drawings 2323-S-0900 series
7. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Walkdown Questions," 84056.026, dated August 23, 1984
8. Communication Report between M. Warner, J. van Amerongen (TUGCO) and W. Horstman (Cygna) dated October 25, 1984
9. Communication Report between T. Webb, M. Hamburg (TUGCO) and W. Horstman (Cygna) dated October 18, 1984
10. Communication Report between M. Warner, C. Biggs (TUGCO) and W. Horstman (Cygna) dated October 10, 1984
11. Brown & Root Procedure No. CEI-20, Revision 9, "Installation of Hilti Drilled-In Bolts"
12. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), "Comanche Peak Steam Electric Station Cygna Review Questions," dated September 6, 1984

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13. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Walkdown Questions," 84056.021, dated August 16, 1984

Summary: Cygna performed walkdown inspections on 49 of the 92 supports within the review scope. Certain discrepancies between the as-built support configurations and the design requirements were as noted below.

A. Support No. 481, Longitudinal Type A_4

Single angles were installed as braces in the longitudinal direction. A pair of angles is required by the design drawing. No change documentation was located.

B. Support No. 408, Type B_4

The lower corner of the frame is modified by CMC 9916, Revision 1, to avoid interference with the CCW heat exchanger. This change document shows that 4" channel sections are to be used for the prescribed modification. A 6" channel section is actually installed.

C. Support No. 649, Type A_1

This installation uses concrete anchorage "Alternate Detail 1" (Gibbs & Hill design drawing 2323-S-0903) which requires the use of an L6x6x3/4. Cygna's field inspection discovered that an L5x5x3/4 was installed. No existing documentation accounted for this discrepancy.

D. Support Nos. 722 and 2606, Detail "N", Drawing 2323-E1-0601-01-S

Cygna's field inspection found a working point violation on the brace attachment to the wall. Design drawing 2323-S-0929 Connection Detail "F" was used (2323-S-0903) which has a tolerance of $b/2 \pm 0.3b$ where $12" < b < 30"$. Cygna's field inspection results show the tolerance used was $b/2 - 0.5b$ (i.e., the brace was located in line with one bolt).

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E. Support Nos. 2992, 2994, 3005, 3017, 3021, 6654, Type A_2

Reference 1 identified the above six supports as follows: "A_2 (except all members shall be MC6x12)," where L = 8'-3" (frame width), h = 4'-2" (frame height).

The Cygna walkdown documented the installed hanger member sizes, as listed below in Table 1. Due to the presence of Thermolag coating, which covers entire team member and part of hanger members, Cygna was unable to determine the installed beam member size. No documentation existed to reconcile the differences between the design requirements and the installation.

TABLE 1
Cable Tray Support Hanger Member Sizes

Dimensions (See Note 1)			Member Size
Support No.	Depth (In)	Flange Width (In)	Existing (Note 1)
2992	6	1-7/8	C6 x 8.2
2994	6	1-7/8	C6 x 8.2
3005	6	1-7/8	C6 x 8.2
3017	6	1-7/8	C6 x 8.2
3021	6	1-7/8	C6 x 8.2
6654	6	2-1/8	C6 x 13

Note: 1. Dimensions of the vertical channels (hangers) are based on measurements by Cygna. Member sizes are determined by selecting the channel type from Reference 3 which most closely matches the measured depth and flange width.

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F. Support No. 455, Type SP-8

Cygna's field inspection indicated that the brace connected to the wall on one side of the support is located outside of the bolt pattern on the base angle. The Detail "B" (2323-S-0903) type connection allows a tolerance of b/2 ± 0.2b.

G. Support Nos. 2998 and 13080, Special Type Supports

These supports were installed in floor slabs with 2" topping. The topping depth was apparently not considered in selecting the length of the anchor bolt. Therefore, the required embedment length was not achieved.

H. Hilti Super-Kwik Bolts Without Stars

Section 3.1.3.1 of Brown & Root Procedure CEI-20 (Reference 11) requires:

> Hilti Super Kwik-bolts shall be additionally marked with a "star" on the end which will remain exposed upon installation.

Twenty-eight of the cable tray supports inspected by Cygna required the installation of Hilti Super Kwik-bolts, of these, only two supports had stars stamped on the bolts. The bolts on the remaining supports were not stamped.

I. Contact Between the Component Cooling Water (CCW) Heat Exchanger and Cable Tray Support Nos. 332 and 408

Gibbs & Hill specification 2323-ES-100 requires a clear distance of six inches between cable tray supports and Class 1 piping including insulation unless otherwise allowed by the Owner. Cygna's walkdown noted that cable tray support numbers 332 and 408 were in contact with the CCW heat exchanger (Reference 13). Documentation did not exist which accepts this installation.

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J. Support No. 2953, Detail E (Drawing 2323-E1-0601-01-S)

This support is attached near the end of an embedded strip plate. The distance from the end of the embedded plate to a penetration through the concrete was less than the minimum distance required for the embedded Nelson studs.

K. Support No. 6654, Type A_2

The weld pattern used to attached the east hanger to the gusset plate on the base angle provided more weld length than required by the design.

L. Support No. 758, Detail V (Drawing 2323-E1-0601-01-S)

The north base angle for this support was shared with support no. 759. This attachment was not documented on the CMC affecting support no. 758.

Status:

A. TUGCO issued CMC 2635, Revision 1, to document the installation discrepancy for support number 481.

B. TUGCO issued CMC 9916, Revision 2, to document the installation discrepancy for support number 408.

C. TUGCO issued CMC 99308, Revision 0, to document the installation of the incorrect size base angle for support number 649.

D. TUGCO issued CMC 99309, Revision 0, to document the anchor bolt installation discrepancy for these two supports.

E. TUGCO issued the CMC's listed below to document the installation of the incorrect member sizes.

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Support Number	CMC No.	Revision
2992	44519	9
2994	99326	0
3005	96079	1
3017	99327	0
3021	30452	2
6654	90714	6

F. TUGCO issued CMC 99307, Revision 0, to document the installation discrepancy for support number 455.

G. TUGCO is to evaluate the effect of reduced embedment length for supports 2998 and 13080. Cygna is evaluating the corrective action requ'red by SDAR 80-05 "Use of Architectural Concrete in Floor Slabs" for supports installed after its issuance.

H. Cygna has discussed the absence of stars on Hilti Super Kwik-bolts (References 10 and 12) with TUGCO. The lack of stars is attributable to the fact that procedures in place at the time of support installation did not contain this requirement (Reference 12). To verify that Hilti Super Kwik-bolts were installed per the design drawings, Cygna witnessed the ultrasonic testing (UT) of several supports (Reference 9). A total of twenty-one supports were tested. All expansion anchor bolts were verified to be Hilti Super Kwik-bolts as required. Therefore, this review issue is considered closed.

I. TUGCO issued CMC 1887, Revision 1 and CMC 9916, Revision 4 for support numbers 332 and 408, respectively. These CMCs specified support modifications to assure that a minimum clearance of 1" was provided between the CCW heat exchanger and the cable tray supports.

J. TUGCO issued CMC 12105, review 1 to document the Nelson stud edge distance violation for support no. 2953.

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K. TUGCO issued CMC 90714, review 3 to document the weld pattern discrepancy for support no. 6659.

L. TUGCO issued calculations evaluating the adequacy of the anchorage considering the loads from both cable tray support nos. 758 and 759.

21. Design Control

References:

1. Gibbs & Hill Drawings 2323-E1-0601-01-S, 2323-E1-0700-01-S, 2323-E1-0713-01-S

2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Design Review Questions," 84056.022, dated August 17, 1984, questions 1, 2, and 6

3. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Design Review Questions," 84056.025, dated August 21, 1984, question 1

4. Gibbs & Hill Cable Tray Support Design Drawings 2323-S-0900 Series

5. Gibbs & Hill Calculations for Support Numbers 3025, 3028, 2861, Cygna Technical File 84056.11.1.225

6. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), "Responses to Cygna Review Questions," dated September 4, 1984, with attached calculations

7. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 3, Sheets 206, Revision 6

8. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), "Response to Cygna Design Review Ques-

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tions," dated September 11, 1984, with attached calculations

9. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 5

10. Gibbs & Hill Drawing 2323-S-0901, Revision 4

11. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support and Electrical Review Questions," 84056.019, dated August 10, 1984, questions 2.1 and 2.2

12. Gibbs & Hill Drawings 2323-E1-0601-01-S, 2323-E1-0700-01-S, and 2323-E1-0713-01-S

13. Gibbs & Hill Specifications 2323-ES-19, Revision 1 "Cable Tray Specification"

14. Gibbs & Hill Calculation Binder 2323-SCS-111C, Set 8.

15. Communications Report between P. Huang (Gibbs & Hill) and J. Russ (Cygna) dated June 13, 1984.

16. L.M. Popplewell (TUGCO) letter to N. Williams (Cygna), "Comanche Peak Steam Electric Station Cygna Review Questions," dated August 27, 1984 with attachments.

17. R.E. Ballend (Gibbs & Hill) letter to J.B. George (TUGCO), "Cable Tray Supports Cygna Phase 4 Audit Activities", GTN-69377, dated August 24, 1984, with attachments.

18. L.M. Popplewell (TUGCO) letter to N. Williams (Cygna), "Comanche Peak Steam Electric Station Cygna Review Questions", dated September 11, 1984, with attachments.

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Summary:

A. The effects of generic CMC's, DCA's and installation specifications were not considered in the original designs as follows:

1. Support type SP-7 with brace is affected by CMC 6187. The CVC was approved and design reviewed by Gibbs & Hill, New York, but its effects were not considered in the SP-7 with brace calculations or any generic reviews.

2. CMC 1970, specifies the allowable end distance for anchor bolt holes in base angles. Change in end distance will change the effective span between anchor bolts used in the calculation of bolt tensile loads and will also significantly change the magnitude of prying action. This effect was not considered in the design of the anchor bolts.

3. Gibbs & Hill installation specification 2323-SS-16b allows a tolerance of 2° for member plumbness. The effects of this tolerance were not considered in the support designs (See Review Issue 4E).

