U. S. ATOMIC ENERGY COMMISSION
DIVISION OF COMPLIANCE
REGION V

Report of Inspection

CO Report No. 50-275/70-1

Licensee:	Pacific Gas & Electric Company Construction Permit No. CPPR-39 Category A
Date of Inspection:	March 2-5 and 12, 1970
Date of Previous Inspection:	September 16, 1969
Inspected by:	A. D. Johnson 4/3/70 A. D. Johnson Reactor Inspector (In-charge)
	J. L. Crews 4/3/70 J. L. Crews Reactor Inspector
Reviewed by:	G. S. Spencer 4/3/70 G. S. Spencer Senior Reactor Inspector
Proprietary Information:	None

SCOPE

Type of Facility:	Pressurized Water Reactor
Power Level:	3250 Mwt
Location:	Diablo Canyon, San Luis Obispo County, California
Type of Inspection:	Routine - Announced
Accompanying Personnel:	G. S. Spencer, March 5, 1970

Scope of Inspection: Pursuant to PI-3800/2, Attachment C-Containment, followup record review and observation of work pertaining to concrete, rebar and liner of the containment building was performed. Also the review included information concerning the installed concrete of the auxiliary building.

SUMMARY

Safety Items - None

Nonconformance Item - Contrary to the requirements of Section 5.1.2.3.(c) of the PSAR, the test specimens used to determine the physical characteristics of the liner plate material were normalized whereas the plate material being installed was found to be in the as rolled condition (not normalized). Section 9.1 of ASTM A-516, the PSAR referenced requirement, prescribes that "for plates 1½ inches and under in thickness not requiring heat treatments, the test specimens shall be prepared for testing from the material in its rolled condition." A construction deficiency notice will be sent to the licensee concerning the nonconformance item. (Section H)

Status of Previously Reported Problems

1. The weakness noted in the contractor's quality control procedure for documentation confirming that adequate personnel and equipment are available before concrete placement operations are performed has been remedied by adding an appropriate provision to the QC inspector's checklist. Similarly, provisions have also been added to the inspector's checklist to show that proper curing procedures are used by the contractor. (Section C.1)

2. The procedures concerning nonconforming components and/or materials have been revised to clearly delineate responsibilities and approval authority for final disposition. This approval authority now rests with the Engineering Department of PG&E. However, the wording of the procedure concerning minor discrepancies handled by ordinary QC procedures was not clearly defined. (Section E.)

Other Significant Items

1. The overall status of construction was reported to be 4.5% complete with 15% completion of the auxiliary building and 10% completion of the containment building.

2. The quality assurance control program as it relates to construction activities appeared to be comprehensive and effective in detecting construction variations from prescribed requirements. However, the system of documenting corrective action was found to lack ready retrieving capability. Also a system to assure that audits of activities are performed on a timely basis had not been formulated. Since the inspection, both of these observations have been remedied as discussed in the management interview on March 12, 1970. (Section 3.2)

3. The records concerning concrete were found to be complete and adequate to show that the concrete placed in the Class I structures to date has conformed to the applicable PSAR and contract requirements. (Section-C.2)

4. A procedure has been implemented to assure that all construction variations from design are appropriately resolved and reported to the Engineering Department. (Section-E.)

5. According to the licensee, aluminum pipes are not used in connection with concrete placement.

6. Two heats of reinforcing steel were found to be of low strength and rejected from use in the containment building base mat. The low strength condition was revealed during testing of Cadweld splices after the steel had been installed in the concrete forms. Subsequent investigation by PG&E revealed that the mill had rolled the bar under nominal size. A change in the mill process increased the size of the steel subsequently supplied to the project. (Section-F.2)

7. The records concerning reinforcing steel were found to be complete and adequate to show that the reinforcing steel placed in the containment base mat conformed to the applicable PSAR and contract specification. (Section-F.)

8. Our inspector observed two open cans of electrodes unattended in the weld area. This practice is contrary to the contractor's procedure covering the use and care of low hydrogen electrodes. As a result of this observation, PG&E has increased the frequency of their QC audit in this area (containment building liner) to twice weekly. (Section-I.)

Management Interview - On-Site

Subsequent to the inspection on March 5 the Inspectors met with Messrs. Hersey and Richards and other members of both the QA and General Construction organizations. The items discussed were the same as detailed below under the corporate office meeting held on March 12, 1970.

Management Interview - Corporate Office

The inspectors met at the PG&E corporate offices with PG&E Vice Presidents Worthington and Sedam, Messrs. Kelly, Richards, Chandler, Bettinger and several other members of the PG&E Engineering and General Construction Departments on March 12, 1970 to review the results of the inspection. The following items were discussed:

1. Reinforcing Steel Quality

   The inspectors stated that the manner and timing by which sub-quality rebar was detected and subsequently rejected (Cadweld testing after the steel was placed in the concrete forms) was significant, and inquired as to whether there might be additional heats of material of similar quality within the structure.

The response by PG&E personnel was that neither the tests of reinforcing steel, some of which (on rebar sizes #14 and #18) were conducted by the PG&E testing lab at the site, nor Cadweld testing, also conducted by the PG&E testing lab at the site, had revealed evidence of the sub-quality of additional heats of steel. The fact that a change was made in the mill process, such that the cross sectional area of the reinforcing steel was increased, was also offered by PG&E representatives as additional assurance of greater strength of the steel.

2. Validity of Physical Test Results - Containment Building Liner

The inspectors stated that heat treatment of the test specimens of the liner material in a manner differently than the plate material itself was contrary to the requirements of the material specification, ASTM A-516, and inquired as to the corrective action planned by PG&E.

Several alternatives were discussed by PG&E representatives, including the preparation of test specimens from plate trimmings, preparation of test specimens from the material already installed, heat treating (normalizing) which the test specimens had been subjected to, or a combination of the above alternatives. In response to the inspectors specific inquiry, Mr. Bettinger stated that the material would be tested in accordance with the governing material specification (ASTM A-516).

It was revealed in the above discussion that the total number of heats of material involved is approximately sixty. Some of the material is still at the mill and other portions are at the PDM shop, in addition to that which has been shipped to the Diablo Canyon site.

The inspectors informed the PG&E representatives that they should expect written correspondence from CO:V on this subject.

3. Weld Rod Control

The inspectors stated that observations at the time of the inspection showed apparent weaknesses in the implementation of procedures covering the care and control of low hydrogen weld electrodes. Mr. Richards stated that, as a result of these observations, audits of the welding area by the PG&E QC staff are to be increased from weekly to twice weekly. He said, also, that thermometers are to be installed in the weld rod holding ovens to permit closer monitoring of oven temperatures.

4. Cadweld Operator Re-Qualification

In response to the inspector's question regarding re-qualification of inactive Cadweld operators, Mr. Richards stated that the qualifications of a Cadweld operator are to be re-examined if he has not been engaged in welding operations for a period of time greater than 90 days.

Re-qualification will include the tensile testing of the first Cadweld made by the operator upon his return to welding activity.

5. Documentation of Followup Action on QA Audit Deficiencies

In reply to the inspectors' comment that documentation related to resolution of deficiencies observed during PG&E QA audits was not readily retrievable, Mr. Richard stated that a policy has been implemented whereby the department charged with resolving a noted discrepancy will respond in writing to the QA Section in a timely manner and that the written response will then be filed with the original audit report.

6. Scheduling of Periodic QA Audits

Mr. Richards provided a tentative schedule of PG&E's planned QA audit program in response to the inspectors' comment that although the frequency of QA audits appeared to have been timely in the past, no apparent effort had been made to develop a schedule to assure that audits continue to be made on a timely basis.

Mr. Richards stated that the audit plan had been developed shortly after the current onsite inspection.

