Attachment 3

TENNESSEE VALLEY AUTHORITY

DIVISION OF ENGINEERING DESIGN

ALL PROJECTS

GENERAL

CONSTRUCTION SPECIFICATION

NO. G-32

FOR BOLT ANCHORS SET IN HARDENED CONCRETE

UNCONTROLLED COPY

	REVISION 0	R1	R2	R3	R4	R5
Date	September 1972 Original Signed by	Oct 1973 Initialed	3-28-75	9-23-75	4-21-76	7-21-77
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TVA 10571A (DEC 74)

TVA

GENERAL CONSTRUCTION SPECIFICATION FOR
BOLT ANCHORS SET IN HARDENED CONCRETE

Title

REVISION LOG
G-32

Revision No	DESCRIPTION OF REVISION	Date Approved
1	Revised DED organization names and revised sections 1.2, 6.1, and 6.2 to clarify project office drawings and reporting requirements.	10-73
2	Revised sections 1.5, 2.1, 2.3, 3.2, 3.3, 4.0, and 5.2 for details. Revised section 6.1 to send reports to appropriate Design Project Manager. Added section 3.5. Made new cover sheet. Added revision log.	3-75
3	Revised section 3.2 to eliminate the use of epoxy grout in fire hazard areas. Revised section 6.1 to require transmittal of anchor test reports to DED for only those anchor lots in which an anchor fails when tested. Revised section 6.2 accordingly. Added Attachment A.	9-75
4	Revised sections 1.2, 1.5, 4.2, and 6.2 to reduce requirements of testing expansion anchors and reporting; section 4.3 to clarify concrete strength for expansion anchors.	4-21-76
5	General revision to add wedge bolt anchors, nondrilling expansion shell anchors, qualification tests on all types of expansion anchors, and to modify other sections accordingly. Only the significant changes for this revision are noted by revision indications on the pages; previous revision indications are deleted. Removed Attachment A.	7-21-77

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1.0 GENERAL

1.1 Scope

This specification prescribes materials and methods for setting threaded anchoring devices for equipment and fixtures into concrete which has previously hardened. The work includes qualification of anchors, anchor installation procedures, and testing of anchors installed in nuclear plant category I structures. | 5

1.2 Drawings

Anchors shall be provided according to drawings prepared by or approved by the Division of Engineering Design (EN DES). Changes shall be made only with the approval of the Engineer. | 5

The Division of Construction (CONST) project office shall prepare drawings, or mark half-size prints of drawings prepared by or approved by EN DES, to show the location of and test information on each lot of anchors which require testing. Drawings will not be required where another system which uniquely and completely defines a lot is adopted and recorded with test information.

1.3 The Engineer

The Engineer as used in this specification shall mean the authorized representatives of the Manager of Engineering Design and Construction. For design considerations, these shall be the Division of Engineering Design acting through the appropriate Design Project Manager or Engineering and Design Branch Chief. For construction, in general, these shall be jointly the appropriate Design Project Manager or Engineering and Design Branch Chief and the project Construction Engineer or their designated representatives; any deviation from this specification must be agreed to jointly by them. | 5

1.4 Reference Specifications

The latest revisions of the following specifications shall apply where referred to in this specification.

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ADCON - PN-025

1.0 GENERAL (Continued)

1.4 Reference Specifications (Continued)

American Society for Testing and Materials

A 36 - Standard Specification for Structural Steel

A 307 - Low-Carbon Steel Externally and Internally Threaded Standard Fasteners

C 109 - Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm cube specimens) | 5

C 144 - Standard Specification for Aggregate for Masonry Mortar

E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements | 5

Tennessee Valley Authority

General Construction Specification No. G-2 for Plain and Reinforced Concrete (hereinafter termed G-2)

Civil Design Standard DS-C6.1, Concrete Anchorages (hereinafter termed Design Standard) | 5

1.5 Definitions

Wherever the words defined below appear in this specification, they shall have the meanings here given.

Attachment. A piece of equipment or fixture to be fastened to hardened concrete.

Anchor. A threaded device for fastening attachments to hardened concrete (distinguished herein as expansion anchors and grouted anchors). | 5

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Expansion Anchor. An anchor which expands laterally in a drilled hole to resist pullout.

Expansion Shell Anchor. An expansion anchor which consists of an internally threaded, externally slit tubular shell with a single cone expander that causes the shell to expand laterally against the sides of a drilled hole.

Self-drilling Expansion Shell Anchor. An expansion shell anchor which uses the shell for drilling the hole (designated herein and on the drawings as SSD).

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1.0 GENERAL (Continued)

1.5 Definitions (Continued)

Nondrilling Expansion Shell Anchor. An expansion shell anchor which is placed in a predrilled hole (designated herein and on the drawings as SPD).

Wedge Bolt Anchor. An expansion anchor which consists of an externally threaded bolt with a split ring or separate wedge pairs that expand laterally against the sides of a predrilled hole when the bolt is torqued, and which will expand further if the bolt is partially extracted from the hole by a tensile load (designated herein and on the drawings as WB). 5

Grouted Anchor. An anchor which consists of a headed bolt or a threaded rod with an end nut, placed in a drilled hole, the remainder of which is filled with grout or dry-pack mortar.