B. Criteria violations in individual support specifications on support plans:

In the generic design of cable tray supports, support dimension and loading limitations are determined for each support type. These limitations are typically stated in the design calculations, but are not shown on the generic support design drawings (Reference 4). The dimensions for each support are specified in a descriptive block on the support plans (Reference 1) and the loading is indicated by the supported tray width shown.

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The tray supports listed below were identified as having loadings or support geometries which exceeded the design limitations. Prior to the Cygna review, justifying documentation did not exist for these individual support designs.

1. Support Nos. 3025, 3028, 2861, Type D_1. Drawing 2323-E1-0713-01-S specifies these supports as type D_1 (except beam to be MC6 x 16.3), L = 11'-9", h = 4'-2", and shows a tray width of 78". The design calculations for Type D_1 supports limit L 8'-0" and tray width to 48".

2. Support No. 2607, Type A_1. Drawing 2323-E1-0601-01-S specifies dimensions of L = 2'-9" and h = 4'-6" for this support. The design calculation for this support type limits h $\leq$ 2'-4".

3. Support No. 657, Type A_1. Drawing 2323-E1-0601-01 specifies this support as Type A_1, L = 7'-0", h = 2'-0". The design calculation for this support type limits L < 6'-0".

4. Support No. 734, Detail H, Drawing 2323-E1-0601-01-S. This drawing specifies that one beam is to be an MC6x15.1, rotated 90° from its normal orientation. The support design requires the use of C6x8.2 beam sections. The section modulus of MC6x15.1 about its weak axis, 1.75 in^3, is smaller than that of C6x8.2 about its strong axis, 4.38 in^3. Therefore, this support should be reevaluated for vertical loads.

   Rotating the MC6x15.1 by 90° from its normal orientation significantly increases the longitudinal stiffness of the beam. Together,

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with CMC 00164 which requires the use of "heavy duty clamp" for this support, significant longitudinal loads can be introduced to it. The support design requires the addition of a longitudinal brace if longitudinal loads are to be resisted.

5. Support No. 3011, Type SP-6. Drawing 2323-E1-0713-01-S specifies dimensions of L = 8'-9" and h = 4'-6". The design calculation for this support type limits L < 6'-0".

6. Support Nos. 2992, 2994, 3005, 3017, 3021, 3111, 6654, Type A_2. Drawing 2323-E1-0713-01-S specifies dimensions of L = 8'-3" and h = 4'-2", and shows a tray width of 78". The design calculation for this support type limit L < 6'-0" and the tray width to 48".

7. Support Nos. 95 and 112, Type SP-7. Drawing 2323-E1-0700-01-S specifies these supports as Type SP-7, L=5'-1" and shows a tray width of 48". The design calculations for Type SP-7 limits the tray width to 30".

8. Support No. 758, Detail V on drawing 2323-E1-0601-S. Drawing 2323-E1-0601-01-S specifies this support as Detail V, h_1=8'-4", h_2=7'-3", h_3=4'-0", l_1=5'-9", l_2=2'-3", a=2'-6" and shows a tray width of 66". The design for this support detail limits the tray width to 60".

9. Support No. 765, 766 and 767, Detail J on drawing 2323-E1-0601-01-S. Drawing 2323-E1-0601-013 specifies these supports as Detail J, L=8'-6", h_1=10'-10", h_2=9'-6" and h_3=3'-6", and shows a tray width of 66". The design for the support detail limits the tray width to 48".

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Additionally, Gibbs & Hill was not consistent in establishing controlling criteria (i.e., support dimensions, tray width, etc.) in support designs. As an example, in several support designs, the support frame was designed for a particular height and width while the anchorages were designed using reactions from a frame with a different height and width. The lack of a single limiting configuration may affect the support dimensions as shown on the cable tray support plans. Within Cygna's scope, support types E_4, SP-6 and SP-8 are affected.

C. Consideration of as-built support conditions in generic reviews which require a case-by-case review:

1. The SP-7 weld underrun analysis considered 5/16" fillet welds which are specified on the design drawings. However, the FSE-00159 fabrication drawings specify smaller weld sizes. In addition, the underrun analysis did not consider the effects of any design changes to the supports which were reported in CMC's and DCA's.

2. Working Point Deviation Study (see Review Issue 12).

D. Inconsistent application of as-built and design information in the evaluation of cable tray supports for Thermolag application:

1. Tray cover weights were not included in the development of the allowable span length table (Procedure CP-EI-4.0-49).

2. Cygna believes that longitudinal supports are not evaluated for the added weight of fire protection. Evidence of the above includes

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the fire protection review for the tray run containing Detail N (Gibbs & Hill Drawing 2323-E1-0601-01-S). If the effect of the added weight of fire protection had been evaluated for the longitudinal supports, the lack of any longitudinal supports in the tray run would have been noted.

3. Fire protection evaluations are performed on a tray-by-tray basis. The cumulative effect of multiple trays with fire protection on one support may not be considered using the approach.

E. Tray spans between supports used in the original support layout

1. Reference 13 indicates that cable trays are to be designed and qualified for 8'-0" spans. Reference 10, Note 13, allows a location tolerance for supports of ± 1/2 Richmond Insert spacing parallel to the tray, and limits the maximum spacing between supports to 9'-0." Gibbs & Hill cable tray support design calculations assume a maximum tributary span of 8'-6," to account for a support spacing of 8'-0" on center and an erection tolerance of ± 6." Cygna reviewed the tray segments within this IAP's scope on the tray support plans (Reference 12) and noted 15 locations where the as-designed tray spans exceeded 8'-0". Cygna's walkdown of these tray segments discovered five locations where the as-built tray spans exceeded 9'-0" (see Reference 11). This indicates that the design and installation limitations for support spacings may not have been complied with in the preparation of support layout drawings and in the field.

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2. Longitudinal support designs indicate that the maximum longitudinal tray span is 40'-0". For several supports within Cygna's review, the support plan drawings (Reference 12) specified these supports to have tributary spans greater than 40'-0" (see Reference 11). In addition, several horizontal tray segments were not provided with any longitudinal supports (see Reference 11). This indicates that the design limitations for the location of longitudinal supports may not have been complied with in the preparation of support layout drawings.

F. Calculations were not provided for change notices

Cygna has noted several design reviews of change notices where the CVC was marked to indicate that new or revised calculations were not required. However, Cygna considers some changes significant. Therefore, some calculations should have been provided to justify their acceptability. In some cases, calculations marked "for reference only" are attached to the CMC which the reviewer had accepted without new or revised calculations.

G. Design Calculation Retrievability and Completeness

During the course of the Phase 2 and 4 reviews, Cygna experienced difficulty in assembling complete support design calculation sets. Cygna noted that Gibbs & Hill has similar difficulty. The following examples illustrate Cygna's concerns.

1. In Phase 2 of Cygna's IAP, Cygna requested on evaluation of the effect of torsion in the C4x7.25 beams on the support design adequacy.

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Gibbs & Hill provided calculations (Reference 14), Sheet 28-33, evaluation torsion in the beams. These calculations were performed in 1982, but were not included in the indicated calculation binder (the cover sheet for Reference 14 indicated that the total number of sheets was 6). Subsequent to Cygna's review of these calculations, they were added to form revision 1 of Reference 14.

2. Cygna requested a list of all calculations relevant to several generic support designs (Reference 15). Gibbs & Hill provided a list of calculation binder and sheet numbers for each support type. The review of these calculations by Cygna indicated that additional calculations were relevant to the support designs which had not been included on the list. For example, the Working Point Deviation Study included several supports listed in Reference 15, but was not referenced in Gibbs & Hills response.

H. Lack of Controlled Design Criteria

1. Cygna has noted instances where the field design review group did not utilize the proper criteria to evaluate support adequacy. The evaluations for fire protection compared the as-built support load to a design load based upon multiplying the allowable distributed load times a 9'-0" tributary tray span. Since the maximum tributary span assumed in the current design calculation is 8'-6", the use of 9'-0" span overestimates the allowable load.

2. Cygna has asked what supplements to the 7th Edition of AISC Specifications were committed to in the FSAR. No evidence was found to indicate that proper direction was given to design engineers to utilize the requirements

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of any supplements to which CPSES was committed.

Status: A. No further discussion is required.

B. Gibbs & Hill has indicated that the engineer preparing a support layout drawing would be familiar with the design limitations. Based upon engineering judgement, these limitations could be exceeded without preparing supporting calculations, since the support map drawings would be subject to design review. Gibbs & Hill should assure that the critical frame limitations have not been exceeded without proper technical justification.

For the individual supports referenced above:

1. Gibbs & Hill provided calculations (Reference 5) evaluating these supports. Support numbers 3025 and 3028 were found acceptable, support number 2861 shows 30% overload of anchor bolts.

2. TUGCO provided calculations (Reference 6) demonstrating the acceptability of support number 2607.

3. TUGCO provided calculations (Reference 6) demonstrating the acceptability of support number 657.

4. Gibbs & Hill/TUGCO have not provided a response.

5. Gibbs & Hill provided calculations (Reference 7) demonstrating the acceptability of support number 3011.

6. TUGCO provided calculations (Reference 8) demonstrating the acceptability of these supports.

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7. No justification has been provided for the overloading of these supports.

8. TUGCO provided calculations demonstrating the acceptability of this support.

9. No justification has been provided for the overloading of this support.

C. No further discussion is required.

D. Cygna is continuing internal evaluation.

E. Gibbs & Hill has indicated that the engineer preparing a support map drawing would be familiar with the span limitations for transverse and longitudinal supports. Based upon engineering judgement, these limitations could be exceeded without preparing supporting calculations, since the support map drawings would be subject to design review.

For the individual span violations noted above,

1. Gibbs & Hill/TUGCO provided calculations (Reference 16) qualifying trays and supports for the transverse span violations.

2. Gibbs & Hill/TUGCO provided calculations (References 17 and 18) qualifying trays and supports for the indicated longitudinal span violations. For tray segments lacking longitudinal supports, the load was applied as additional transverse loads on transverse type supports located around a 90° bend from the unsupported tray segment. For one tray run without any existing mechanism to resist longitudinal loads, segments T120SBC25 and T130SCA45, the addition of a new longitudinal support was required.