A. Persons Contacted

J. D. Worthington	-	Vice President, Engineering Department
C. H. Sedam	-	Vice President, General Construction Department
D. V. Kelly	-	Project Engineer
M. H. Chandler	-	Manager, Station Construction
W. R. Hersey	-	Project Superintendent
R. R. Friedrichs	-	Resident Civil Engineer
W. R. Forbes	-	Supervising Inspection Engineer
R. V. Bettinger	-	Civil Engineer
G. V. Richards	-	Director, Quality Engineering
L. G Carr	-	Quality Assurance Engineer
J. L. Murin	-	Quality Assurance Engineer
F. W. Brady	-	Quality Assurance Engineer
L. J. Garvin	-	Quality Assurance Engineer
P. L. Bussolini	-	Quality Control Engineer (Civil)
D. Maxwell	-	Civil Engineer (Concrete Testing Laboratory)
W. N. Harris	-	Quality Assurance Engineer, G. F. Atkinson Co.
H. Nunes	-	Quality Assurance Engineer, G. F. Atkinson Co.
G. Mendez	-	Quality Control Supervisor, Pittsburgh-Des Moines Steel Co. (PDM)
J. Vouri	-	Quality Control Supervisor, Pittsburgh Testing Laboratory (PTL)

B. Project Administration (On-site)

In addition to the general information concerning PG&E's on-site project administration contained in CO Report No. 50-275/69-7, the following, more detailed information concerning the development of PG&E's on-site management staff was obtained during the current visit.

1. General Construction Department

The Project Superintendent is the senior representative of the General Construction Department at the plant site and exercises general supervision of on-site activities. He supervises the progress of work through Resident Engineers, Field Engineers, and Field Inspectors.

There are three Resident Engineers employed at the plant site to supervise civil, mechanical, and electrical engineering activities, respectively. At a later date other Resident Engineers may be assigned for startup or other special tasks. With respect to quality assurance, the responsibilities of a Resident Engineer include:

a. Supervision of preparation of quality control plans for site related activities.

b. Direction of quality control activities.

c. Review and approval as required of quality control plans prepared by others.

d. Supervision of Field Engineers and Inspectors.

Along with the individual construction inspectors, individual field engineers have been currently assigned to follow the civil construction activities of each of the major structures which include the containment, auxiliary, and turbine buildings.

Also on the Project Superintendent's staff and reporting directly to him is the Coordinating Quality Control Engineer. His designated principal responsibility is to advise the Project Superintendent on quality control matters and to coordinate quality control activities at the site. This latter responsibility he exercises through Quality Control Engineers assigned to and working with the Resident Engineers. Considered together, the responsibilities of the Coordinating Quality Control Engineer and The Quality Control Engineers include:

a. Coordination of all quality control activities at the plant site.

b. Preparation of quality control plans and review of quality control matters.

c. Participating in activities associated with disposition of nonconforming materials.

PG&E's total complement of personnel attached to the site organization was reportedly to be approximately 120. Personnel directly involved in quality control activities related to monitoring the individual contractors performing the actual construction work was stated to be about 60. This number of personnel was further classified as 30 civil, 20 mechanical, and 10 electrical.

Figure 1, attached, shows the on-site organization of the PG&E Construction Department.

2. Quality Engineering Section

A group of three engineers attached to the Quality Engineering Section reside at the site. This group, under the direction of Mr. L. Carr, reports directly to the Director of Quality Engineering in San Francisco, California who in turn is responsible to the Vice President, Engineering for the development and implementation of the Quality Assurance program. The Section is responsible for continually reviewing the Quality Assurance program and reports directly to the Vice President on its adequacy and the extent to which it is being implemented. The organization and functions have been patterned after the QA program described in the PSAR for the construction of Unit No. 2 (Docket No. 50-323) and will be the same used for the construction of Unit No. 2.

According to the policy instructions, the Section is also organizationally independent of project design and construction and has the authority and freedom to investigate any activity within the Engineering or General Construction Departments affecting quality of work. The Section performs its function largely by performing periodic audits and reporting the findings to the appropriate department management personnel.

The inspector reviewed the file of audit procedures which have been developed and implemented. These procedures included audits

titled as follows. (The number in parentheses following each item designates the number of audits performed to date for the particular activity.)

a. Concrete: (3)

Receiving inspection and storage
Batch plant
Placing and finishing of concrete
Laboratory operation

b. Records of materials in containment base slab (Special)

Reinforcing steel
Concrete

c. Production and control of aggregate (1)

d. Laboratory apparatus and test equipment (1)

e. Reinforcing steel: receiving and storage, placement and testing (3)

f. Containment structure liner: (1)
Drawing distribution and control
Construction planning and procedures
Material shipment, receipt, identification and storage
Erection, fitup and welding control
Welding materials

g. Inspectors work (1)

h. Receiving and storage of mechanical equipment (1)

i. Tank fabrication (1)

j. PG&E's Resident Engineers (1)

k. PG&E's Construction Superintendent (1)

From a review of the audit program reports, the following observations were made by the inspector.

a. Where deficiencies were indicated by the auditor, the documentation concerning the followup action required by the department concerned was not readily available. However, in each case questioned by the inspector, Mr. Carr was able to obtain documentation showing the corrective action initiated to remedy the deficiency.

(See management interview section of this report for the proposed procedure to improve retrievability of documentation showing the disposition of reported deficiencies.)

b. Although frequency of audits appeared to be adequate, a tentative schedule had not been developed to assure that periodic audits of activities are performed in a timely manner. (See management interview section of this report for the proposed action concerning the scheduling of future audits.)

c. Audit procedures appeared to be comprehensive and included all pertinent contract and PSAR requirements. The procedures concerning the audits of concrete and reinforcing steel are attached as Appendicies A & B, respectively and show the throughness of the audit procedures currently developed and implemented.

C. Concrete (PI 3800/2)

1. Review of QC System

During the previous review of the QC System, as reported in CO Report No. 50-275/69-7, provisions were lacking concerning documentation to show that adequate personnel and equipment were available for concrete placement operation.

The inspector was shown that the checklist, which must be completed and approved by both PG&E and Atkinson, had been revised to include a provision for documenting the availability of adequate personnel and equipment prior to commencement of placing concrete for any given pour. Also the inspectors checklist includes verification that the contractor has implemented the proper curing procedures after completion of the pour.

2. Followup Record Review

a. Concrete Strength Tests

The inspector reviewed the records related to all of the concrete installed to date for the containment and auxiliary building. The recorded information showed that the frequency of concrete strength tests varied from 90 to 120 cubic yards produced. Additional random samples were taken whenever the batch plant operator suspected improper operation. The vast majority of strength tests were for each 96 yards of concrete produced. The contract specifications requires such tests to be performed for each 100 cubic yards of concrete produced.

The recorded strength results for Class A concrete, (5000 psi - 60 days) used for the containment building and the main columns in the auxiliary building ranged from a low of 5999 psi to upper value of 7251 psi. The results recorded for the Class B concrete (3000 psi - 28 days) used for the auxiliary building, except for the main columns, was found to range from a low of 3027 psi to a high of 4700 psi with a weighted average strength of approximately 3900 psi.

b. Concrete Slump Tests

The information contained in the records showed that slump tests have been taken on the same frequency as the cylinders for strength tests.

Maxwell stated that normally additional slump tests are performed whenever the batch plant operator or inspector notes a change in the amperage required to drive the plant mixer. He said that a 10 amp. change from normal for a particular mix indicates that the slump is probably being affected. Therefore, a slump test, necessary checks and adjustments are all made to immediately return the plant to proper operations. He said however that these additional slump checks are not normally recorded in the official records which show that the product meets the required specifications.

The results of the slump tests ranged from a low of two to a high of five. (Specification stipulates 3 ± 1). However a check of the strengths of the cylinders formed from the cement which was recorded to be out of slump specification showed that the strengths were well above the specified limits.

c. Mix Designs Adhered To

On several occasions the inspector checked the batch plant tape which shows the concrete ingredients along with the mix design designation. The reviewed tapes showed that the product produced conformed to the mix design prescribed for the given pour. In addition to the mix designs prepared by PG&E, Atkinson employed an independent Laboratory to develop design mixes. The approved mix designs currently being used at the site are shown in Appendix C.

d. Batch Plant Equipment Calibrations

The inspector reviewed a certificate supplied to PG&E by the sealer of weights and measurements of San Luis Obispo County showing the calibration of the batch plant scales on October 1, 1969. In addition to the yearly calibration by the County,

PG&E checks the calibration of the equipment with a standard weight calibrated to the county's weights. The records showed that this additional check of the scales had been performed on a weekly schedule in accordance with PG&E's procedures.

e. Implementation of 4605.04h (Records and Control)

The inspector reviewed the checklist described in CO Report 50-275/69-7 to verify that (1) the location is ready for concrete placement, (2) the proper mix design is requested and mixed, (3) the proper mix is delivered to the proper location in the time required, and (4) proper placement crews are available with proper equipment. The review included all of the checklist concerning placement of concrete to date in the auxiliary and containment buildings. No deficiencies were observed.