Category I. Nuclear plant equipment and structures so classified in the plant Safety Analysis Report. (Category I is class I in nuclear plants under construction at the time of original issue of this specification.)

Lot. A number of anchors in a nuclear plant category I structure which are considered as a group for testing purposes. A lot shall consist of the anchors installed by a specific crew either in a specific location in the plant or over a period of time. If the lot is defined on the basis of anchor location, the lot shall consist of: (a) the anchors for a single piece of equipment having three or more anchors, (b) the anchors on a floor, wall, or ceiling which has conveniently indicated boundaries, or (c) a long line of anchors on a floor, wall, or ceiling for a continuous structure such as a cable tray. If a lot is defined on the basis of anchors installed over a time period, the maximum time period shall be 2 weeks, each crew shall apply a unique identification mark on the concrete adjacent to the anchor or to a piece of equipment with more than one anchor, and a record of all anchor installations shall be kept. Regardless of the basis for defining the lot, anchors of a different type or brand shall be considered in separate lots and sufficient records shall be kept to ensure that all anchors are assigned to a lot. 5

Slip. During testing, an expansion shell anchor shall be considered to have exhibited slip if the gage on the loading device indicates a dropoff or lack of advancement of load while the anchor is being strained.

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1.0 GENERAL (Continued)

1.5 Definitions (Continued)

Approved, Permitted, Required. Wherever such words are used in this specification, they shall be held to refer to the orders or instructions of the Engineer unless another meaning is plainly intended.

Called For. Wherever these words are used in this specification, they shall mean called for by drawings, memorandums, or separate specifications issued by the Division of Engineering Design.

5

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2.0 MATERIALS

2.1 Expansion Shell Anchors

Unless otherwise called for, expansion shell anchors shall be used only for bolts 7/8-inch or smaller in diameter and shall conform to the requirements of section 2.8.

2.2 Wedge Bolt Anchors

Unless otherwise called for, wedge bolt anchors shall have the following diameters and minimum lengths:

Diameter (in.)	1/4	3/8	1/2	5/8	3/4	1	1-1/4
Minimum Length (in.)							
Regular	3	3-1/2	5-1/2	6	8-1/2	9	12
Long	-	5	7	8-1/2	10	12	-

Long wedge bolt anchors shall be color-coded or stamped in accordance with section 3.3. (Minimum bolt lengths and color-coding or stamping of long anchors is required to permit in-process inspection of anchor embedment by measurement of bolt projection.) 5

The bolt material for wedge bolt anchors shall have a minimum yield strength of 70,000 psi.

Wedge bolt anchors shall conform to the requirements of section 2.8.

2.3 Drill Bits

The manufacturer of nondrilling expansion shell anchors and wedge bolt anchors shall specify the maximum diameter drill bit (to the nearest 0.001 inch) that is to be used for the installation of each size anchor. Before its initial use, the diameter of each drill bit shall be checked to assure that it does not exceed the maximum.

For qualification tests, drill bits shall have a diameter within 0.002 inches of the maximum. The diameter of the bit shall be checked before drilling the hole for installation of each test anchor.

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2.0 MATERIALS (Continued)

2.4 Bolts

Unless otherwise called for, all bolts except wedge bolt anchors shall conform to ASTM A 307, Grade A, or shall be made of rods which conform to ASTM A 36, with nuts which conform to ASTM A 307, Grade A. Rods shall have UNC threads on both ends with a nut on the embedded end which is tack welded in place.

2.5 Portland Cement Grout

Portland cement grout shall be a job-proportioned mixture of portland cement, fine aggregate, and water, with or without admixtures; or a commercial premixed portland cement-based grout and water.

All material for job-proportioned grout shall conform to the requirements of G-2, except as modified below. Cement shall be type I, II, or III. Fine aggregate shall conform to ASTM C 144 except that no more than 10 percent shall pass the No. 100 sieve, or to G-2 except that all material which will not pass the No. 16 sieve shall be discarded.

Job-proportioned grouts shall have a maximum ratio of water to cement of 0.5. The fine aggregate shall be added in as great a quantity as will still provide adequate flowability. Admixtures, if used, shall reduce bleeding and cause a slight expansion of the grout before hardening. Admixtures shall be added in the quantity recommended by the manufacturer. 5

Premixed grout shall be Five Star grout, U.S. Grout Corporation, New Greenwich, Connecticut; Embeco 713 grout, Master Builders, Cleveland, Ohio; or equal. Premixed grout shall not contain oxidizing catalysts. Premixed grout shall have water added in the quantity recommended by the manufacturer for a flowable or pourable consistency.

2.6 Dry-Pack Mortar

Dry-pack mortar shall be a job-proportioned mixture of portland cement, fine aggregate, and water.

All materials for dry-pack mortar shall conform to G-2 except as modified below. Cement shall be type I, II, or III. Fine aggregate shall conform to ASTM C 144 except that no more than 10 percent shall pass the No. 100 sieve, or to G-2 except that all material that will not pass the No. 16 sieve shall be discarded.