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F. Cygna is continuing internal evaluation.

G. Cygna is continuing internal evaluation.

H. Cygna is continuing internal evaluation.

22. Design of Support No. 3136, Detail "5," Drawing 2323-S-0905

Reference:
1. Gibbs & Hill Calculation Binder SAB-1341, Set 3, revision 0.
2. Communication Report between B.K. Bhujang (Gibbs & Hill) and N. Williams, et al. (Cygna) dated October 20, 1984
3. Gibbs & Hill Calculation Binder SAB-1341, Set 3, revision 1.

Summary: Support No. 3136, located at elevation 790'-6" at the Auxiliary Building/Safeguards Building boundary, is embedded in a fire wall. In reviewing the calculations, (Reference 1) for the design of this support, Cygna located several possible discrepancies. A list of Cygna's questions was provided (Reference 2, Attachment A) to Gibbs & Hill for their review.

Status: Gibbs & Hill/TUGCO has provided a response to Cygna's concerns (Reference 3). Cygna is currently evaluating the acceptability of the response. 11

23. Load Placement In STRESS Models

Reference:
1. Gibbs & Hill Computer Output Binder 2323-DMI-5P
2. Gibbs & Hill Calculation Binder 2323-SCS-215C, Set 2.

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Summary: For the design of standard support cases A_i, B_i, C_i and D_i, where i = 1 to 4, finite element analyses were performed (Reference 1) using the program STRESS. Single beam elements were used to model the horizontal members (beams). Tray loads were applied at the beam/hanger intersection rather than within the span of the beam where the tray is physically located.

Modeling the load placements in this fashion eliminates the effects of bending and torsion due to vertical loads on the beams, and for cases D_i, will totally remove the load from the support.

Support cases A_3, A_4, B_3, B_4, C_3 and C_4 have been reevaluated in Gibbs & Hill's Working Point Deviation Study (Reference 2) considering the load application at the tray centerline, so this issue is not a concern for these support types.

Since support cases A_1, B_2, B_1, B_2, C_1 and C_2 are unbraced frames, they have not been reevaluated by Gibbs & Hill in the Working Point Deviation Study or similar, more refined analyses. 11

Status: Gibbs & Hill should provide justification for the adequacy of the finite element analyses of support cases A_1, A_2, B_1, B_2, C_1, C_2, and D_1 through D_4.

24. Design of Flexural Members

Reference: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray Support Review Questions," 84056.031, dated August 31, 1984

2. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna) "Comanche Peak Steam Electric Station Cygna Review Questions," dated September 28, 1984

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3. Communication Report between E. Bezkor et al. (Gibbs & Hill) and M. Engleman et al. (Cygna) dated April 11, 1985

4. Gibbs & Hill Drawing 2323-S-0903.

Summary: In the design of cable tray support flexural members (i.e., beams) Gibbs & Hill did not consider several important items as discussed below.

A. Additional major axis bending stresses due to transverse loads are introduced by the vertical eccentricity between the cable tray centerlines and the beam neutral axis (Reference 1). Gibbs & Hill provided calculations (Reference 2) indicating that the increase in bending stress did not exceed 2.5% of the allowable stress level. However, the analysis incorrectly assumed that the beam was a fixed-fixed member, effectively isolating it from the remainder of the support structure. In addition, the load transfer mechanism that was assumed to be provided by the tray clamps may not be inherent in all clamp configurations (also see Review Issue 18).

B. Minor axis bending of the beams due to transverse loading is introduced by the horizontal eccentricity between the beam neutral axis and the location of the tray clamp bolt holes in the beam's top flange (Reference 1). Gibbs & Hill's response (Reference 2) did not consider the allowed tolerance in bolt hole gage per DCA 17838, Revision 8. A load transfer mechanism was assumed to be provided by the clamp which will allow the trays and supports to act as a system, resulting in increased transverse loads on adjacent supports and no minor axis flexure in the beams. The validity of this assumption depends on the resolution of Review Issues 10 and 18.

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C. Vertical loading introduces torsion into the beams due to the horizontal offset between the tray clamp location and the shear center of the beam. In Gibbs & Hill's response (Reference 2), the torsional moment was completely eliminated based on an assumed moment resistance provided by the tray clamps and the tray/support system concept (also see Review Issue 10 for the acceptability of this concept).

D. Torsion is introduced into the beam by longitudinal loading due to:

1. The vertical offset between the tray centerline and the beam shear center (for longitudinal trapeze type supports, e.g., $L\text{-}A_1$, $L\text{-}B_1$).

2. The vertical offset between the tray centerline and the shear center of the composite beam (for longitudinal supports similar to SP-7 with brace, Detail 8, drawing 2323-S-0903, etc.)

Gibbs & Hill's evaluation of the torsional effects are included in Reference 2. The evaluation of torsion due to loading type 1 only considers the eccentricity between the shear center and the top of the tray rungs for ladder type trays or the tray bottom for trough type trays. The centroid of the tray fill is a more appropriate location from which to calculate the eccentricity. For loading type 2, the longitudinal load is applied at the bottom of the tray side rails, rather than the centroid of the tray fill. The tray clamps are assumed to provide rotational restraint to the top flange of the composite beam, and all torsional moments are assumed to be resisted by a couple formed between adjacent vertical supports through flexure of the cable tray. All these assumptions must be justified per Review Issues 10 and 18. 11

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E. Gibbs & Hill has not consistently considered the reduction in the beam section properties due to bolt holes through the flanges (also see Review Issue 9) and weld undercut effects. Based on CMC 58338, Revision 0, the welded connection between the beam and hanger can include vertical fillet welds crossing the web of the beam, thus weld undercut would affect the beam capacity at this critical location. Weld undercut could also affect the beam capacity at beam-to-base angle/plate connection for the cantilever type of supports. In addition, based on the tray installation tolerances provided in Gibbs & Hill specification 2323-ES-100, Section 2.28 and the effect of CMC 2646, Revision 5, the tray clamp can be located such that the bolt hole is in the same cross-sectional plane as the effective weld undercut. Thus, it is possible that both reductions may occur simultaneously.

F. Gibbs & Hill has not evaluated the effects of shear stresses on beam acceptability. Shear stresses will be introduced by two loadings:

1. Direct shear due to applied forces; and,

2. St. Venant shear associated with torsional loads (see Items C and D above). Cygna's review indicates that direct shear stresses are minor and generally do not govern the design of flexural members. When these stresses are considered in combination with the potentially large St. Venant shear stresses, the effect can be a significant factor in the member design (Reference 3).

G. Gibbs & Hill generally assumes an allowable major axis bending stress of 22 ksi for beam designs. The capacity reduction based on the unsupported length of the beam's compression flange (AISC Equation 1.5-7) is either not

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considered at all or not properly considered (also see Review Issue 14). Justification is provided based on the assumption that the tray and tray clamp will provide lateral bracing to the beam's compression flange. This assumption is dependent on the tray clamp's ability to provide bracing (also see Review Issue 18) and neglects the possibility of bottom flange being in compression due to support frame sidesway and seismic uplift. For the cantilever type of supports, the "l" value in Equation 1.5-7 is improperly selected as discussed in Review Issue 14.

Status:

A. Gibbs & Hill should provide technical justification for the assumed load transfer mechanism provided by the tray clamps and the fixed end conditions used in the evaluation of the increased major axis bending.

B. For status, see Review Issue 10.

C. For status, see Review Issue 10.

D. Gibbs & Hill should provide justification for the assumed location of the applied longitudinal load, the assumed behavior of the tray clamps and the system concept. (See also status for Review Issues 10 and 18.)

E. Gibbs & Hill should provide technical justification of the beam adequacy considering weld undercut and bolt hole section reductions occurring at the same location. (See also Review Issue 9.)

F. Gibbs & Hill should provide technical justification that the combined direc. and St. Venant shear stresses are at an acceptable level.

G. The outcome of this issue is dependent on resolution of Review Issues 14 and 18.

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25. Cable Tray Qualification

References:

1. Gibbs & Hill Specification 2323-ES-19, Revision 1
2. Gibbs & Hill Structural Calculation 2323-SCS-111C, Set 7, Revision 1
3. T.J. Cope, Test Report and Calculations for the Qualification of Cable Trays
4. CPSES FSAR, Section 3.10B.3, Amendment 44
5. Gibbs & Hill Specification 2323-ES-100, Revision 2
6. IEEE "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," STD 344-1975
7. CPSES FSAR Section 3.7B.3.5
8. Gibbs & Hill Drawing 2323-S-0901, Revision 4
9. L.M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), "Response to Cygna Review Question 2.1 of Letter 84056.019," dated August 27, 1984 with attached calculations

Summary: The qualification requirements for cable trays are outlined in References 1 and 4. In reviewing related specifications, calculations, and installations of cable trays, Cygna has noted several areas of concern.

A. Qualification of cable trays is performed through static load testing and calculation of loading interactions for dead load plus three components of seismic load (Reference 1, Section 3.9 and Reference 3). Seismic loads are calculated by the equivalent static load method, using total tray dead weight times the peak spectral acceleration. No apparent dynamic amplification factor (DAF) is used.

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Reference 6, Section 5.3, and Reference 7, recommend the use of a DAF = 1.5 unless justification is provided. (See also Issue 8).

B. The interaction equation specified for checking cable tray capacity (Reference 1, Section 3.9.4) is limited in its application, and may have been used incorrectly.

The testing and qualification of cable trays is based on an 8'-0" simply supported tray span, References 1 and 3, yet Reference 8, Note 13, allows a support installation tolerance resulting in a maximum tray span of 9'-0" for Unit 1.

The capacity values derived in the tray testing are total loads (in lbs) uniformly distributed over an 8'-0" section of cable tray (Reference 3). These values, F_n, F_t and F_l, as used with the interaction equation are only applicable to qualifying tray sections with 8'-0" spans. However, for the fire protection evaluation calculations (Reference 2) and tray span violation calculations (Reference 9) total loads for various tray spans were calculated as $f_n' = w * l$, where w is the tray unit weight and l is the tray span. This load was compared with the rated tray capacity using the interaction equation.