3. Follow-up Observation of Work

Preplacement QC Inspection

The following observations of the inspector were made during the visit concerning placement of the 5-inch concrete slab on top of the containment base slab in preparation for installation of the floor of the steel liner.

a. Preplacement Inspection

The area was clear of extraneous material and the placement inspection card had been signed by both PG&E and Atkinson's representatives.

b. Placement of the Concrete

The concrete appeared to be properly placed with an adequate crew size, equipment and techniques. The concrete was being dropped from a bucket from a distance of between 2 to 3 feet. The crew included the foreman, two men operating vibrators, two men using shovels to transfer excess concrete from one area to another (the vibrators were not used to move the concrete), two men screeding the area and two men finishing the concrete with wooden trowels. Also the work was being witnessed by a PG&E concrete inspector and two PG&E surveyors were present to assure the level was proper.

c. Proper Delivery of Concrete

An examination of a batch plant ticket, which the truck driver presented to an Atkinson laborer upon delivery of the concrete, showed the concrete was the proper mix requested for the pour and that the truck had delivered the concrete and departed from the area within 25 minutes from the time shown on the ticket representing the time the concrete was manufactured. The contract specification limits such time to 45 minutes.

D. Atkinson QA-QC Program

The QA-QC system of the Atkinson Construction Co., the prime contractor for constructing the civil structure, was reviewed and discussed with Messrs. Harris and Nunes of Atkinson. The inspector observed that Atkinson has developed schedules and review procedures to assure that all concrete activity related materials delivered to the site meet the requirements of the contract which in turn has been determined to satisfy the requirements contained in the PSAR.

The records were noted to be in a readily retrievable filing system. Upon request, the records concerning test results of aggregates and cement certifications were shown to the inspector. The inspector observed that certain figures were circled in red. Mr. Nunes explained that the circled values were out of contract specification and were transmitted to PG&E as a variation from specification which needed resolution before use of the material in Class I structures. The Inspector was told that any deviation outside of the specifications, no matter how small, was circled. To demonstrate that the results of the tests were reviewed to assure consistency with the specification, either Mr. Nunes or Mr. Harris now initials the documents as requested by a PG&E QA audit of their program. The various contract specifications concerning the material and frequency of testing required were observed to be posted next to the QC engineers desk for ready reference purposes.

E. Discrepancy Control

PG&E has developed an on-site discrepancy control procedure. The procedure appears to be complete in that it requires all significant variations from specification to be documented and reported to PG&E's design engineering department either immediately or at a later date depending upon the significance of the variation. If judged by site personnel to be a deviation, Engineering is immediately contacted for resolution. If judged as only a minor variation it may then be resolved by site engineers. However, the design personnel are still apprised of the variation and resolution and are free to take exception with the site personnels' handling of the situation.

However the wording of the portion of the procedure exempting certain items from the formal reporting procedure may be of concern and will be a subject for review during the followup QA inspection scheduled for Diablo No. 2 on March 26 and 27, 1970.

The following information was obtained from concrete discrepancy reports and shows how the system operates.

1. During a pour of Class A concrete in the containment base mat, the ice handling equipment at the batch plant became disabled due to failure of one of the motors which drives the ice conveyor of the plant. Therefore, the concrete could not be maintained at a temperature of less than 55°F as specified by the contract. Upon contacting Mr. Bettinger of the PG&E civil engineering department in San Francisco, permission was obtained to substitute an upper temperature limit of 70°F. Mr. Bettinger's basis was that since only approximately a foot in height remained to be installed for the pour, the 55°F temperature was no longer the critical factor that it would have been had many feet remained for completion of the concrete pour. Maximum concrete temperature measured for the concrete in question was 65°F. The investigation of the equipment failure by the licensee and the plant vendor concluded that the particular motor that failed was undersized. To preclude recurrence, a larger size motor was secured and installed.

2. Cement was delivered to the site prior to completion of 7 day and 23 day strength reports.

   Based on available 3 day test reports and chemical analysis of the cement, PG&E engineering research department recommended proceeding with use of the cement with the understanding that in the unlikely event the manufactured concrete failed to meet the required specifications, consideration would be given to the implication of failure to meet specification and if necessary the placed concrete would be removed.

   The required subsequent tests demonstrated that the cement and manufactured concrete conformed to the required specifications.

   Southwest Portland Cement Company (SWPCO) who furnished the cement for the project was requested to provide an increase in their lead time so that 28 day strength results would be available on all future cement set aside for the Diablo project. Mr. Harris indicated that since the problem occurred SWPCO has been very cooperative and has been maintaining two to three silo's ahead of the one currently being emptied. Also, Harris said that to assure that delivery

from the silos are proper, the bins at the site are locked and the batch plant supervisor has instructions not to accept delivery and unlock the bins until he has verified that the information on the truck driver's certificates conforms to the schedule provided by SWPCO and Atkinsons QA section.

F. Concrete Reinforcing Steel

The records relating to the reinforcing steel used in the concrete foundation of the containment building were reviewed, and discussions relating to these records were held with Messrs. Carr, Murin and Garvin.

The review was limited to the steel which had been supplied to ASTM Standard Specification A-615, Grade 60. The PG&E contract specifications[1/] relating to reinforcing steel impose the following requirements in addition to those of the ASTM standard specification given above for Grade 60 bar:

Carbon Content, percent.....0.45, maximum
Manganese Content, percent....1.30, maximum
Tensile tests specimen size...full section

All material was supplied by the Pacific States Steel Corporation (PSSCO), Union City, California. According to Mr. Murin, PSSCo has contracted with the Pittsburgh Testing Laboratory (PTL) to provide independent quality control over the manufacture and field fabrication of reinforcing steel. The PTL inspectors witness the tensile testing of steel both at the PSSCo mill (No. 11 and smaller size bar) and at the PG&E testing lab at the Diablo Canyon site (No. 14 and 18 size bar).

The quality control records were observed to contain material tests reports, including chemical and mechanical properties, for a total of 65 heats of Grade 60 rebar. The records of 16 heats of Grade 60 material were selected at random for detailed review by the inspector. The following information and observations resulted from this review.

1. Chemical Composition of Rebar

The range of chemical properties were as shown in Table I.

Table 1 - Grade 60 Rebar Chemical Composition

Chemical Element	Required Composition, % PG&E Spec	ASTM	Range of Reported Composition, %
Carbon	0.45, max.	none	0.37 to 0.44
Manganese	1.30, max.	none	0.81 to 1.12
Phosphorus	-	0.050, max.	0.002 to 0.007
Sulfur	-	none	0.030 to 0.053

1/ Contract 8831, PG&E to G. F. Atkinson Co., Section 4.)

No discrepancies were revealed insofar as the chemical composition of those heats reviewed.

2. Tensile Properties of Rebar

The records revealed that two heats of No. 18 size rebar were rejected by PG&E for failure to meet the minimum tensile and yield stress requirements of 90,000 psi and 60,000 psi, respectively. In the case of each of these heats of steel (Nos. 17525 and 36446), the discrepant (low strength) condition was revealed by the testing of Cadweld splices, after the steel was installed in the concrete forms. The origonal material tests reports by PSSCo in each case showed strengths well in excess of the minimum strength specified. (See Table 2.)

Table 2 - Original Material Test Report
Results by PSSCo - Rebar Heat Nos. 17525 and 36446

Heat No.	Yield Stress (psi)	Tensile Stress (psi)
17525	68,000	109,690
36446	70,220	98,740

The original test reports for each of the above heats of steel were dated September 12, 1969. A Cadweld testing report dated September 17, 1969 showed a failure of the rebar, from heat No. 17525, at a strength of 88,500 psi. A subsequent Cadweld testing report dated September 30, 1969 showed a failure of the rebar, from heat No. 36445, at a strength of 89,750 psi.