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2.0 MATERIALS (Continued)

2.6 Dry-Pack Mortar (Continued)

Dry-pack mortar shall have a ratio of fine aggregate to cement of 2.5 to 3.0 by weight. The mortar shall contain only sufficient water to result in a mixture that will stick together on being molded into a ball by a slight pressure of the hands without exuding water, but leaving the hands damp.

2.7 Epoxy Grout

Epoxy grout shall consist of an epoxy binder and ovendried fine aggregate. The epoxy shall be a two-component modified system formulated and recommended by the manufacturer for grouting of anchor bolts. The epoxy shall be suitable for bonding to wet surfaces unless holes are to be dried before grout placement. Fine aggregate shall be added to the epoxy in sufficient quantity to result in adequate flowability. Fine aggregate shall be graded standard sand for ASTM C 109 cement tests, sandblast sand, or other fine aggregate recommended by the epoxy manufacturer.

2.8 Qualification of Expansion Anchors 5

2.8.1 General

Qualification tests in accordance with the methods of Appendix A or B shall be performed prior to the initial use of each size and brand of expansion anchor. For each major project, qualification tests shall be performed on anchors installed in project-placed concrete. Anchors for use on smaller projects may be qualified on the basis of tests performed at a major project or at Singleton Materials Engineering Laboratory.

Before qualification tests are made, the results of static tension tests performed by an independent testing laboratory shall be obtained from the manufacturer. The tests shall be in accordance with ASTM E 488 and shall indicate that the requirements of section 2.8.2 will be met. The anchor capacities listed in manufacturers catalogs may be used only if it can be determined that proper embedments, concrete strength, and test methods were used. Information on the mechanical properties and applicable specification designations of the anchor materials shall also be obtained from the manufacturer.

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2.0 MATERIALS (Continued)

2.8.2 Requirements

A specific brand and size of expansion anchor to be qualified for use shall have an average ultimate tensile capacity as determined by Appendix A or B equal to or exceeding the following:

Minimum Ultimate Tensile Capacities (Kips)

Anchor Type	Size								
	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
SPD	2.0	2.9	4.3	6.5	8.8	12.4	14.9	-	-
SSD	2.4	3.5	5.1	7.8	10.5	14.9	17.8	-	-
WB	2.4	-	3.6	8.4	11.0	16.8	-	25.2	32.8

If the average ultimate tensile capacity for a size and brand of anchor fails to meet the requirement, but the average of the two larger ultimate tensile capacities does meet the requirement, a retest using new anchors may be performed.

An anchor shall be disqualified if it fails to meet the ultimate tensile capacity requirement, if it is difficult to install, if installation results in damage to the concrete or anchor, or for any other reason which significantly affects production or inservice performance. 5

2.8.3 Reports

A complete report of all expansion anchor qualification tests shall be made. The report shall include the individual test reports detailed in Appendices A and B. One copy of the report shall be sent to the design representative of section 1.3 and four copies to the construction representative as soon as the report is completed.

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3.0 INSTALLATION

3.1 General

Unless otherwise called for, anchors shall be installed only in concrete with a compressive strength of at least 3000 psi and shall not be installed in concrete block or masonry mortar. Expansion anchors shall be installed through topping or cladding only if expansion shell anchors are not subjected to shear loading and are completely embedded in structural concrete and if, for wedge bolt anchors, the topping or cladding thickness is considered to be a portion of the total attachment thickness. When grouted anchors are installed through topping or cladding, the required embedment shall be from the face of structural concrete. The holes drilled for all types of anchors shall be carefully cleaned of all dust and debris before installation of the anchor. The anchor type installed shall be that designated on the drawings or the equivalent permitted by section 3.7. The anchor designation EA on the drawings indicates that reduced allowable loads were used and that any SSD, SPD, or WB anchor of the indicated size which conforms to sections 2.1 or 2.2 may be installed.

3.2 Expansion Shell Anchors

Expansion shell anchors shall be installed according to manufacturer's instructions. The holes for nondrilling expansion shell anchors shall be drilled with drill bits conforming to section 2.3. In no case shall the top of the installed anchor protrude from the concrete surface, nor shall it be recessed more than 1/8 inch. 5

The ASTM A 307 bolt installed in an expansion shell anchor shall be of such length that it will extend at least one nominal bolt diamter into the anchor after tightening. The bolt shall be tightened not less than 1/8 turn or more than 1/4 turn after the nut, washer, attachment, and concrete have come into intimate contact.

3.3 Wedge Bolt Anchors

Wedge bolt anchors shall be installed in holes with a minimum depth equal to the bolt length minus the thickness of the attachment. The maximum hole depth shall not exceed 2/3 of the thickness of the concrete member in which the anchor is being installed. The drill bits shall conform to section 2.3.