For evaluation of trays with spans other than 8'-0", a capacity comparison must be made in terms of tray bending moment which is proportional to $(w * l^2)$, rather than the total load on the tray section. For example, if an 8'-0" tray span will support a total distributed load of 1600 lbs (200 lb/ft) by increasing the span to 10'-0", a uniform load of 128 lb/ft (1280 lbs) would result in the same bending moment at mid span. Therefore, the capacity for the 10'-0" span would be 1280 lbs and not the 1600 lbs assumed.

C. Cygna has noted several instances of modifications to cable tray hardware without adequate justification or documentation.

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1. Tray Segment No. T130SCA46 is assumed to be a 24"x6" ladder-type tray in the fire protection evaluation calculations for Safeguards Building Elevation 790'-6". Cygna's walkdown indicates that this tray is actually a 24"x4" ladder-type tray with 6" side rail extensions added to increase the tray depth. The tray qualification test report (Reference 3) does not provide qualification for trays using side rail extensions. Cygna's concerns include the ability of these extensions to resist bending moments, the shear flow through the connection bolts, and the effect of the reduction in tray side rail section properties due to the bolt holes used to attach the side rail extensions.

2. Tray Segment T120SBC35 is joined to a tray reducer with side rail splice connector plates. These plates have been modified by removing portions of their bottom flanges such that only the web area remains. This connector will not satisfy the requirements of Reference 1, Section 3.7, Paragraph f, which states that connectors "shall have moment and shear strengths at least equal to those of the continuous uncut side rail." Cygna was unable to locate documentation justifying this modification of vendor supplied hardware.

D. Cable tray section properties are calculated based on the test results (Reference 3). The moment of inertia is calculated based on the flexural displacement formula. For horizontal transverse loading (i.e., in the plane of the rungs) ladder-type cable trays show a truss-like behavior, and the deflection will be due to both flexure and shear deformations.

This will effect the calculated moment of inertia as used in any Gibbs & Hill analyses which consider the tray properties for frequency or displacement calculations.

Status:

A. Gibbs & Hill should provide justification for the DAF used for tray evaluation.

B. Gibbs & Hill should provide justification for the use of the tray capacity interaction equation.

C. Gibbs & Hill/TUGCO should provide documentation illustrating the acceptability of the use of tray side rail extensions and modifications to tray connector plates.

D. Gibbs & Hill should provide justification for the use of the flexural deflection formula for the calculation of the cable tray moments of inertia.

26. Base Angle Design

References:

1. Gibbs & Hill Calculation Binder 2323-SCS-215C, Set 2 through 6.
2. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 1.

Summary:

A. In References 1 and 2 the base angles were modeled as simply supported beams. This modelling technique does not include the stiffening effects of concrete bearing at the angle ends.

B. The principal axes were not considered in the analyses of the base angles subjected to the various loadings.

C. The base angle lengths due to the maximum spacing of the Richmond Inserts were not considered in the Working Point analyses.

Status:

A. Gibbs & Hill should provide technical justification for modeling the base angles as simply support beams.

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B. Gibbs & Hill should consider the principal axis properties of angle sections in the base angle analyses.

C. Gibbs & Hill should consider the most critical spacing of the Richmond Inserts in the Working Point Analyses.

27. Support Qualification by Similarity

References:

1. Gibbs & Hill Calculation Binder 2323-SCS-104C, Set 1.
2. Gibbs & Hill Calculation Binder 2323-SCS-104C, Set 5.
3. R.E. Balland (Gibbs & Hill) letter to J.B. George (TUGCO), GTN-69361, dated August 21, 1984, with attachments.
4. R.E. Balland (Gibbs & Hill) letter to J.B. George (TUGCO), GTN-69377, dated August 29, 1984, with attachments.

Summary:

A. In Gibbs & Hill design calculations, several support types were qualified by similarity to another support type without any justification to show similarity. Review of the geometry, loading, connection details, etc., by Cygna indicated that the designs were not obviously similar, and that calculations should have been provided. Supports in this catagory are:

1. Detail A, drawing 2323-E1-0700-01-S. Reference 2 states that Detail A is similar to case SP-7. Cygna noted that the cantilever length for Detail A is greater than for SP-7 and that the anchor bolt attachment is unlike the attachment for SP-7.

2. Detail N, drawing 2323-E1-0601-01-S. Reference 1 states that Detail N is similar to Details V and R on the same drawing. Cygna noted that the frame geometry and tray locations for Detail N was unlike either of the cited details.

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3. Detail J, drawing 2323-E1-0601-01-S. Reference 1 states that Detail J is similar to case B_3. Cygna noted that the member sizes used are different than those for case B_3 and the frame dimensions exceed the design limits fo case B_3.

4. Detail V, drawing 2323-E1-0601-01-S. Reference 1 states that Detail V is similar to Detail B, drawing 2323-E1-0713-01-S. Cygna noted that Detail B is a three bay frame with braces in all bay and was designed as a pinned truss. Detail V does not have braces in all bays, and if the same design technique is applied, the frame would be statically unstable.

B. Estabilshment of allowed working point deviations for individually designed supports based on similarity to standard support types was done without justification. See Issue 12.H for a discussion of this issue. 11

Status: A. Gibbs & Hill/TUGCO provided calculations to justify the assumed design similarity (References 3 and 4).

B. See Issue 12.H for status.

28. Critical Support Configurations

References: 1. Gibbs & Hill Calculation Binder 2323-SCS-101C, Set 1.

2. Gibbs & Hill Calculation Binder 2323-DMI-5P

3. Gibbs & Hill Calculation Binder 2323-SCS-215C, Sets 2-5.

4. Gibbs & Hill Specification 2323-ES-19, "Cable Trays", revision 1.

Summary: Gibbs & Hill design calculation (References 1, 2 and 3) for trapeze type supports considered only a limited number of

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support aspect ratios. Justification was not provided to indicate that the chosen aspect ratios would provide the critical configuration to evaluate all components of the support design. The determination of aspect ratios was based on an assumed frame width based on supported tray width and the maximum frame height. The frame width determination assumed that: (a) trays were installed with a minimum 6" horizontal spacing, (b) the distance between the side rail of a tray and the vertical hanger flange was a minimum of 3", and (c) all trays on a support were 24" or less in width.

Cygna's support walkdown noted that trays were installed with spacings as small as 1" between adjacent trays, and 0" between tray siderails and the hanger flange. Reference 4 indicates that cable tray installations at CPSES allow a maximum tray width of 36". 11

Status: Gibbs & Hill/TUGCO should provide justification for the aspect ratios used for support designs.

29. Cumulative Effect of Review Issues

References: None

Summary: In this Review Issues List, a number of the cited issues may lead to small unconservatisms when occurring singly in a support design. Such unconservatisms may usually be neglected. However, since several of these issues pertain to all cable tray support designs on a generic basis, their effect can be cumulative, such that many small unconservatisms may be significant. Therefore, any reevaluation of support designs should consider the cumulative effect of all pertinent Review Issues.

Status: The additive effects of the findings described in the Review Issues List must be addressed as part of the CPRT Plan.

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1. Governing Load Case for Design

References: 1. Communications Report between R. Kissinger (TUGCO), B. Bhujang (Gibbs & Hill), and J. Russ and N. Williams (Cygna) dated 10/1/84

2. CPSES FSAR, Sections 3.8.3 and 3.8.4

Summary: Gibbs & Hill used the equivalent static method to design the conduit supports. In all load cases, the equivalent static accelerations used in designing the supports for SSE events are less than 160% of the corresponding accelerations for 1/2 SSE (OBE) events. Based on this finding and citing Section 3.8.4 of the CPSES FSAR which allows a 60% increase in allowables for structural steel between OBE and SSE events, Gibbs & Hill determined that the design was governed by the OBE event.

To validate this conclusion, the 60% increase in allowables must be liberally interpreted to be applicable to all support components rather than applicable only to structural steel as specified in the CPSES FSAR. Catalog items such as Unistrut components and Hilti expansion anchors do not have increased allowables for SSE events. By designing these catalog components to the OBE event, the manufacturer's design factor of safety is not maintained for the SSE event.

Furthermore, for the design of structural steel, the 60% increase in allowables is acceptable for axial and strong-axis bending stresses in structural members. The 60% increase cannot be applied to certain other allowable stresses. For example, the maximum increase in baseplate stresses may only be 33%, at which point the material yield is reached. A limit on maximum allowable stress is not provided in the FSAR.

These limitations were not considered in the selection of the governing seismic load case.

Status: Discussion with Gibbs & Hill is required. Also see Cable Tray Review Issue 1.

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2. Dynamic Amplification Factors

References: 1. Communications Report between P. Huang (Gibbs & Hill) and J. Russ (Cygna) dated 2/5/85

2. Communications Report between P. Huang (Gibbs & Hill) and J. Russ (Cygna) dated 2/6/85

3. Gibbs & Hill Calculation 2323-SCS-100C, Set 4, Sheets 1-11

4. CPSES FSAR, Section 3.7B.3.5.

Summary: Reference 4 specifies that a dynamic amplification factor (DAF) of 1.5 be used unless otherwise justified. Gibbs & Hill submitted a calculation demonstrating a DAF of 1.0 for both cable tray and conduit runs. That calculation was based on a Class 5 piping damage study.

A reanalysis was performed for cable tray runs (see Cable Tray Review Issue 8), which established 1.14 as an acceptable DAF for the design of supports (with certain restrictions). Cable Tray Review Issue 25 identifies the need to perform a reanalysis to address the DAF for tray stress as well.

Status: Similar reanalyses for the Dynamic Amplification Factors are necessary for conduit and supports.

3. Combination of Deadweight and Seismic Responses

References: 1. Gibbs & Hill Calculation 2323-SCS-109C, Set 1, Sheets 154-163

Summary: In all Gibbs & Hill design calculations, the acceleration due to deadweight is combined with the seismic accelerations using the SRSS method. A 1.0 g deadweight acceleration is first added to the vertical seismic acceleration. The sum is then combined with the two horizontal seismic components using the SRSS method.