The records showed that during the period September 11 through October 1, 1969 several additional samples of steel(12 samples from heat No. 17525 and 25 samples from heat No. 36446) were subjected to tensile testing. Some of these tests were conducted at the site, and others were tested by a consultant laboratory (Signet Testing Laboratories, Inc. Hayward, California) at the direction of PSSCo. The results of these tests showed that in the case of heat No. 17525, seven specimens failed at below the minimum specified yield and/or tensile strength. A typical yield stress for those specimens which failed below the specified strength was approximately 58,500 psi. A typical value for those specimens which failed to meet the tensile stress requirement was approximately 88,000 psi.

The retest results for heat No. 36446 were similar to those for heat No. 17525, with 14 of the 25 specimens failing to meet the specified strength. In this case, the yield stress for those

specimens failing to meet the specified strength ranged from 56,750 psi to 59,500 psi. The tensile stress for those specimens which failed to meet the specified strength ranged from 89,000 psi to 89,500 psi. The deficiencies with regard to the steel from heat Nos. 17525 and 36446 were the subject of a Deviation Report (No. 2), initiated by the PG&E QA staff, and dated October 23, 1969. This report indicated that the deficiencies were reviewed by a Material Review Board (MRB), consisting of Messrs. Carr and Friedrichs of PG&E and Mr. W. N. Harris of G. F. Atkinson Company.

The following is quoted from Deviation Report No. 2, regarding the disposition of the material:

> "All bars of these two heats were removed from the containment structure, cut-up, and returned to Pacific States Steel"

With the exception of the two heats of steel discussed above, the records showed the tensile properties of the steel to be in accordance with ASTM Standard Specification A-615, Grade 60. The records showed that in the case of 3 of 65 heats of steel, retests were conducted in accordance with paragraph 11.3 of ASTM A-615, because the test specimen developed a flaw. In a letter dated October 22, 1969, Mr. Vouri of PTL stated that all specimens which fail to meet the specified strength during test shall be "visually inspected, comments recorded, test samples identified and forwarded to PG&E, Diablo Canyon Site..."

According to Mr. Carr, investigation by PG&E revealed that PSSCo had, during manufacture of the rebar from heat Nos. 17525 and 36446, rolled the bar to approximately 1.5% below the nominal cross sectional area (4.00 square inches for No. 18 bar) specified by ASTM A-615. The specification permits under weight, or cross sectional, variation (for a bar lot) of 3.5%. Mr. Carr stated that the rolling process was adjusted by PSSCo to provide a cross sectional area of approximately 1.5% larger than that specified by ASTM A-615 on subsequent bars manufactured for the Diablo Canyon project. Mr. Garvin stated that dimensional checks of the rebar were conducted by the PTL, and that the records of these inspections would be included in the site project records.

G. Cadweld Inspection and Testing

The records of Cadweld inspections and testing were reviewed, and discussions relating to them were held with Messrs. Vouri, Marin and Bussolini. The following information resulted from the review.

1. Qualification of Welding Operators

The records showed that a total of 20 Cadweld operators had been qualified. All were employees of PSSCo. The qualification examination of these operators was conducted by a representative

of Erico Products, Inc. (Erico). For each operator qualified, a test splice was visually inspected and tensile tested, and the first 20 production splices were witnessed by an Erico representative. Among the 20 operators qualified through February 3, 1970, were three Cadweld Foremen, one General Foreman and the Project Superintendent.

Each qualified welder had been assigned an identifying code (letter and number combination) from which the position(s) for which he was qualified could be readily determined.

2. Inspection and Testing Frequency

The PG&E contract[2/] requires a visual inspection of [illegible]ces in accordance with the latest Erico inspection procedure and tensile testing of the splices made on No. 18, Grade 60 bars (only) in accordance with the following schedule:

...One out of the first ten splices.
...Three out of the next 90 splices.
...Two out of the second and subsequent 100 splice units.

At least 25 percent of the total number of splices tested are required to be production splices, with the balance consisting of sister splices.

3. Inspection and Testing Results

The PSSCo has contracted with the PTL to provide quality control for the Cadweld splice program. PTL inspectors, under the direction of Mr. Vouri, witness the preparation and production of each splice and conduct a post-weld visual inspection of each splice. They also witness the tensile testing of splices.

The records of Cadweld splices made during construction of the containment building foundation mat were selected for review. Summary reports by PTL showed that a total of 3648 Cadweld splices had been completed through January 27, 1970. Of this number, a total of 48 splices had been rejected on the basis of visual inspections. One splice, as discussed below, was rejected because it failed under tensile test below the specified strength.

The inspector selected at random the records of four welding operators for in-depth review. These welders had welded a total of 514 splices. The records for each of the four welders showed that the numbers of sister and production splices had been selected for test in accordance with the schedule given previously in this section.

2/Ibid, Paragraphs 4.33 and 4.34

The single splice which failed under test to develope the required tensile strength (90,000 psi for No. 18 size bar) was tested on January 13, 1970. The records showed that it was a sister splice, welded in the horizonal position by welder "P" (W. Griffin). The splice was designated P-1-100, and was the mating splice to a production splice designated P-1-102. The splice designations indicate that sister splice P-1-100 was the approximately 100th horizonal splice made by Mr. Griffin. The splice failed at a strength of 63,250 psi. An entry in the test record stated that the splice had failed by pulling of the bar from the sleeve. The following notation had been entered on the inspection sheet for this splice:

> "This Cadweld failed physical test due to moisture. Before Cadweld was made, water got into crucible causing failure of sister Cadweld."

In response to the inspector's inquiry Mr. Vouri explained the above notation as follows. A canvas covering had been constructed to protect the welding area. Water had collected on the canvas during a rain. Movement of the canvas covering caused the spillage of some water into the crucible while splice P-1-100 was being prepared for welding. Mr. Vouri stated that inexperience on the part of the PTL inspector resulted in the splice being "passed" for test.

Investigation and evaluation of the splice failure consisted of the following actions. The mating production splice (P-1-102) was cut from the reinforcing structure and subjected to test. It showed a strength of 99,000 psi, well above that specified for the bar.

Five batches of Cadweld powder were identified as possibly suspect, since material had been used from each during the period splice P-1-100 was made. Samples of each batch of material were sent to Erico, along with the parts from the failed splice. Erico prepared splices using material from each suspect batch of powder and subjected them to tensile test. The results of these tests are given in Table 3, and show in each case a failure strength well above the specified strength (90,000 psi) of the bar spliced.

Table 3 - Test Results For Splices
Made With Suspect Cadweld Powder

Powder Date Code	Strength of Splice, psi*
FK - BX - 7	107,250
FK - BX - 6	107,150
FK - BX - 5	107,900
FK - BX - 4	106,750
**FM - BY - 11	107,250

* - All splices failed by fracture of the bar.
** - Powder from this batch was found in the rebar splice area, making it highly suspect as the batch from which splice P-1-100 was made. This splice was made using the same rebar pieces which were joined by splice P-1-100.

Erico in a letter, R. E. Rylander to Mr. J. Vouri, dated February 1970, concluded the following with regard to their evaluation of the failure of splice P-1-100.

> "...We feel that the rebar was not part of the cause of the splice failure.
>
> "...from the evidence of our examinations and tests, we believe the low pull of splice P-1-100 resulted from moisture present in the sleeve and possibly the graphite pouring basin.
>
> "This moisture resulted in a porous, low strength filler metal condition.
>
> "As there is no substantiating evidence for suspecting causes other than discussed above and in view of the test data accumulated both in this report and in actual field use, we conclude that the (failure of -ed) P-1-100 is a single occurrence type of event"

In addition to the above evaluations, corrective action by PG&E and PTL included the reinspection of all available (more than 150) splices inspected by the PTL inspector who inspected and passed splice P-1-100, and a similar reinspection of approximately 45 splices made by the operator who welded splice P-1-100. All of the splices were found to be satisfactory.

A review of the PG&E contract specifications and discussions with project personnel revealed that the ends of rebar to be joined by Cadweld splices must be square cut. Shearing of the rebar ends is prohibited. The splicing procedures require the use of a square stock spacer to provide a spacing of approximately 3/16-inch between bars within the Cadweld sleeve.