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3.0 INSTALLATION (Continued)

3.3 Wedge Bolt Anchors (Continued)

Unless otherwise called for, wedge bolt anchors shall not be installed through attachments with thicknesses at the point of anchorage greater than the following:

Diameter (in.)	1/4	3/8	1/2	5/8	3/4	1	1-1/4
Thickness (in.)							
Regular	1	7/8	1-1/2	7/8	1-3/4	1	1-3/4
Long	-	2-3/8	3	3-3/8	3-1/4	4	-

(Note: The maximum attachment thickness does not increase uniformly with anchor diameter due to non-uniform changes in embedment and anchor length).

Long wedge bolt anchors may be used for any anchorage where a regular anchor would be acceptable provided the maximum hole depth is not exceeded. Where the attachment thickness is greater than the maximum allowed for regular wedge bolts, long wedge bolt anchors shall be installed after being identified for inspection either by painting the exposed end a bright color or by stamping the bolt length or a code for the bolt length into the exposed end of the bolt.

Before insertion in the hole, and with the washer in place, the nut shall be screwed onto the bolt until the end of the bolt is approximately 3/4 of the way through the nut. The assembled wedge bolt shall then be inserted in the hole through the attachment and hammered down until the nut, washer, and attachment are in intimate contact. The anchor shall be tightened to a minimum of the following torque or the installation torque determined by Appendix B, whichever is greater. 5

Bolt Diameter (in.)	1/4	3/8	1/2	5/8	3/4	1	1-1/4
Torque (ft.-lbs.)	5	15	40	70	120	240	400

Torque shall be read while the nut is in a tightening motion.

After tightening wedge bolt anchors, the projection of the anchors above the attachment at the point of anchorage shall not exceed the following:

Bolt Diameter (in.)	1/4	3/8	1/2	5/8	3/4	1	1-1/4
Maximum Projection (in.)	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2

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3.0 INSTALLATION (Continued)

3.4 Grouted Anchors

Grouted anchors shall be installed in drilled holes which have a diameter between two and three times the nominal bolt diameter. The bolt shall be embedded to the depth called for but not less than 8 nominal bolt diameters. Hole sides require a small visual roughness. If none is apparent, as may occur with core drilling, a chisel or equivalent shall be used to make two or more shallow grooves on opposite sides in approximately the bottom half of the hole. Holes for epoxy grouted anchors shall be dry unless the epoxy manufacturer specifically permits grout placement into damp holes. Holes for epoxy grouted anchors shall be primed with a coat of neat epoxy and the epoxy grout shall be placed while the prime coat is still tacky. 5

Unless specifically called for, grouted anchors may be set using either portland cement-based grout, dry-pack mortar, or epoxy grout conforming to section 2.0. (Where the EN DES organization responsible for the design of equipment or fixtures considers fire hazard significant or expects operating temperatures greater than 120° F, the drawings will specify that epoxy grout shall not be used.) Epoxy may be ignited by welding of metal in contact with the epoxy. 5

Where grout is used to set the anchor and the grout will not flow from the hole, the hole shall be filled approximately half full of grout and the bolt inserted by twisting and working in and out to ensure elimination of all voids. The remainder of the hole shall then be filled with grout, the bolt shall be fixed in position, and the grout shall then be cured.

Where grout will flow from the hole, the hole and anchor shall be fitted with a cover plate of wood or other material through which the grout can be pressure injected. For vertical or upward sloping holes, a small air vent pipe shall be placed to the highest elevation in the hole and grout injected through a port in the cover plate. For horizontal or downward sloping holes, an air vent shall be placed through the cover plate at the highest elevation in the hole and grout shall be injected through a pipe to the lowest elevation of the hole. When grout flows from the vent, both the port and the vent shall be positively closed off. The cover plate shall be coated with a bond-preventing material on the grout side and shall be removed after the grout has cured. 5

Where dry-pack mortar is used to set the anchor, the bolt shall rest against the bottom of the hole or if the hole was drilled too deep, mortar shall be placed in the hole and thoroughly compacted with the head of the bolt until the desired bolt 5

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3.0 INSTALLATION (Continued)

3.4 Grouted Anchors (Continued)

embedment or projection is achieved. Mortar shall then be placed uniformly around the bolt and thoroughly compacted in layers which have a compacted thickness of about 3/8 inch. The mortar shall be compacted by striking with a hammer a steel pipe placed around the bolt or a hardwood rod. If a pipe is used, it shall be of such diameter that it can be shifted laterally to obtain compaction over the entire mortar surface. More than one size of pipe may be required. If a hardwood rod is used, it shall have a diameter such that the entire grout surface can be compacted.

Anchors using portland cement grout or dry-pack mortar may be placed in service in 7 days and 3 days, respectively, provided that the exposed surface has been protected from drying and that temperatures of the concrete have been maintained above 50° F. Anchors using epoxy grout may be placed in service when final cure is achieved. Accelerated curing according to manufacturer's instructions is permissible. 5

Unless otherwise called for, grouted anchors 5/8 inch or greater in diameter shall be tightened to that tightness attained with a few impacts of an impact wrench or the full effort of a man with an ordinary spud wrench. Smaller anchors shall be tightened 1/4 turn after the nut, washer, attachment, and concrete have come into intimate contact.