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Gibbs & Hill has submitted calculations which compare the acceleration vector magnitudes calculated with the standard combination method and with the SRSS method. For most buildings and elevations, the magnitude of the resultant acceleration using the SRSS method does not differ significantly from the resultant using the standard combination method. However, the difference in vector direction was not considered and is of greater importance, since each load direction contributes to different components of response in the conduit supports. To properly assess the impact of this combination method, the critical response should be evaluated instead of the magnitude of the acceleration applied to the support. 2

Status: Discussion with TUGCO/Gibbs & Hill is required.

4. Measurement of Embedment from Top of Topping

References: None

Summary: Note 5a on Gibbs & Hill Drawing 2323-S-0910, Sheet G-4a allows reduced expansion anchor embedment for certain supports at lower building elevations.

Such a reduction is not acceptable for 1/4" and 3/8" Hilti Kwik-bolts with 2" embedment requirement since these bolts are embedded in topping only.

The reduction may not be acceptable for other sizes depending on the actual acceleration versus the design acceleration. The affected support types within Cygna's scope are the CSM-18 and CST-17 series.

Status: Technical justification is required for instances allowed by the note.

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5. Bolt Hole Tolerance and Edge Distance Violation

References: 1. Gibbs & Hill Drawing 2323-S-0910, Sheet G-lb, Note 15

2. AISC Specifications, 7th Edition, Section 1.16.5, Minimum Edge Distance

3. AISC Specifications, 7th Edition, Section 1.23.4, Riveted and Bolted Construction - Holes

Summary: A. Reference 1 allows bolt hole tolerances which vary with the bolt size, whereas the AISC Specifications provide zero bolt hole tolerances. Therefore, the bolt holes in Gibbs & Hill designs should be considered oversized and should be treated as such in bearing connection calculations.

B. Reference 2 requires that a minimum clear distance be maintained for oversize holes. Some Gibbs & Hill designs do not provide the minimum edge distances required in the AISC Specifications. For example, support types CA-5a and CSM-42 provide edge distances of 3/4". Per Reference 2, 25/32" is required.

Status: Discussion with Gibbs & Hill is required.

6. FSAR Load Combinations

References: 1. CPSES FSAR, Section 3.8.4.3.3

Summary: Cygna is concerned that all applicable loads, as defined in Reference 1, were not explicitly considered the conduit support designs.

These concerns include loads due to pipe whip and jet impingement as well as the use of design accelerations which do not envelop Containment Building and Internal Structure spectra.

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Status: Discussion with Gibbs & Hill is required to determine if any justification exists. Also see Cable Tray Review Issue 19.

7. Support Self Weight

References: 1. Cygna Generic Conduit Support Review Checklists (not yet issued)

Summary: Cygna's review has noted that support self weights were not uniformly considered in the various designs. For most CA-type supports, the support weight is negligible and was not included in the calculation of support loads. For the CSM- and CST-type supports in the review scope, part or all of the self weight was neglected in the designs. The omitted self weight may be an insignificant portion of the total load on the support; however, for most designs, the anchor bolts are designed to an interaction ratio of 1.0. Any additional load will produce unacceptable interaction ratios over 1.0.

In the design of the CSM-6b, CSM-18 series, and CSM-42 supports, only a portion of the support weight was considered. The CSM-6b support is a braced cantilever configuration composed of Unistrut members. The weight of the cantilever member was included in the load calculation, but the weight of the brace member was neglected. For most of the supports composed of structural tubes (CSM-18 series and CSM-42), the member length considered in the calculation of self weight was taken as the length from the baseplate to the conduit centerline. The additional length from the conduit centerline to the free end of the cantilever was neglected.

For the CST-3 and CST-17 Unistrut support designs, the total support self weight was neglected. For larger support frames, the tributary conduit weight capacity is quite small, and the self weight can be a large portion of the total load on the support.

Status: Discussion with Gibbs & Hill is required.

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8. Torsion of Unistrut Members

References:

1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cygna Study of Unistrut Torsional Capacity," 84056.040, dated January 18, 1985

2. Communications Report between R. Kissinger (TUGCO) and J. Russ (Cygna) dated 1/8/85

3. Communications Report between S. McBee (TUGCO) and J. Russ (Cygna) dated 2/21/85

4. Communications Report between R. Miller (CCL), R. Kissinger and S. McBee (TUGCO), and J. Russ and N. Williams (Cygna) dated 2/25/85

5. Communications Report between R. Kissinger and S. McBee (TUGCO), R. Miller (CCL), and D. Leong, J. Russ, and N. Williams (Cygna) Dated 4/9/85.

6. Communications Report between R. Kissinger and S. McBee (TUGCO), P. Huang (Gibbs & Hill), R. Miller and R. Yow (CCL), and D. Leong and J. Russ (Cygna) dated 4/10/85.

Summary: Torsional loading of Unistrut members is not considered in the support designs. Unistrut does not support the use of members for torsional loading. Since analysis of asymmetric sections is difficult, testing of the members was proposed.

TUGCO/Gibbs & Hill are evaluating the effects of torsion in Unistrut components by a support qualification test program (References 5 and 6). Cygna personnel visited the CCL test labs (Reference 4, 5 and 6) and provided the following comments on the test scope and procedures: 2

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1. Enveloping of Conduit Supports:

   - TUGCO/Gibbs & Hill assume that the group of tested conduit supports adequately envelops all generic type supports at CPSES. Detailed documentation is required to assure the validity of this assumption. The documentation should address the weak link of each enveloping support and how the tests correlate with the perceived weak link of each support qualified by comparison.

   - The conduit support test scope does not address concerns from the Review Issues List. When screening each support to determine the enveloping group to be used in the test scope, all applicable concerns from the Review Issues List should be included in the comparison of design and configurational requirements.

   - The effect of applicable generic and support-specific design changes should be addressed in the qualification test program.

2. Worst case support configuration and loading for the tested support: 2

   - The chosen member lengths and load magnitudes and directions may not be the critical case. Cygna noted that the selected configurations may not adequately address torsional behavior of the generic support design.

   - The choice of larger diameter conduits in the testing of some supports resulted in the testing of C708-S clamps. P2558 clamps were not tested in the majority of the support configurations.

   - Clamp loadings should induce tensile forces in the clamp bolts. Many tests load the members in bearing instead of maximizing clamp load.

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- For composite Unistrut sections, the loading direction should be selected to provide tensile loads on spot welds to test the integrity of the composite section.

3. Test Procedures:

- In the visit documented in Reference 4, Cygna noted that a yoke plate had impinged upon an outrigger, which imparted additional, unintended forces into the support. The effect of this additional load must be considered when reducing the test data.

- In the visit to the test lab documented in Reference 5, Cygna noted two discrepancies in the test set-up. The hydraulic ram which applied the transverse and vertical load was attached in a manner such that longitudinal conduit displacement rotated the ram from the perpendicular. Due to this rotation, a force in the longitudinal conduit direction was imparted in a direction opposite to the load applied by the longitudinal ram. The impact of the effective reductions in the longitudinal and transverse forces should be addressed in the data reduction.

  Cygna noted that in a test of a conduit support using detail CSD-1a (Reference 5), the supporting wide flange beam to which the detail was attached via a strainsert bolt was not sufficiently stiffened to prevent a deflection in the flange due to a rotation in the connection detail. Technical justification should be given for the ability of the support member flanges to resist bending due to imparted connection moments without significant deflection. Otherwise, the effect of flange deflections must be considered in the data reduction.

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* Strainsert bolts were used to anchor the specimens to the test fixture. These bolts were preloaded to 3200 lbs. for all test cases. Cygna is concerned that the preload used may not be applicable for all test cases. The supports employ expansion anchors of various diameters and embedments, which implies a range of allowable bolt tensions. Additionally, use of a preload will affect the support stiffness and hence any deflections measured in the test.

In addition to the testing scope, Gibbs & Hill is also reanalyzing supports which are not subjected to torsional loads using AISI code provisions. Gibbs & Hill intends to address the adequacy of the majority of conduit support designs utilizing Unistrut members by either testing or analysis.

Status: After discussions with Cygna (References 5 and 6), TUGCO/Gibbs & Hill agreed to provide documentation supporting the selection of the test scope. The documentation has not been received to date. The Gibbs & Hill analyses using AISI methods have not been completed.

9. Improper Use of Catalog Components

References:

1. Communications Report between P. Patel, et al. (Gibbs & Hill) and J. Russ, et al. (Cygna) dated 9/20/84
2. Communications Report between D. Kissinger (TUGCO) and N. Williams (Cygna) dated 10/11/84
3. Communications Report between E. Irish (Unistrut) and D. Leong and J. Russ (Cygna) dated 1/21/85
4. Communications Report between E. Irish (Unistrut) and D. Leong and J. Russ (Cygna) dated 2/4/85
5. Gibbs & Hill Calculation 2323-SCS-153C, Sheet 1/37

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6. Cygna Generic Conduit Support Review Checklists (not yet issued)

Summary:

A. In addition to Cygna's comments on the implicit increase in allowables for SSE loads (see Review Issue 1), Cygna has other concerns regarding the support designs using catalog components.

AISC-derived allowables are used in the design process. These values are generally conservative for bending, but are generally unconservative for axial allowables, as catalog allowables are based on the AISI Code which considers buckling of thin, open sections.

Examples of Cygna's concern are discussed below:

- CSM-6b: 20 ksi was used for Fa, the axial allowable. This value is equal to .6 Fy, where Fy = 33 ksi and was used for any member length without considering slenderness effects. Catalog values range from 5.77 ksi for a brace length of 60" to 13.9 ksi for a 24" brace.
- CST-3: The design employed the AISC table of axial stress allowables for 36 ksi steel.
- CST-17: The design employed the AISC tables of axial stress allowables for 36 ksi steel. The table value was then reduced by a ratio of 33/36.