As mentioned previously in this report (Section F.), the testing of Cadweld splices revealed two heats of reinforcing steel with low strength characteristics. With the exception of these two splices and sister splice P-1-100 discussed above, the strength of those splices for which testing results were reviewed ranged between 92,250 psi and 114,250 psi.

In reviewing the Cadweld records, it was observed that one welding operator had been inactive (produced no splices) for a period of time approaching 90 days, from mid-September to early-December. In response to the inspector's inquiry, Messrs. Vouri and Murin stated that no limit had been set on the period of inactivity of a welding operator, such that his weld qualifications would have to be re-examined. This observation was discussed at the time of the management interview, at which time PG&E personnel stated a time limit of 90 days is to be established, beyond which a welder's qualification would be re-examined. The re-examination will include the tensile testing of the first Cadweld produced by the welder after his return to activity.

H. Containment Building Liner Material

While touring the containment building area, the erection of steel plate to form the lower (approximately 3-foot high) ring of the cylindrical wall and the floor liner of the containment building was observed to be in progress. The material for the 3-foot shell ring was observed to be approximately 3/4-inch in thickness and that for the floor plates was approximately 1/4-inch in thickness. The work was being performed by the Pittsburgh-Des Moines Steel Company (PDM).

The material test reports (MTR's) for the liner material were reviewed and discussions relating to them were held with Messrs. Carr and Brady. According to Mr. Brady, MTR's covering the first portion of the liner material to be erected had been provided to the PG&E QA staff by PDM on March 9, the day that current inspection commenced. The MTR's which Mr. Brady provided for review covered 10 heats of steel which had been supplied by the United States Steel Corporation (USS), Geneva Works, Provo, Utah.

The MTR's covering 4 of the 10 heats of steel were selected for detailed review by the inspector. The material was identified as plate conforming to ASTM Standard Specification A-516, with Charpy V-Notch impact properites of at least 15 foot-pounds average at a test temperature of +20°F. The ASTM Standard Specification given above differs from that described in the PSAR[3] which is ASTM A-442. This change in material designation is to be covered in the FSAR submission, according to Mr. Bettinger.

The following notation had been stamped on each of the MTR's supplied by USS.

> "Test specimens were normalized at 1650°F for 30 minutes per inch of stack, cooled in still air"

The material description on the MTR's did not indicate that the plates had been normalized. In response to the inspector's inquiry, Mr. Brady stated that PG&E had "taken exception" to the notation on the MTR's, since it was their understanding that the plates had not been normalized either at the USS mill or the PDM shop. The inspector called to the attention of Mr. Brady paragraph 9.1 of ASTM A-516, which states "For plates 1½-inch and under in thickness not requiring heat treatment, the test specimens shall be prepared for testing from the material in its rolled condition." Mr. Brady stated that the discrepancy had been detected by Mr. Carr only two days prior, and that the matter was currently being evaluated by the PG&E Engineering Department. Subsequent discussions with Messrs. Carr, Brady and others revealed that the discrepancy had gone unnoticed by both the PDM QC department and the PG&E vendor inspection group, both of which groups had conducted inspections at the USS mill.

Additional information relating to the corrective action being considered by PG&E in regard to physical testing of the liner plate materials was obtained at the time of the Management Interview on March 12, and is included in that section of this report.

Tables 4 and 5 show the chemical and physical properties reported by USS on the MTR's which were reviewed by the inspector.

Table 4 - Chemical Properties Reported by USS - Containment Liner Plates

Heat No.	C	Mn	P	S	Si
93E448	0.20	0.90	0.013	0.017	0.21
93E324	0.21	1.04	0.012	0.019	0.22
93E352	0.20	0.94	0.017	0.017	0.22
99E360	0.24	1.03	0.025	0.023	0.21

No discrepancies were identified between the chemical composition reported and that required by ASTM Standard Specification A-516.

Table 5 - Physical Properties Reported by USS - Containment Liner Plates*

Heat No.	Yield Point, psi	Tensile Strength, psi	Elongation in 8 in., %	Impact, Ft-Lbs
93E448	48,000 to 52,400	70,700 to 73,000	26 to 30	41.1 to 41.6
93E324	50,400 to 53,000	75,500 to 76,700	25	34.3 to 40.6
93E352	49,600 to 52,000	72,300 to 76,000	21 to 28	25.0 to 94.6
99E360	51,400 to 52,400	77,400 to 81,700	25 to 27	62.6 to 94.6

*These physical properties are recorded here for reference only, since the data apparently have been invalidated by improper heat treatment (normalizing) of the test specimens.

I. Weld Rod Control

The PDM procedure for the care and control of weld electrodes was reviewed with Messrs. Brady, Bussolini and Mendez. According to Mr. Mendez, the only weld electrodes being used to weld the containment building liner are of type E7018, low hydrogen rods. The PDM procedures limit the time during which these type electrodes may be exposed to the atmosphere to a maximum of 4 hours. Mr. Mendez stated that all electrodes for use at the Diablo Canyon project are purchased in 10 pound cans, and that electrodes which are exposed for greater than 4 hours are to be wasted and not rebaked. Records are maintained by PDM which show the date, time and quantity of rods returned. Mr. Mendez explained that all unused rods are returned to the holding oven during the lunch hour and at the end of each shift, and that no rods are left unattended in the welding area. The procedures require that the holding ovens be maintained at a temperature between 250°F and 350°F.

The inspector and Mr. Murin toured the welding area at approximately 10:00 a.m. on March 12. At this time it was observed that the weld rod holding oven was at a sufficiently low temperature such that the storage shelves were only warm to the touch of the hand. No weld electrodes were in the oven, however. The oven was not equipped with a temperature indicator.

Later, at approximately 12:30 p.m. on March 12, the inspector and Mr. Brady toured the welding area. Welding operators had left the area for their lunch period. Two open cans, approximately half filled with type E7018 electrodes were observed unattended in the area. Inspection of the weld rod storage area revealed that the holding oven was locked closed. The inspector and Mr. Brady met with Mr. Mendez at approximately 2:00 p.m. to review the previous observations. Mendez said that there appeared to have been a breach of the weld rod control procedures,

and that he would investigate. Mendez, Mr. Brady and the inspector returned to the welding area, where discussions were held with two welding operators and a welding inspector. These discussions revealed the following information. The welding operator attempted to return the weld rods to the oven at the beginning of his lunch period. He found the oven locked, however, and the welding inspector was not available to unlock it. The welding operator, reportedly, then returned the unused rods to the welding area, a distance of approximately 150 feet. The rods were, reportedly, returned to the welding inspector after the lunch period. Subsequent inspection of the holding oven revealed that it contained several open cans of type E7018 electrodes. At this time the holding oven was observed to be quite hot to the touch of the hand. Mr. Mendez showed our inspector records of weld rod issuance, which showed that the electrodes in question had been issued to a welding operator at 10:00 a.m. that day and returned to the oven at approximately 1:00 p.m. From these records it was determined that the rods had not been exposed for a period of time in excess of that permitted (4 Hours) by the PDM procedures. Both Messrs. Brady and Mendez stated, however, that there had been a violation of the procedures which require that weld rods be returned to the holding oven when not in use, and that rods not be left in the welding area unattended.

Mr. Bussolini showed the inspector the results of QC audits conducted of the PDM welding area during each of the three weeks prior to the current inspection. Neither of these audits had revealed deficiencies. When asked if observations such as that made by our inspector would have been identified as a deficiency, Mr. Bussolini said yes. At the time of the Management Interview, Mr. Richards stated that the QC audits by PG&E were to be increased from once weekly to twice weekly. This frequency of audit is to continue until PG&E is satisfied that the use and care of weld electrodes is satisfactory. Mr. Richards also stated that thermometers were to be placed in the weld rod holding ovens.