3.5 Location (Anchor centerline)

3.5.1 General

Unless otherwise called for, the restrictions of sections 3.5.2 and 3.5.3 shall be applied to the location of anchors. (These requirements are given in the Design Standard and should be used by the CONST project for anchors installed for construction purposes.) 5

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3.0 INSTALLATION (Continued)

3.5.2 Expansion Anchors

Expansion shell anchors shall not be located closer to a free concrete edge than 6 nominal bolt diameters, or 10 bolt diameters if the anchor is loaded in shear toward the edge. Wedge bolt anchors shall not be located closer to a free concrete edge than 10 nominal bolt diameters regardless of loading. Minimum spacing between expansion shell anchors and wedge bolt anchors shall be as given in the following table:

	Minimum Spacing (in.)								
Size (in.)	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1	1-1/4
SPD and SSD	2-1/2	3-1/2	4	5	5-1/2	6-1/2	7	-	-
WB	3	-	4	5	7	8-1/2	-	9-1/2	10-1/2

3.5.3 Grouted Anchors

Grouted anchors shall not be located closer to a free concrete edge than 6 nominal bolt diameters, or 1.25 times the minimum embedment if the anchor is loaded in shear toward the edge. Grouted anchors shall not be located closer than 16 nominal bolt diameters from an adjacent bolt. Grouted anchors used as replacements for expansion anchors are not required to meet these location requirements.

3.6 Equivalent Anchors

Unless otherwise called for, anchor substitution may be made if the load capacity of the substitute anchor equals or exceeds the load capacity of the called for anchor in both tension loading alone and shear loading alone. The following working load capacities in tension alone and shear alone as provided by the Design Standard are to be used to determine acceptable substitute anchors.

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3.0 INSTALLATION (Continued)

3.6 Equivalent Anchors (Continued)

Allowable Working Loads (Kips)

Anchor Type	Loading	Size								
		1/4	5/16	3/8	1/2	5/8	3/4	7/8	1	1-1/4
SSD	Tension	0.54	0.78	1.14	1.74	2.34	3.30	3.96	-	-
	Shear	0.30	0.50	0.80	1.40	2.25	3.30	4.50	-	-
SPD	Tension	0.45	0.65	0.95	1.45	1.95	2.75	3.30	-	-
	Shear	0.30	0.50	0.80	1.40	2.25	3.30	4.50	-	-
WB	Tension	0.60	-	0.90	2.10	2.75	4.20	-	6.30	8.20
	Shear	0.50	-	1.20	2.00	3.00	4.15	-	6.70	9.75
Grouted (A 307 or A 36)	Tension	0.58	0.94	1.42	2.58	4.10	6.06	8.39	11.00	17.6
	Shear	0.39	0.63	0.95	1.72	2.73	4.04	5.60	7.30	11.70

(Note: The above table shall not be used for design. Design shall be in accordance with the Design Standard.)

3.7 Reinforcing Steel

Unless otherwise called for, no reinforcing steel shall be cut to install anchors without specific approval of the design representative in section 1.3.

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TVA 10635 (EN DES-5-77)

4.0 TESTS

Testing is required on expansion anchors designated as SSD, SPD, or WB for all equipment in nuclear plant category I structures. Testing is not required on anchors designated EA, expansion anchors supporting a 1-hole pipe strap for an individual conduit less than 4 inches in diameter, or other anchors where EN DES documents state that testing is not required. Tests shall be made as soon after installation of a lot as is practicable. Anchors which fail to meet the requirements shall be replaced in accordance with section 5.0. | 5 | 5

4.1 Selection

Anchors to be tested shall be randomly selected within a lot after installation of the lot. If there are anchors of more than one bolt size in a lot, the size difference shall be ignored unless some anchors are twice the size of the smallest anchors. In this case, approximately one-third of the tests shall be on the smaller size(s) and two-thirds shall be on the larger size(s).

Number of Anchors in Lot	Minimum Number to be Tested
Less than 5	1
5 to 15	2
16 to 60	3
More than 60	5 percent

4.2 Expansion Shell Anchors (SPD and SSD) | 5

4.2.1 Equipment

A calibrated center-hole hydraulic jack equipped with a gage whose least division represents no more than a 100-pound load on the anchor shall be used to load the anchors. The load shall be transferred from the jack to the anchor with a high-strength threaded rod with a minimum yield strength of 50,000 psi. The reaction from the jack shall be delivered to the concrete surface through a device which bears no closer than 8 inches from the anchor centerline and which is adjustable to ensure that the anchor is loaded axially.