B. Components were used in ways not intended by the vendors.

Cygna concerns in this area are as follows:

- Allowables are not listed for P1001C3 sections in the Unistrut catalog. Member properties are given for the X-Y axes instead of the

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principal axes. Discussions with Unistrut indicate that the uses of P1001C3 are unique with respect to load application and member restraint. Thus, no generic allowables can be provided. Unistrut places the burden on the designer to properly consider the capacity of the section for its intended use. Gibbs & Hill has not provided adequate evaluation of these members.

- The Unistrut catalog indicates that the intended use of P1325, P1331, P1332 brackets is for single members in a pinned connection. Gibbs & Hill uses two brackets on double members, which Cygna believes to be a moment resisting connection. Gibbs & Hill considers these connections pinned for some brackets in CSM-6b, CST-3, and CST-17 supports. Unistrut does not provide allowables for this bracket configuration.

- Gibbs & Hill references Unistrut Test C-49 to obtain allowables for the double bracket connection in CST-3. The designed connection is subject to tensile and shear loads. The test provided data for loading the bracket in tension only. Gibbs & Hill compared the calculated tensile load to the allowable, ignoring the calculated shear.

- P1941 plate connectors are used to connect headers to outriggers in CA-1a and CA-2a supports. Gibbs & Hill calculations indicate that tightening the Unistrut bolts to the specified torque overstresses the plate and causes excessive bowing of the plate. Discussion with Unistrut indicates that these connectors are to be used to construct frames where the connected members are restrained at both ends. Clarification of this concern is required for CA-1a and CA-2a supports, since the member end restraint required by Unistrut has not been provided.

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In Revision 1 of Gibbs & Hill Drawing 2323-S-0910, Sheet CA-1a, Note 7, was added to provide P1064 plates if bending of the P1941 plates occurs. In Gibbs & Hill Calculation 2323-SCS-153C, Sheet 1/37, a discussion of field installation practice documents that the P1064 plates do not reduce the bowing of the outriggers. Unistrut tests showed no bowing of the outriggers when the P1064 plates were used. Verification of the bolt torques used in the test set-up is required.

- Four types of Superstrut clamps are specified for use on conduit supports: C708, C708-U, C708-S, and modified C708-S (see Review Issue 18). These clamps are not designed for three-directional loading but are used in that capacity. Allowables for tensile loading only are given in the Superstrut Catalog. 2

Status: TUGCO/Gibbs & Hill should provide technical justification for the above issues.

10. Anchor Bolts

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray and Conduit Support Review Questions," 84056.015, dated August 6, 1984, question A2b regarding CSD-1a

Summary: Cygna has the following concerns regarding anchor bolt designs:

A. For the conduit support designs reviewed, Gibbs & Hill was inconsistent in the treatment of prying of concrete attachments on anchor bolt tension. The increase in anchor bolt tension was handled in one of three ways: 2

- In some support designs, prying was neglected.

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- For most supports with baseplates, a prying factor of 1.5 was used. For this case and the one above, justification for the assumed prying factor or the lack thereof was not provided by Gibbs & Hill.

- In a few other support designs, the method on pages 4-89 to 4-90 of the 8th Edition AISC Manual of Steel Construction was used to justify the use of a prying factor of 1.0. For this case, justification of the applicability of the method is required, since the concrete attachments in the conduit support designs differ from the steel-to-steel connections addressed in the 8th Edition Method. 2

B. The concrete connections for conduit support CST-17, Type 17 consist of box brackets around the P5000 header members, through which the Hilti Kwik-bolts pass. The header is 3.25 inches deep, and the anchor bolt is loaded at a considerable distance above the concrete surface. The Gibbs & Hill design does not consider moments induced in the anchor bolt due to shears applied above the concrete surface.

Status: TUGCO/Gibbs & Hill should provide technical justification of the above issues.

11. Longitudinal Loads on Transverse Supports

References:

1. Communications Report between E. Irish (Unistrut) and J. Russ (Cygna) dated 7/25/84

2. Communications Report between R. Kissinger and S. McBee (TUGCO), R. Miller (CCL), and D. Leong, J. Russ and N. Williams (Cygna) dated 4/9/85. 2

3. Cygna Generic Conduit Support Review Checklists (to be issued)

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Summary: Some transverse supports have the same order of longitudinal stiffness as long cantilever multi-directional supports. Since conduit clamps provide restraint in three-directions, longitudinal loads, which were not considered in the design, may be imparted to the supports.

Additionally, the displacements due to torsion of longitudinal support beam members may induce some longitudinal loads into transverse supports.

Status: Technical justification of the above issues by Gibbs & Hill is required.

12. Hilti Kwik-Bolt Substitutions

References: None

Summary: Note 4 on Gibbs & Hill Drawing 2323-S-0910, Sheet G-4a, allows the substitution of all Hilti Kwik- and Super Kwik-bolts with those of a larger size. A reduction in the allowables for the larger bolts may be necessary since the actual spacing may be smaller than that required. Thus, a situation may occur where the replacement bolts have a lower capacity than the bolts in the original design.

Examples of Cygna's concern are described below:

- CSM-18c: 1/2" Hilti Kwik-bolts at 5" spacing were used in the original design. If all 1/2" bolts are substituted with 3/4" or 1" bolts, the tensile allowable for the replacement bolts will be less than the design tensile allowable of 3012 lbs. (2750 lbs for 3/4" bolts and 2930 lbs. for 1" bolts).

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- CSM-42
  Type III: 1" Hilti Super Kwik-bolts at 7.5" spacing were used in the original design (allowable tension = 12452 lbs, allowable shear = 6884 lbs). If all 1" bolts are replaced by 1-1/4" bolts of equal embedment, the bolt capacity is significantly reduced (allowable tension = 6405 lbs, allowable shear = 6221 lbs).

Status: Technical justification by Gibbs & Hill is required for supports affected by this note.

13. Substitution of Smaller Conduits on CA-Type Supports

References: 1. Communications Report between S. McBee (TUGCO) and J. Russ (Cygna) dated 3/7/85

Summary: CA-type supports are designed using ZPA for large (> 2") diameter conduits while peak accelerations are used for small diameter conduits (<2"). For CA-type supports where capacities are tabulated on the drawings, small diameter conduits may be installed unless specifically prohibited on the drawings. Although the deadweight load of the small diameter conduits must be less than the capacity, the seismic load of the small diameter conduits may exceed the equivalent seismic load of the large diameter conduits considered in the original design.

As an example, support type CA-15 was designed for two 3" conduits with a deadweight capacity of 156 lbs. However, five 1-1/2" conduits can be installed on a CA-15 support, giving higher seismic loads than designed for. The rigid span loads for two 3" conduits are 343 lbs. and 109 lbs. for the vertical and horizontal directions respectively. The flexible span loads for five 1-1/2" conduits are 504 lbs. and 450 lbs. for the vertical and horizontal directions respectively.

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This item possibly affects support types CA-6, CA-7, CA-12, CA-14 Series, and CA-16a.

Status: Discussion with TUGCO and Gibbs & Hill is required. TUGCO is investigating this item with respect to fire protected supports.

14. Use of CA-Type Supports in LS Spans

References:
1. Communications Report between M. Warner, et al. (TUGCO) and W. Horstman, et al. (Cygna) dated 2/20/85
2. Communications Report between M. Warner (TUGCO) and N. Williams, et al. (CYGNA) dated 2/27/85.
3. Communications Report between S. McBee (TUGCO) and J. Russ (Cygna) dated 3/7/85

Summary: CA-type supports are used to support LA spans, which are limited to a 6' length. CST-type and CSM-type supports are used to support LS spans, which can be up to 12' for transverse spans and 24' for longitudinal spans. In field installations, when conduits run from walls to equipment in the middle of a room, a transition is made between LA spans and LS spans. The concerns are discussed below.

For CA-type supports, ZPA was used to determine the design load for large diameter conduits (> 2" diameter.) Since the conduits are field-run, CA-type supports may be installed adjacent to multi-directional supports. The span between the two supports is considered to be an LA-span, since the span length must not exceed that specified by the design of the CA-type support. The rigidity of the span can no longer be assumed, due to the flexibility of the multi-directional support and the effect of the flexible spans past the multi-directional support. Peak acceleration should then be used to determine the design load for that span.

There is evidence that decreased support capacity is considered for the fire protected supports (see TUGCO Instruction CP-EI-4.0-49), since support capacities are

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given for both LA spans and LS spans. For unprotected lines, there is no indication that this was considered.

Status: TUGCO is investigating the practice for fire protected supports. Additional discussion is required for unprotected supports.

15. Stresses in Cable Trays Due to Attached Conduit Supports

References:
1. Cygna Generic Conduit Support Review Checklists (to be issued)
2. Gibbs & Hill Calculation 2323-SCS-156C, Set 1, Sheets 101-104

Summary: This item applies to CSD-16 in the Cygna review scope and to any similar details. Cable tray spans are ostensibly designed to the capacity of the tray. The addition of CSD-16 to the tray rails adds loads above the capacity of the cable tray. Therefore, a generic stress check for the trays is not possible, and all tray spans with these conduit supports should be individually checked.

Status: Cygna's comments require discussion with Gibbs & Hill.

16. Increases in Allowable Span Lengths

References:
1. Communications Report between P. Huang (Gibbs & Hill) and D. Leong and J. Russ (Cygna) dated 12/27/84
2. Gibbs & Hill Calculation 2323-SCS-189C, Set 1, Sheets 15-24
3. Communications Report between R. Kissinger and S. McBee (TUGCO), P. Huang (Gibbs & Hill), R. Miller and R. Yow (CCL), and D. Leong and J. Russ (Cygna) dated 4/10/85.

Summary: In the revised Gibbs & Hill Drawing 2323-S-0910 package, LA span lengths were increased by a ratio of the refined to the unrefined spectra. Gibbs & Hill provided a calculation to

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show that the above changes are correct with respect to the spectral ratios and that rigid spans remain rigid (diameters > 2"). This is adequate for support designs, since support loads are proportional to span lengths. However, an evaluation of the conduit stress is required, since conduit bending stress is proportional to the square of the span length.