FIGURE 1

PG&E ORGANIZATION
(ON - SITE)

CONSTRUCTION DEPARTMENT
DIABLO CANYON SITE - UNIT 1

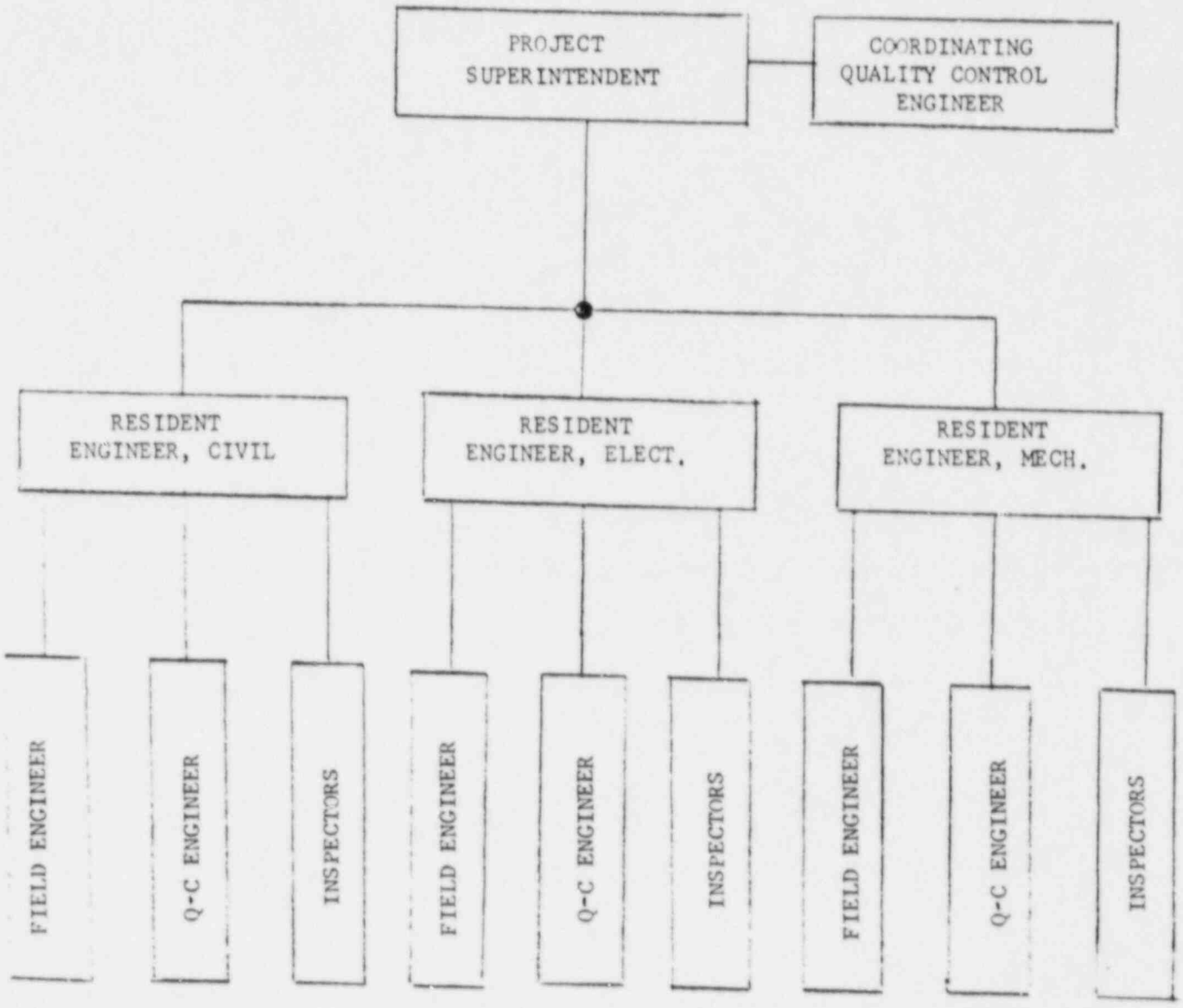

FIGURE 1

PACIFIC GAS AND ELECTRIC COMPANY
DIABLO CANYON SITE
QUALITY ASSURANCE ENGINEERS AUDIT

CONCRETE: MATERIALS, MIXING AND PLACEMENT

1.0 APPLICATION

This plan is applied to all concrete work provided under Specification No. 8831, including the reactor containment and other critical primary system support structures, which must be of specified high quality.

2.0 REFERENCES

2.1 Specifications, Drawings, Codes, Regulations

Quality control of concrete work is based on application of the following criteria.

Document	Title	Authority/Source	Spec 8831 Reference
8831	Specification for Construction of Buildings and Related Structures	PG&E	-
	Section 2 - Forms		Section 2
	Section 5 - Concrete		Section 5
	Inspectors Instructions for Operating Concrete Laboratory	PG&E	-
	Inspectors Instructions for Placement of Concrete	PG&E	-
	Quality Assurance Manual	GFA	-
8849	Specifications for Concrete Batch Plant	PG&E	Section 5 para. 6.81
ACI 214	Recommended Practice for Evaluation of Compression Test Results of Field Concrete	ACI	Section 5 para. 4.2
ACI 301	Specifications for Structural Concrete for Buildings	ACI	Section 5 para. 4.1

Document	Title	Authority/Source	Spec 8831 Reference
ACI 613	Recommended Practice for Selecting Proportions of Concrete	ACI	Section 5
C29	Test for Unit Weight of Aggregate	ASTM	Section 5 para. 5.4
C33	Specification for Concrete Aggregates	ASTM	Section 5 para. 2.34
C39	Test for Compressive Strength of Concrete Cylinders	ASTM	Section 5
C40	Test for Inorganic Impurities in Sands for Concrete	ASTM	Section 5 para. 2.351
C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	ASTM	Section 5 para. 5.82
C87	Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar	ASTM	Section 5 para. 5.4
C88	Test for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate	ASTM	Section 5 para. 2.352
C94	Specification for Ready-Mixed Concrete	ASTM	Section 5 para. 6.1
C109	Test for Compressive Strength of Hydraulic Cement Mortars	ASTM	Section 5 para. 5.211
C114	Chemical Analysis of Hydraulic Cement	ASTM	Section 5 para. 5.2
C117	Test for Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing	ASTM	Section 5 para. 5.4
C123	Test for Lightweight Pieces in Aggregate	ASTM	Section 5 para. 5.4
C125	Definition of Terms Relating to Concrete Aggregates	ASTM	Section 5
C127	Test for Specific Gravity and Absorption of Coarse Aggregate	ASTM	Section 5 para. 2.353
C128	Test for Specific Gravity and Absorption of Fine Aggregate	ASTM	Section 5 para. 5.4

Document	Title	Authority/Source	Spec 8831 Reference
C131	Test for Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine	ASTM	Section 5 para. 2.361
C136	Test for Sieve or Screen Analysis of Fine and Coarse Aggregates	ASTM	Section 5 para. 5.4
C142	Test for Friable Particles in Aggregates	ASTM	Section 5 para. 5.4
C143	Test for Slump of Portland Cement Concrete	ASTM	Section 5 para. 5.3
C150	Specification for Portland Cement	ASTM	Section 5 para. 5.21
C151	Test for Autoclave Expansion of Portland Cement	ASTM	Section 5 para. 5.213
C173	Test for Air Content of Freshly Mixed Concrete by the Volumetric Method	ASTM	Section 5 para. 2.51
C190	Test for Tensile Strength of Hydraulic Cement Mortars	ASTM	Section 5
C191	Test for Time of Setting of Hydraulic Cement by Vicat Needle	ASTM	Section 5 para. 5.214
C192	Making and Curing Concrete Compression and Flexure Test Specimen in the Laboratory	ASTM	Section 5 para. 4.7
C204	Test for Fineness of Portland Cement by Air Permeability Apparatus	ASTM	Section 5 para. 5.215
C231	Test for Air Content of Freshly Mixed Concrete by the Pressure Method	ASTM	Section 5 para. 2.51
C235	Test for Scratch Hardness of Coarse Aggregate Particles	ASTM	Section 5 para. 5.4
C260	Specification for Air Entraining Admixtures for Concrete	ASTM	Section 5 para. 2.5
C295	Recommended Practice for Petrographic Examination of Aggregates for Concrete	ASTM	Section 5 para. 5.4