The load-pressure relationship for the jack shall be verified before initial use and at 1-year intervals thereafter. The gages used with the jack shall be calibrated every 2 months or every 100 anchor tests, whichever occurs first; but calibration is not required more frequently than every 2 weeks during continuing anchor installations. The jack and/or gage shall be recalibrated any time there is a question as to jack operation or gage accuracy. | 5

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POOR ORIGINAL

4.0 TESTS (Continued)

4.2.2 Procedure

The high-strength threaded rod shall be inserted in the anchor or coupled to the bolt of the anchor. The hydraulic jack and bearing device shall be centered over the threaded rod and adjusted until the threaded rod is axially concentric with the center hole of the jack. A nut and bearing plate shall be put on the threaded rod and snugged against the ram of the jack. Load shall be applied without shock and as uniformly as practicable to the proof load as follows:

Bolt size (in.)	1/4	5/16	3/8	1/2	5/8	3/4	7/8
Proof load (lbs.)	900	1700	2200	4000	5400	7600	8300

If an anchor slips, it shall be reset and retested or it shall be replaced and the new anchor tested (see section 5.0). If an anchor slips in being retested, it shall be replaced. If an anchor slips, an adjacent anchor shall also be tested. (The loads are not intended for concrete strengths less than 3000 psi, or for concrete masonry, or for anchors set closer than 6 bolt diameters to an edge. Failures at or below proof load should be by slipping of the anchor within the hole.)

4.3 Wedge Bolt Anchors (WB)

4.3.1 Equipment

Calibrated torque wrenches with capacities approximately 25 percent greater than the installation torque of the largest bolt to be tightened with each wrench shall be used to verify that appropriate installation torque was applied to wedge bolt anchors. Wrenches shall be calibrated every 6 months or any time there is a question as to wrench accuracy.

4.3.2 Procedure

Torque shall be applied to the anchor without shock and increased as uniformly as possible to the torque determined in section 3.3. If the nut on an anchor is turned by this torque, two anchors in addition to the number required by section 4.1 shall be tested. If the nut on any subsequent anchor turns, all anchors in the lot shall be retightened and a new test sample selected in accordance with section 4.1. If the nut on any of these anchors turns when torqued, all anchors in the lot shall be tested. Anchors on which the nut turns when torqued after retightening shall be replaced and the new anchor tested.

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6.0 RECORDS AND REPORTS

6.1 General

Records shall be made of all anchor testing and replacements and kept in the plant records storage. For a lot in which an anchor failed when tested, one copy of the complete report as specified in section 6.2 shall be transmitted to the appropriate EN DES Design Project Manager upon the completion of testing and corrective action on that lot. For lots in which no anchors failed when tested, a memorandum shall be transmitted monthly while anchor installations are being made, listing the project feature, the test report number, and the lot identification on all such lots.

6.2 Report Content

Reports shall include the project feature; the test report number; identification of the anchor lot; the type and brand of anchor used; the total number of each size anchor in the lot; the number of each size anchor tested; the location, size, and slip load of each expansion shell anchor which exhibited slip, with the corrective action taken; the location and size of wedge bolt anchors that failed to meet torque or projection requirements; and information on jack or torque wrench calibration as called for in section 4.2 or 4.3. | 5 | 5

The boundaries or identification of all anchor lots, the test report number for each anchor lot, and the identification of the specific anchors tested in each lot shall be recorded as called for in section 1.2. Test information shall be transmitted to EN DES as required in section 6.1. Required drawings shall not be general equipment layouts, but shall show specific anchor locations, except if anchors are shown only on drawings of individual equipment, such drawings or portions of them may be used, but they shall be referenced to their layout drawing and that drawing shall be marked to show the boundaries of anchor lots.

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5.0 REPLACEMENT

5.1 General

5.1.1 Expansion Shell Anchor

An expansion shell anchor which requires replacement at the same location shall be replaced by the next larger size expansion shell anchor or by a grouted anchor of the same or larger size. A grouted replacement anchor does not require testing. 5

5.1.2 Wedge Bolt Anchors

A wedge bolt anchor which requires replacement at the same location shall be replaced by a wedge bolt anchor of the same or larger size or a grouted anchor of the size required by section 3.7. 5

5.2 Removing Anchors

5.2.1 Expansion Shell Anchor

Expansion shell anchors which slip under test loading may be removed by the test equipment except that the hydraulic jack shall bear directly against the concrete around the anchor, or by an alternate method which prevents spalling of the concrete surface. If the anchor is not to be replaced by another in the same location, in lieu of removing the anchor, the anchor shell may be dry packed or grouted full. 5

5.2.2 Wedge Bolt Anchors

Wedge bolt anchors that have failed to meet torque, projection, or attachment thickness requirements may be removed by jacking from the hole with a center hole jack which bears directly against the concrete adjacent to the anchor or by an alternate method which prevents spalling of the concrete surface. If the anchor is not to be replaced by another at the same location, the anchor may be cut off as close to the surface as possible, driven into the hole, and the hole dry packed or grouted full. 5

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Appendix A

QUALIFICATION TESTS FOR EXPANSION SHELL ANCHORS

A.1 SCOPE

This method of test shall be used to determine the ultimate tensile capacity of expansion shell anchors (type SSD and SPD). Tests shall be made on each brand, type, and size of anchor that is to be used.

A.2 APPARATUS

The apparatus shall consist of that required by section 4.2.1.

A.3 PROCEDURE

Place a minimum 8-inch-thick concrete slab with 3/4-inch-maximum size aggregate in accordance with G-2. The average compressive strength of two field-cured standard cylinders shall be between 3000 and 4000 psi at the time of anchor testing.