Status: In Reference 3, Gibbs & Hill stated that the conduit spans discussed in this review issue are shorter than the spans discussed in Review Issue 22. TUGCO is providing additional information to address Review Issue 22. If Review Issue 22 is resolved, Review Issue 16 is resolved by comparison. If Review Issue 22 is not resolved, technical justification for Review Issue 16 is required.

17. Substitution of Next Heavier Structural Member

References: None

Summary: This item refers to Note 5 on Gibbs & Hill Drawing 2323-S-0910, Sheet G-1a. Most supports are designed to the allowable load limits for the Hilti Kwik-bolts. Since support self weight has not been properly considered in some designs (see Review Issue 7), Hilti Kwik-bolts may be overstressed in generic designs using structural steel.

Status: Discussion with Gibbs & Hill is required. 2

18. Clamp Usage

References: 1. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Cable Tray and Conduit Support Review Questions" 84056.015, dated August 6, 1984, question A4

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2. N.H. Williams (Cygna) letter to J.B. George (TUGCO), "Conduit Support Walkdown Questions," 84056.020, dated August 13, 1984, question 3

3. Communications Report between E. Irish (Unistrut) and J. Russ (Cygna) dated 7/25/84

4. Communications Report between T. Keiss, et al. (TUGCO), B. Bhujang, et al. (Gibbs & Hill) and W. Horstman, et al. (Cygna) date 10/9/84

5. Communications Report between R. Miller and R. Yow (CCL), E. Bezkor and P. Huang (Gibbs & Hill), C. Mortgat (TERA), R. Kissinger and S. McBee (TUGCO), and N. Williams and J. Russ (Cygna) dated 3/29/85. 2

6. Cygna Generic Conduit Support Review Checklists (to be issued)

Summary:

A. In the following two Gibbs & Hill designs in Cygna's review scope, P2558 clamps may be reamed to accommodate larger bolts. As a result, the minimum edge distance requirements are violated. 2

For CA-5a supports, clamps for small diameter conduits (<2") must be reamed to accommodate 3/8" Hilti Kwik-bolts. The washers for 3/8" Hilti Kwik-bolts will not fit properly on the clamps. The washer is an integral part of the bolt, and justification for its omission, alteration, or distortion during installation is required.

For the IN-CSM-15a support, clamps for the 5-inch diameter flexible conduit are reamed to accommodate 1/2" Nelson studs.

For both designs, justification for the alteration of a vendor component and evaluation of the effect of the alteration on the component allowable is required.

B. C708-S clamps for conduits can be modified by cutting off the end portion of the clamp ears. This modification removes two of the four bolt holes from the

CONDUIT SUPPORTS
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clamp. Justification for this modification is required. Also see Review Issue 9 for discussion of clamp allowables. 2

C. In the Cygna walkdown, clamp distortion was noted for the following supports:

Support ID	Support Type
C12G03528-8	CSM-18f
C12002935-4	CA-5a
C12G03126-18	CSM-42
C12G02851-6	CA-5a

Status: Further discussion with TUGCO, Gibbs & Hill is required for all the above issues 2

19. Documentation Deviations Between Inspection Reports, CMC's and IN-FP Drawings

References: 1. Communications Report between P. Patel (TUGCO) and D. Leong and J. Russ (Cygna) dated 2/18/85

Summary: For each conduit line, an inspection is performed and documented on an inspection report (IR). All CMCs and applicable IN-FP drawings should be reflected on the IR.

Examples of Cygna's concerns are discussed below:

- Line C11003395, IRME-18120F, Support -1: On the IR, the support is listed as CSM-18f, Revision 4. On CMC 62903, the support is listed as CSM-18b, Revision 14. Based on the CMC information, the IR is in error.
- Line C12G-05087, IRME-16817F, Support -4: On the IR, the support is listed as CSM-18c, Revision 13. On CMC 62905, Revision 0, the support is listed as Revision 9. On CMC 62905, Revision 1, the support is listed as Revision 12. Five such discrepancies occur for supports in Cygna's review scope.

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- Line C12004695, IRME-16089F, IN-FP-216, and IN-FP-226: There are discrepancies between the IR and both IN-FP drawings for support types CA-1a and CA-2a. There is no structural difference in the supports, but a documentation inconsistency exists. Six such discrepancies occur for supports in Cygna's review scope.

Status: This item is still under review. Additional issues will be noted as the review progresses.

20. Nelson Studs

References:
1. Communications Report between P. Huang and R. Sanders (Gibbs & Hill) and J. Russ (Cygna) dated 8/7/84
2. Gibbs & Hill Calculation 2323-SCS-156C, Set 1, Sheets 131-160
3. Gibbs & Hill Calculation 2323-SCS-109C, Set 1, Sheets 164-184

Summary: In the original conduit support design calculations, Gibbs & Hill did not check Nelson studs for conformance with vendor specifications and allowables. Subsequently, Gibbs & Hill supplied Cygna with Nelson stud qualification calculations to determine the adequacy of the installed stud configurations. Cygna has the following comments on the calculations provided: 2

- Reference 3 provides evaluation of the stud stresses. A pretensioning force was assumed to relieve applied loads to the studs. The calculation did not account for the flexibility of the clamp and shim plate or relaxation of the preload.
- The allowable Nelson stud forces reported by TRW/Nelson are based on shear applied at the weld location. In the conduit support designs, the studs are loaded at the clamp, which produces a moment in the stud. This additional moment was not considered in the Reference 3 calculation.

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- Reference 2 (Sheets 151 through 160) provides evaluation of the shim plate attaching the Nelson studs to the structural member. The stress distribution assumed for the weld connecting the shim plate to the member is not realistic, as it introduces an infinite stress at the bottom of the plate. The assumption affects the results of the yield line analysis performed to check the adequacy of the shim plate.

- Weld underrun was not considered in the Reference 2 calculation.

Summary: Further discussion with Gibbs & Hill is required for the resolution of the above concerns.

21. Conduit Fire Protection Configuration

References: 1. Communication Report between T. Keiss (TUGCO) and W. Horstman, et al. (Cygna) dated 10/16/84

Summary: Gibbs & Hill fire protection calculations consider a round configuration of Thermolag material around conduits. The Thermolag weight on the spans was calculated based on this configuration. The Cygna walkdown and discussions with TUGCO indicate that a square configuration was also used in the field installations. Documentation of the specific configuration installed was not maintained.

Status: Evaluation by Gibbs & Hill of the as-built configuration with respect to the design configuration is required to insure that the design adequately envelops the field condition. Preliminary evaluation by Cygna indicates that small unconservatisms exist for some cases.

22. Span Increase for Fire Protected Spans

References: 1. Communications Report between T. Keiss (TUGCO) and W. Horstman, et al. (Cygna) dated 10/16/84

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2. Communications Report between T. Keiss (TUGCO) and J. Russ and N. Williams (Cygna) dated 10/27/84

3. TUGCO Instruction CP-EI-4.0-49

4. Gibbs & Hill Drawing 2323-S-0910, LA Series

5. Gibbs & Hill Drawing 2323-S-0910, LS Series

6. Gibbs & Hill Calculation 2323-SCS-1017, Set 1

7. Communications Report between S. McBee (TUGCO) and D. Leong (Cygna) dated 4/16/85

8. Communications Report between W. Zehe (Triangle PWC) and D. Leong and J. Russ (Cygna) dated 4/17/85 2

9. Communications Report between S. McBee (TUGCO) and D. Leong (Cygna) dated 4/18/85

10. Communications Report between S. McBee (TUGCO) and J. Russ (Cygna) dated 5/7/85

Summary: TUGCO Instruction CP-EI-4.0-49 (Reference 3) gives allowable conduit spans for fire-protected runs. Cygna noted that, in most cases, the fire-protected spans exceed the allowable spans for unprotected conduit spans documented in the 2323-S-0910 drawing package (References 4 and 5). 2

Cygna reviewed the design calculations for the fire-protected spans (Reference 6) and concluded that the increase in length for the fire-protected spans could be attributed to the removal of conservatisms from the analysis, such as using the refined rather than the unrefined spectra. Cygna agrees with the analysis method used in the span design; however, Cygna does not agree with the conduit stress allowables used in the analysis.

To obtain allowable stress values for the conduits, Gibbs & Hill used test data supplied by the vendor to obtain yield stress values. Cygna has three major comments on the derivation of the allowables:

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- The allowable stress values vary with conduit nominal size. The vendor test data consists of three to four tests for specimens of each conduit size. Gibbs & Hill used the lowest tested yield stress for each conduit size or an imposed minimum yield stress value of 33 ksi to obtain allowables for that particular conduit size. Justification for the imposed minimum yield stress value was not provided. Cygna feels that it is not appropriate to specify different allowable stresses for each conduit size.

- Gibbs & Hill did not provide documentation to justify the applicability of the vendor test data to the conduits installed at CPSES. Cygna understands that electrical conduit is fabricated in accordance with ANSI C80.1, which does not contain requirements for material conformance.

  Cygna spoke to Triangle PWC, the conduit supplier for CPSES, regarding the test data provided to Gibbs & Hill (Reference 8). Triangle PWC informed Cygna that as a rule, no certification test reports are provided with the product and that any test data in the public domain represented a general sample of conduit they have produced. They also stated that Triangle PWC is a processor and does not manufacture the steel used for the conduits. There are no ASTM standards applicable to conduits.

- A dynamic amplification factor (DAF) of 1.0 was used in the conduit stress evaluation without justification. Review Issue 2 discusses the reanalysis efforts by Gibbs & Hill to address this concern. Results of those reanalyses should be applied to the conduit stress analyses described here.

The items discussed above concerning the conduit allowable stress apply to all conduit span calculations performed by Gibbs & Hill.

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Status: Cygna has discussed the conduit allowable stress issue with TUGCO (References 7,9, and 10). TUGCO/Gibbs & Hill are investigating the derivation of the allowable stresses used in the design. 2

23. Grouted Penetrations

References: 1. Communications Report between R. Kissinger and S. McBee (TUGCO), P. Huang (Gibbs & Hill), R. Miller and R. Yow (CCL) and D. Leong and J. Russ (Cygna) dated 4/10/85.