Document	Title	Authority/Source	Spec 8831 Reference
C309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete	ASTM	Section 5 para. 12.22
C360	Test for Ball Penetration in Fresh Portland Cement Concrete	ASTM	Section 5 para. 5.3
C494	Specification for Chemical Admixture for Concrete	ASTM	Section 5 para. 2.6
C618	Fly Ash and Raw or Calcined Natural P0330/ans for use in Portland Cement Concrete	ASTM	Section 5 para. 2.22
Calif. 217	Sand Equivalent Test Method	Calif. Div. of Highways	Section 5 para. 2.353
Calif. 227-B	Cleanness Value Test Method	Calif. Div. of Highways	Section 5 para. 2.364
CRD-C572	Polyvinyl Water Stops	US Army Corps of Engineers	Section 5 para. 14.3
-	General Industry Safety Orders	State of Calif.	General Conditions para. 7.2
As Issued	Construction Drawings	PG&E	Section 1 para. 15.0
As Issued	Shop Drawings	Contractor	Section 1 para. 8.0

3.0 ATTACHMENTS

3.1 Check Lists

Check lists, as attached, are listed below:

Check List A - Receiving and Storage

Check List B - Batch Plant

Check List C - Placing and Finishing

Check List D - Laboratory

Note to the Quality Assurance Engineer

The check lists are guides designed to assist the PG&E Quality Assurance Engineer in monitoring the activities of the supplier/contractor. Surveillance should be based on the requirements of the contract documents which specify the applicable technical and regulatory criteria.

To achieve uniform understanding of word meanings used in the Check List, the following definitions will apply for actions specified.

Examine - An action of reviewing some form of paperwork such as certificate of inspection, laboratory test result or material certification.

Observe - The continuous presence of a PG&E representative through all phases of a single operation to visually confirm measurements, readings, recordings, method, procedures, or processes being performed by a supplier/contractor.

Inspect - The actual performance by a PG&E representative of measuring, gauging, testing, or similar operation to determine a characteristic.

Verify - The action of a PG&E representative by observation, inspection, or a combination of both.

Classification of word meanings above shall in no way restrict the PG&E representative from performing other reasonable surveillance he shall deem necessary for the equipment/material.

QUALITY ASSURANCE AUDIT CHECK SHEET FOR RECEIVING, INSPECTION AND STORAGE OF CONCRETE MATERIALS

Date _____

A	RECEIVING INSPECTION AND STORAGE	Yes	No	Name
	On each of the following items, verify that:			
A.1	The Contractor's approved receiving inspection and storage procedures are being implemented satisfactorily.	( )	( )	_____
A.2	The cement mill test results have been checked to see that they meet the specification requirements and then signed by a GFA and a PG&E representative.	( )	( )	_____
A.3	The cement, pozzolan, aggregates, air entraining agent, water reducing agent, and retarders, meet the requirements of 2.0 "Material For Concrete" in section 5 of spec. 8831. Also, that each has been approved by Constructor. That a certificate of compliance with appropriate ASTM standards accompanies each load of pozzolan, air entraining agent, water reducing agent, and retarders delivered to the project.	( )	( )	_____
A.4	The aggregate reports from the quarry have been checked for compliance to the specification requirements and have been signed by a GFA and PG&E representative.	( )	( )	_____
A.5	The Contractor is sending copies of all quality assurance reports to PG&E Resident Engineer.	( )	( )	_____

QUALITY ASSURANCE AUDIT CHECK SHEET FOR CONCRETE BATCH PLANT

Date _____

	On each of the following items, verify that:	Yes	No	Name
B.1	The Contractor's approved quality assurance procedures are being implemented satisfactorily.	( )	( )	_____
B.2	Cement from different cement plant silos are not mixed in concrete plant silos.	( )	( )	_____
B.3	Cement and pozzolan are not placed in batch plant silos until accepted by Constructor.	( )	( )	_____
B.4	All aggregates are dried or drained at time of batching to obtain a stable moisture content per paragraph 6.3 in section 5 of Spec. 8831.	( )	( )	_____
B.5	Contractor does not mix any concrete until prior approval of the proportions and ingredients has been obtained from the Constructor.	( )	( )	_____
B.6	All concrete material is measured for each batch by direct weighing.	( )	( )	_____
B.7	The weight and liquid measuring equipment is operating and the print-out tape is recording what really goes into each batch.	( )	( )	_____
B.8	Manual additions to the concrete batch are being noted on the print-out tape.	( )	( )	_____
B.9	A copy of concrete batch print-out tape is being sent with the concrete load to the pour site.	( )	( )	_____
B.10	A copy of the concrete batch print-out tape is on file in the Contractor's office.	( )	( )	_____
B.11	Prior to "start up" all weighing and measuring equipment is tested, sealed and certified by local authorities, and that the certificate(s) have been transmitted to Constructor.	( )	( )	_____
B.12	The weekly check of weighing equipment by absolute weight has been made. Record variations between weighing equipment and standard weights and verify that the percentage of variation is within the tolerances specified in para. 6.42 of Spec. 8831.	( )	( )	_____

CONCRETE BATCH PLANT (Continued)

Date _____

		Yes	No	Name
B.13	Concrete is mixed until there is a uniform distribution of material, and for a period of not less than 1½ minutes after all ingredients are in the drum, or for the number of revolutions specified by the manufacturer.	( )	( )	_____
B.14	The mixer is completely discharged and that it is kept clean and in good working order.	( )	( )	_____
B.15	Temperature, slump, percent air entrained and cylinder samples are being taken at the rate of one set per 100 cubic yards. For placements less than 100 cubic yards, one set shall be taken.	( )	( )	_____
B.16	The Contractor has documented all quality assurance activities.	( )	( )	_____

QUALITY ASSURANCE CHECK SHEET FOR PLACING AND FINISHING OF CONCRETE

Date _____

	On each of the following items, verify that:	Yes	No	Name
C.1	The Contractor's approved quality assurance procedures are being implemented satisfactorily.	( )	( )	_____
C.2	The Contractor's foreman and the PG&E inspector are present as the lift is being placed.	( )	( )	_____
C.3	The lift has been checked against the latest revision of the drawing.	( )	( )	_____
C.4	Prior to placing concrete the line and grade have been checked and adequate equipment such as vibrators, chutes, buckets, cranes and conveyors are available.	( )	( )	_____
C.5	Prior to placing concrete, forms and reinforcement are free of hardened concrete, dirt, chips, sawdust, frost and ice, and other foreign matter.	( )	( )	_____
C.6	Surfaces of hardened concrete against which new concrete is to be placed, have been made rough with coarse aggregate exposed, and that such surfaces have been thoroughly cleaned of all loose aggregate, foreign matter, and laitance that would impair bond.	( )	( )	_____
C.7	Immediately prior to placing the next lift of concrete, the surface of the hardened concrete has been wetted and given a ½ inch coat of bonding mortar on all horizontal joints, and that vertical joints are wetted and slushed with a coat of neat cement grout.	( )	( )	_____
C.8	Temperature for classes of concrete at a time of placing meets the requirements of para. 7.3 in Spec. 8831.	( )	( )	_____
C.9	Prior to placing concrete, Contractor has installed, secured, accurately located, and firmly anchored in place with templates, all items to be embedded in or extended through concrete.	( )	( )	_____
C.10	Placement of concrete does not commence until Constructor's approval has been obtained.	( )	( )	_____
C.11	Concrete is placed within 45 minutes after introduction of water to the mix, and that concrete which shows evidence of initial set prior to placement is discarded.	( )	( )	_____
C.12	Concreting is carried on as a continuous operation without planes on separation until the approved pour unit is completed.	( )	( )	_____

PLACING AND FINISHING OF CONCRETE (Continued)