Install three anchors of each size in accordance with section 3.2. The minimum edge distance shall be 6 nominal bolt diameters and the minimum anchor spacing shall be 12 nominal bolt diameters. The drill bit diameters shall be those required by section 2.3. Thread the high-strength rod into the anchor. Center the jack and bearing device over the high-strength rod and adjust the location until the rod is axially concentric with the center hole of the jack. Place the bearing plate on top of the jack and snug it down against the ram of the jack with the nut. Load the anchor uniformly and without shock until the anchor fails. 5

A.4 REPORT

The report shall include the anchor brand, type, and size, the ultimate tensile capacity of each anchor, the average ultimate tensile capacity of each 3-anchor set, the mode of failure of each anchor, and the concrete class and compressive strength at the time of anchor testing.

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Appendix B

QUALIFICATION TESTS FOR WEDGE BOLT ANCHORS

B.1 SCOPE

This method of test shall be used to determine the ultimate tensile capacity of wedge bolt anchors (type WB), to determine if the installation torque given in section 3.3 will result in the required preload, and to determine the required installation torque if the torque given in section 3.3 does not result in the required preload. Tests shall be made on each branch, type, and size of anchor that is to be used.

B.2 APPARATUS

1. Calibrated center-hole hydraulic jack equipped with a gage whose least division represents no more than a 100-pound load.

2. High-strength coupling nut, a high-strength threaded rod (rod size and yield strength shall result in a yielding force in the rod at least 20 percent greater than the required ultimate tensile capacity of the anchor), and a bearing plate and nut for attachment to the jack. 5

3. Bearing device for transferring the jack reaction to the concrete surface at least 15 inches from the anchor centerline and which is adjustable to ensure that the anchor is loaded axially.

4. Calibrated torque wrench.

B.3 PROCEDURE

Place a minimum 15-inch-thick concrete slab with 3/4-inch-maximum size aggregate in accordance with G-2. The average compressive strength of two field-cured standard cylinders shall be between 3000 and 4000 psi at the time of anchor testing.

Install three regular length wedge bolt anchors of each size in accordance with section 3.3. The minimum edge distance shall be 10 nominal bolt diameters and the minimum anchor spacing shall be 12 nominal bolt diameters. The drill bit diameters shall be those required by section 2.3 for qualification tests. Install each anchor through a steel plate or plates which have a total thickness equal to the maximum attachment thickness given in section 3.3. The bearing plates shall be small enough to permit the bearing device to bear on the concrete. Before tightening and without changing the bolt projection, remove the plate and install a thinner

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B.3 PROCEDURE (Continued)

plate, or if multiple plates were used, remove one or more of the plates, so that sufficient threads are available for tightening and coupling to the loading device. Tighten the anchor to the torque given in section 3.3.

Couple the high-strength rod to the anchor. Center the jack and bearing device over the high-strength rod and adjust the location until the rod is axially concentric with the center hole of the jack. Place the bearing plate on top of the jack and snug it down against the ram of the jack with the nut.

Load the anchor uniformly and without shock until the washer can be moved with the fingers (lift-off). If the load at lift-off is greater than 1.5 times the working load tension of section 3.7, the installation torques given in section 3.3 are acceptable. If the lift-off load is less than 1.5 times the working load, loosen the nut and then retighten to a torque approximately 10 to 20 percent greater than previously used. Reload to lift-off. Continue lift-off tests until a torque which produces the required tension is achieved. The average torque for the three anchors of each size tested shall be the installation torque. 5

After completion of lift-off tests, load the anchor until the anchor fails.

B.4 REPORT

The report shall include the anchor brand and size, all data relating to determination of installation torques, the ultimate tensile capacity for each anchor, the average ultimate tensile capacity of each 3-anchor set, the mode of failure of each anchor, and the concrete class and compressive strength at the time of anchor testing.

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SEQUOYAH NUCLEAR PLANT - RESPONSE TO NRC-OIE BULLETIN 79-02

Action Item 1 - Flexible Plates

All anchor plates were assumed rigid in calculating anchor loads for Sequoyah Nuclear Plant. The effects of rigid plate assumptions are discussed in the TVA Generic Response. As indicated in that response, rigid plate assumptions will underestimate anchor loads under service or normal operating load conditions, but will not effect system capacity if the safety factor utilized in the design of the anchors is equal or greater than that used in the design of the attachment or attachment plate by a sufficient margin to compensate for any displacement limitations of the anchors. At most the effect of this underestimation would be an increase in system deflections by 20 to 25 percent under service load conditions. This should not be significant considering the relative inaccuracies involved in determining system deflections.

Action Item 2 - Expansion Anchor Factor of Safety

The allowable loads for concrete bolt anchors contained in table 1 were used by TVA engineers prior to the issuance of TVA's Civil Design Standard DS-C6.1 for Concrete Anchorages in September 1975 (see the Generic Response). Table 1 indicates a factor of safety of 4 for working loads based on manufacturers' data. For extreme loading conditions load allowables were increased by 60 percent. Only self-drilling type expansion anchors were used at Sequoyah prior to 1976. As indicated in the Generic Response safety factors of 4 for wedge bolts and 4.5 for shell-type anchors based on minimum qualification test requirements were used from 1976, to the present for service load conditions.