Summary: For conduit runs embedded in walls and floors, longitudinal conduit supports are not required if there are no bends in the run. The grouted penetrations are assumed to carry the entire longitudinal load for such a conduit run. Additionally, all grouted penetrations are assumed to be multi-directional supports, sharing conduit load with the supports closest to the penetration. Calculations were not performed to assure the capability of the penetration to carry the required loads. Other supports on the conduit run may also be affected depending on run configuration and relative stiffness of the supports. 2

Status: In Reference 1, Gibbs & Hill agreed to provide technical justification for the capability of the grouted penetrations to resist the required loads. As a minimum, the following two items should be provided:

- Design calculations demonstrating the load capacity of the grouted penetrations.
- QC documentation of the placement of the embedded conduits to validate the assumptions of the above-mentioned design calculations.

24. Rigidity of CA-Type Supports

References: Cygna Generic Conduit Support Checklists (not yet issued)

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Summary: In the design of CA-type supports, the rigidity of the conduit spans was checked to justify the use of ZPA in calculating the design loads for the supports. In determining the rigidity of the conduit spans, Gibbs & Hill assumed that the CA-type supports were rigid. The frequencies of the conduit systems were due to the span flexure between rigid supports only. The design calculations for the CA-type supports did not include stiffness evaluations to validate the assumptions. 2

Status: Discussion with Gibbs & Hill is required.

25. Cumulative Effect of Review Issues

References: None

Summary: In this Review Issues List, a number of the issues cited may lead to small unconservatisms when occurring singly in a support design and can usually be neglected. However, since several of these issues pertain to all conduit support designs on a generic basis, their effect can be cumulative, such that many small unconservatisms may be significant. Therefore, any reevaluation of support designs should consider the cumulative effect of all pertinent Review Issues.

Status: The additive effects of the findings described in the Review Issues List must be addressed as part of the CPRT Plan.

CYGNA
ENERGY SERVICES
101 California Street, Suite 1000, San Francisco, CA 94111-5894 415/397-5600

August 13, 1985

Mr. J. Redding
Texas Utilities Generating Co.
c/o Westinghouse
4901 Fairmount Ave.
Bethesda, MD 20814

Subject: Electrical Review Questions
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 4
Texas Utilities Generating Company
Job No. 84056

Dear Mr. Redding:

As part of the CPSES IAP Cygna has conducted a review of design procedures and design inputs in the electrical/I&C area. This review was conducted the week of June 25, 1985 at the Gibbs & Hill office in New York. Several issues were identified at that time which require further information for resolution. These issues are briefly discussed in the attached telecons. Although we have added these items to revision 2 of the electrical/I&C RIL, we are unable to determine whether any problem exists without further input from the Gibbs & Hill engineers.

If there are any questions, don't hesitate to call.

Very truly yours,

N.H. Williams

N.H. Williams
Project Manager

Enclosure

cc: Mr. S. Treby (USNRC) w/attachments
Mr. S. Burwell (USNRC) w/attachments
Ms. J. Ellis (CASE) w/attachments
Mr. J. Beck (TUGCO) w/attachments
Mr. R. Ballard (Gibbs & Hill) w/attachments
Ms. J. van Amerongen (TUGCO/EBASCO) w/attachments

CYGNA

Communications Report

Company: Texas Utilities	[x] Telecon [ ] Conference Report
Project: Texas Utilities Electric Company Independent Assessment Program - Phase 4	Job No. 84056
	Date: 8/1/85
Subject: Phase 4 Electrical Open Items	Time: 10:30 A.M
	Place: CES-SFRO
Participants: P. Lalaji	of Gibbs and Hill
J. Oszewski, K. Zee	Cygna

Item	Comments	Required Action By
	Cygna Asked Mr. Lalaji various questions associated with the documents reviewed during the Phase 4 IAP. The questions involved clarification or justification of calculation methods and inputs used in the following groups of calculations:	

1) System short-circuit calculations

- Justify the use of cable impedances based upon 75°C.
- Explain why the subtransient reactance assumed for large 480V loads is 25% when typical values are less than 17%.
- Explain why the 480V short-circuit calculation is based upon a maximum available momentary symmetrical 6.9KV short-circuit current of 36,000A when calculated values are 38,000A.
- Are updated grid capacities available since the calculation is based upon grid capacities determined in 1974?
- Was a short-circuit decrement curve used to determine the diesel generator's short-circuit contribution?

2) System voltage calculations

- G&H Calculations III-7 and III-8 show overvoltage and undervoltage conditions on the safety buses. Has this condition been corrected?

Signed: N. H. Williams /plm

Distribution: ~~N. Williams, J. Redding, J. van Amerungen, K. Zee, S. Treby, J. Ellis, S.~~ Burwell, Project File

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CYGNA

Communications Report

Item	Comments	Required Action By
	• How did G&H determine the offsite grid voltage variation.	
	• Where are system voltages during 480V motor starting calculated?	
	3) Overcurrent protection/Relay coordination studies	
	• Explain why motor thermal limits and transformer ANSI points were not used.	
	• Which G&H calculation shows the coordination of the diesel generator's short-circuit capability and the 6.9KV feeders.	
	• It appears that the primary and back-up protective devices for the reactor coolant pump motor electrical penetration conductors are connected to the same current transformer. It also appears that the breakers have a common control power source. Please clarify and/or justify.	
	4) Cable sizing calculations	
	• Justify why the cables inside containment were sized for a 50°C ambient when the long term post accident temperature is approximately 65°C.	
	Cygna also asked Mr. Lalaji to review motor starting and load sequencing for the component cooling water pump motor starting against an open discharge valve.	
	Mr. Lalaji said that he would review these items with the cognizant engineer(s). Further discussion of the above items in greater detail is planned for the week of 8/5/85.	G&H/Cygna

CYGNA

Communications Report

Company:	Texas Utilities	[x] Telecon	[ ] Conference Report
Project:	Texas Utilities Electric Company	Job No.	84056
	Independent Assessment Program - Phase 4	Date:	8-6-85
Subject:	Phase 4 Electrical Open Items	Time:	3:30 P.M.
		Place:	CES-SFRO
Participants:	P. Lalaji	of	Gibbs and Hill
	K. Zee		Cygna

Item	Comments	Required Action By
1.	Mr. Lalaji called to continue the discussion of the electrical open items - ref. communications report between P. Lalaji and J. Oszewski, K. Zee dated 8-1-85, 10:30 A.M. Mr. Lalaji said that the open items list should be formally sent to Gibbs and Hill; i.e. Mr. R.E. Ballard, and that he would not take any action to resolve the open items until directed to do so by the project.	

Signed: N H Williams /plm Page 1 of 1

Distribution: N. Williams, J. Redding, J. Oszewski, R. Porter, K. Zee, S. Treby, J. Ellis, S. Burwell, Project File

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CYGNA
ENERGY SERVICES
101 California Street Suite 1000 San Francisco, CA 94111-5894 415 39

October 9, 1985
84056.086

Mr. W. G. Council
Executive Vice President
Texas Utilities Generating Company
Skyway Tower
400 North Olive Street, L.B. 81
Dallas, TX 75201

Subject: Information Requests - Pipe Stress Analyses
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Independent Assessment Program - All Phases

Dear Mr. Council:

Pursuant to our conversation on October 1, 1985, Cygna is requesting information from Gibbs & Hill in order to close out open issues related to the pipe stress analyses reviews. The enclosed communications report documents the initial questions which were asked on October 8. These questions are a result of Cygna's internal review of our issues database. This database is comprised of open items and findings documented in observations, checklists, letters, memos and communication reports from all phases of the IAP. We anticipate that all other pipe stress questions for Gibbs & Hill's Applied Mechanics Group will be issued by October 18, 1985.

Very truly yours,

N.H. Williams

N. H. Williams
Project Manager

NHW:jst
Attachment

cc: Mr. V. Noonan (USNRC) w/attachment
Mr. S. Burwell (USNRC) w/attachment
Mr. S. Treby (USNRC) w/attachment
Mr. W. Horin (Bishop, Liberman, et al) w/attachment
Mr. J. Redding (TUGCO) w/attachment
Ms. J. van Amerongen (TUGCO/EBASCO) w/attachment
Mrs. J. Ellis (CASE) w/attachment

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CYGNA

Communications Report

Company	Texas Utilities ☒ Telecon	☐ Conference Report	
Project	Comanche Peak Steam Electric Station Independent Assessment Program - Phase 3	Job No.	84042
		Date	10/8/85
Subject	Pipe Stress Questions	Time	a.m.
		Place	SFRO

Participants

	of	
H. Mentel	of	Gibbs & Hill
L. J. Weingart	of	CES

Item	Comments	Req'd Action By
1.	Review of the main steam inside containment analyses noted the following items: a. Two LOCA load cases were run: unbroken and broken loop. b. Unbroken loop loads and stresses were included in the emergency combination while broken loop was used in the faulted combination. c. Broken loop loads and stresses were always higher than unbroken loop loads (as would be expected). d. The CPSES FSAR does not specifically require LOCA loads to be considered for emergency condition. Why was the unbroken loop case run?	
2.	Review of G&H Project Guide PG-25, dated 3/1/83, "Procedure for Preparation and Design Review of Line Lists, Modes of Operation and Valve Lists," indicates that line lists are to be generated on the form included as Exhibit 1 of that procedure. Cygna did not find evidence of this during the reviews conducted at the CPSES site. Instead, computer listings apparently were used which did not have all of the information indicated on Exhibit 1 of PG-25. Please explain the reason for this discrepancy and the manner in which the computer listing was maintained and controlled.	
3.	Cygna could not determine what tolerance, if any, was used for support orientation (i.e., angle) when performing the as-built stress analysis. Please provide this value and the reference document for it.	

Signed: N. Williams   Page   of

Distribution: N. Williams, J. Redding, L. Weingart, S. Treby, J. Ellis, S. Burwell, Project File, C. Wong, J. van Amerongen

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