Date _____

		Yes	No	Name
C.13	Concrete from transit mixers is not discharged directly from the mixer into the forms unless specifically allowed by Constructor.	( )	( )	_____
C.14	Concrete is placed in a manner that will prevent the segregation of material and displacement of reinforcement.	( )	( )	_____
C.15	When placing operations involve dropping of concrete 5 feet or more, concrete is deposited through pipes, chutes, or elephant trunks.	( )	( )	_____
C.16	Concrete is worked into all places around reinforcement, into all corners and recesses and is thoroughly compact with all voids filled.	( )	( )	_____
C.17	The type and design of vibrators has been approved by Constructor.	( )	( )	_____
C.18	The intensity of vibration visibly affects a mass of concrete of one inch slump over a radius of at least 18 inches.	( )	( )	_____
C.19	Vibrator methods of use meet with Constructor's approval.	( )	( )	_____
C.20	Construction joints occur only where shown on drawings, and that vertical joints are staggered by at least 6 inches.	( )	( )	_____
C.21	PG&E concrete placement form C-18 is being filled out.	( )	( )	_____
C.22	Final clearance for placement has been given by Constructor and the Contractors Placement Card has been signed by Contractor and PG&E inspector. After placement is complete, the Placement Card is signed by the Contractor.	( )	( )	_____
C.23	Concrete surfaces do not contain voids or strata of segregated, porous concrete, honeycomb, or fractures. Exposed surfaces are free from fins, projections, excessive amounts of air bubble, laitance, crazing, and other defects.	( )	( )	_____
C.24	Unformed surfaces are compacted, struck-off to grade and wood floated to an even dense surface.	( )	( )	_____
C.25	All unsound and damaged concrete has been chipped to a depth of three inches or more, and the excavated area is undercut slightly to make patch secure.	( )	( )	_____

PLACING AND FINISHING OF CONCRETE (Continued)

Date _____

		Yes	No	Name
C.26	Cavities are filled with mortar or concrete, as directed, which shall be deposited in thin layers not more than one inch in thickness.	( )	( )	_____
C.27	All patches are thoroughly bonded, free from shrinkage, cracks, and other defects.	( )	( )	_____
C.28	Concrete is maintained in a moist condition for a minimum of seven days, commencing as soon as possible after concrete is placed.	( )	( )	_____
C.29	Uncured concrete is protected against injury due to adverse weather conditions.	( )	( )	_____

QUALITY ASSURANCE CHECK SHEET FOR CONCRETE LABORATORY OPERATIONS

Date _____

	On each of the following items, verify that:	Yes	No	Name
D.1	The testing machines have all been calibrated against appropriate standards.	( )	( )	_____
D.2	The inspectors training and experience records are on file in the quality assurance files.	( )	( )	_____
D.3	Written instructions for laboratory personnel are available and are being followed.	( )	( )	_____
D.4	Tests and record forms C-2 through C-17 are being completed and filed in accordance with Specification 8831.	( )	( )	_____
D.5	The concrete curing room is operating properly.	( )	( )	_____
D.6	Screen analysis and fineness modulus is being performed upon the concrete aggregate at least once per 100 tons, but not more than 10, nor fewer than one per day.	( )	( )	_____

APPENDIX B

Pacific Gas and Electric Company
Diablo Canyon Site

Quality Assurance Engineers Audit
Reinforcing Steel: Receiving and Storage, Placement and Testing

Audit Date: _____

1.0 Receiving Inspection and Storage of Reinforcing Steel	Yes	No	Inspection
On each of the following items, check that:			
1.1 Contractor's receiving inspection and storage procedures are being implemented satisfactorily.	—	—	_____
1.2 Contractor is assuring that all steel received from the manufacturer or fabricator is tagged/ marked/identified by heat number, size, grade, origin.	—	—	_____
1.3 Any untagged bundles received at site are not used until identified and retagged.	—	—	_____
1.4 Contractor's Shop Quality Control documents, forms QC-6 and QC-1 have been received and are on file for each heat.	—	—	_____
1.5 Contractor's received documents, forms BF 1608, QC-2 and shop drawings detailing heat numbers have been received and are on file for each shipment received.	—	—	_____
1.6 Splice sleeves, exotheric powder and graphite molds for Cadweld splices, are stored in a proper manner.	—	—	_____
1.7 All material is inspected for cleanliness to standards established by Constructor.	—	—	_____

	Yes	No	Inspection
1.8 Material damaged in transit is rejected, and discrepancies between shipping papers and shipment, are documented satisfactorily.	___	___	_____
1.9 Rejected material is placed in a segregated storage area for disposition.	___	___	_____
1.10 Contractor submits the receipt and inspection records to Constructor within five days after material has arrived at the site.	___	___	_____
1.11 All welding electrodes, wire and flux are inspected when received for compliance to purchase order including identity type and class.	___	___	_____
1.12 All rebar is stored on adequate supports above ground.	___	___	_____

2.0 Condition Fabrication and Placement of Reinforcing Steel	Yes	No	Inspection
On each of the following items, check that:	—	—	—
2.1 Contractors Quality Assurance organization is adequate for performing work as set forth in the Quality Assurance Program.	—	—	—
2.2 Contractor's quality assurance personnel are observing and checking that all work is in accordance with drawings and specifications.	—	—	—
2.3 All cadwelding procedures, operators and inspection personnel have been qualified by Cadweld manufacturer's representative and Contractor's form 8 is on file for each welder.	—	—	—
2.4 All butt and lap welding operations are carried out in conformance with Section 4 of Specification 8831 and AWSD 12.1.	—	—	—
2.5 Contractor's inspector is visually inspecting every weld.	—	—	—
2.6 Placement of reinforcing steel is being carried out in accordance with the approved drawings, and specifications with regard to material, bar size, configuration, number of bars, spacing, and splicing.	—	—	—
2.7 Contractor's Variation and Deviation Reports, are on file for all variations and deviations from drawings and specifications.	—	—	—
2.8 Placed reinforcing steel is free from dust, loose rust, scale, concrete, oil, grease or any other material which could adversely affect the bond with concrete.	—	—	—
2.9 Contractor's form QC-3 is in proper use and is on file for each working day.	—	—	—

		Yes	No	Inspection
2.10	Contractor's form [illegible] and [illegible] is [illegible] use and is on file for all sp[illegible] each working day.	—	—	_____
3.0	Testing of Splices			
	On each of the following items, check that:			
3.1	Contractor prepares the proper number of test splices in accordance with paragraphs 4.342, 4.344 and 4.43 in Section 4 of Specification 8831.	—	—	_____
3.2	Sister splices are being performed in the same position and at the same time and with identical heats as the production splices of the crew being tested.	—	—	_____
3.3	Additional random splices are removed from the job for testing in accordance with paragraph 4.6 in Section 4 of Specification 8831.	—	—	_____
3.4	Contractor documents the testing of all test specimens by Constructor's test laboratory at the site, and copies of constructor's form 206 are on file for all specimens tested.	—	—	_____
3.5	In the event a Cadweld splice fails the tensile test, Contractor has the specimen examined and corrective action is taken based on the results of this examination. Refer paragraph 4.352 in Specification 8831.	—	—	_____
3.6	Contractor records the location of all test splices (both sister and cut-out splices.)	—	—	_____

Audit Remarks: _____

_____

_____

APPENDIX C

DIABLO CANYON CONCRETE MIXES

DATE: February 13, 1970

NUMBER	MIX REFERENCE	SLUMP INCHES	BATCH WEIGHTS FOR ONE CUBIC YARD							
			WATER GALLONS	CEMENT LB	POZZOLAN LB	SAND LB	3/4 LB	1 1/2 LB	MRA MRL OZ	AIR MRVR OZ
1	MB	10	52	1042	- -	2280	- -	- -	- -	- -
2 *	B 3/4	3	31.8	540	- -	1359	1661	- -	34.5	2
3 *	B 1 1/2	3	30.0	517	- -	1154	1029	937	34.5	2
4	BP 3/4	3"	46	517	78	1203	1470	- -	35	3.2
5	BP 1 1/2	3"	42	489	73	1048	935	850	34	3.0
6	MA	10"	52	1332	- -	2018	- -	- -	- -	- -
7 *	A 3/4	3"	36	618	111	1252	1531	- -	47	3.9
8 *	A 1 1/2	3" *	33.7	578	127	1055	940	855	47.0	2.5
9										
10										

LEGEND

A - 5000 PSI Mix
B - 3000 PSI Mix
P - Pozzolan
M - Mortar

* Revised February 19, 1970
* Added Slump Mix #8 February 13, 1970

APPENDIX C