Attached figures 1-4 were used for combined loads prior to the issuance of DS-C6.1. Thereafter, a linear relationship was used for combining loads. (See Section 2.3.2.2 of DS-C6.1.)

Major piping systems were designed by Basic Engineers, Bergen-Paterson, and EDS Nuclear. For design of anchorage Basic Engineers used a minimum factor of safety of 5., EDS Nuclear used a minimum factor of safety of 6 prior to the issuance of DS-C6.1 in September 1975. Afterwards, EDS used DS-C6.1 to design anchorages. Bergen-Paterson has used DS-C6.1 to design anchorages. The factors of safety utilized in DS-C6.1 are discussed in the preceeding paragraphs. A few small piping systems were designed by TVA. On these systems, a minimum factor of safety of 4 for service load conditions was used. All other safety system anchorages were designed by TVA engineers using the above safety factors.

Action Item 3 - Cyclic Loads (Seismic and High Frequency) 55C168

No special design requirements were applied prior to DS-C6.1 for seismic or for high frequency vibrating loads. The high amplitude, low frequency, and limited cycles associated with seismic loading do not warrant special consideration. It is assumed that support problems generated by high frequency system vibrations will be quickly identified under operating conditions and that subsequent corrections of the situation are more

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critically related to reducing system vibrations than to corrections of anchorages. Wherever system vibrations persist and create problems with shell-type anchors, those anchors can be replaced with deeper setting wedge-type anchors. (See Generic Response to action item 3 for additional discussion.)

Action Item 4 - Testing of Expansion Anchors

All expansion anchor installations at Sequoyah were subject to in-process test requirements of TVA General Construction Specification G-32 as discussed in the Generic Response to action item 4. Sequoyah QCP 1.14, "Production Lot Acceptance Tests of Expansion Type Bolt Anchors," (implements the requirements of G-32 at Sequoyah). A representative sampling of those tests results is contained in table 2. The percent of failures to the number of tests conducted was approximately 1.2 percent.

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TABLE 1

Allowable Loads for Concrete Bolt Anchors

Ultimate loads are taken from the lowest average test load obtained from manufacturers' data.

Bolt Diameter	Bolt Area (gross)	A-307 Bolts		Bolt Anchors			Remarks
		Tension	Shear	Min Units	Tension	Shear	
1/4"	0.049	690#	490#	2	500#	220#	Other types of equiva-strength may be substituted.
3/8"	0.110	1,540#	1,110#	2	1,100#	500#	Other types of equiva-strength may be substituted.
1/2"	0.196	2,740#	1,960#	2	2,000#	900#	Other types of equiva-strength may be subsitutued.
5/8"	0.307	4,300#	3,070#	3	2,900#	1,300#	Other types of equiva-strength may be subsitutued.
3/4"	0.442	6,190#	4,420#	3	4,000#	1,800#	Other types of equiva-strength may be substituted.
7/8"	0.601	8,420#	6,010#	3	5,000#	2,200#	Other types of equiva-strength may be substituted.
1"	0.785	11,000#	7,850#	3	6,100#	2,700#	Limited availability.

F.S. = 4:1 = $\frac{\text{Ult. Ld.}}{\text{Work Ld.}}$ - Using 3000# concrete

Minimum spacing

6 dia. o.c.
3 dia. edge — use 50 percent above values

9 dia. o.c.
6 dia edge — use fill values (linear interpolation)

Applies to following products:

Nail Lead Co. "Cinch Anchor"
Rawl Co. "Multi-Calks"
Star Bt. Co. "Slugin"
Phillips Co. "Redheads"
and other equivalent products

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TABLE 2

SUMMARY OF ANCHOR TEST SAMPLING

Discipline	Building	Year	Number of Anchors Represented	Tested	Failed Test	Failed Spacing Limits	Test Fail: Percent
Civil	AB	1976	23,090	6,176	30	-	0.5
	DGB	1976	648	154	0	-	0
	RB1	1977	5,901	1,508	22	-	1.5
	RB2	1977	487	155	2	-	1.3
		1979	371	156	0		0
Subtotal			30,497	8,149	54		0.7
Electrical	RB1	1977	752	104	0	20	0
	RB2	1977	82	16	0		0
		1979	3,058	632	3	21	0.5
Subtotal			3,892	752	3		0.4
Mechanical	RB1	1977	223	62	2	-	3.2
	RB2	1977	60	19	0	-	0
		1979		2,573	67		2.6
Subtotal				2,654	69		2.6
Total				11,555	126		1.1

AB - Auxiliary Building
DGB - Diesel Generator Building
RB1 - Reactor Building 1
RB2 - Reactor Building 2

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CONC BOLT ANCHOR LOADS

$\frac{5}{8}$" ϕ BOLTS

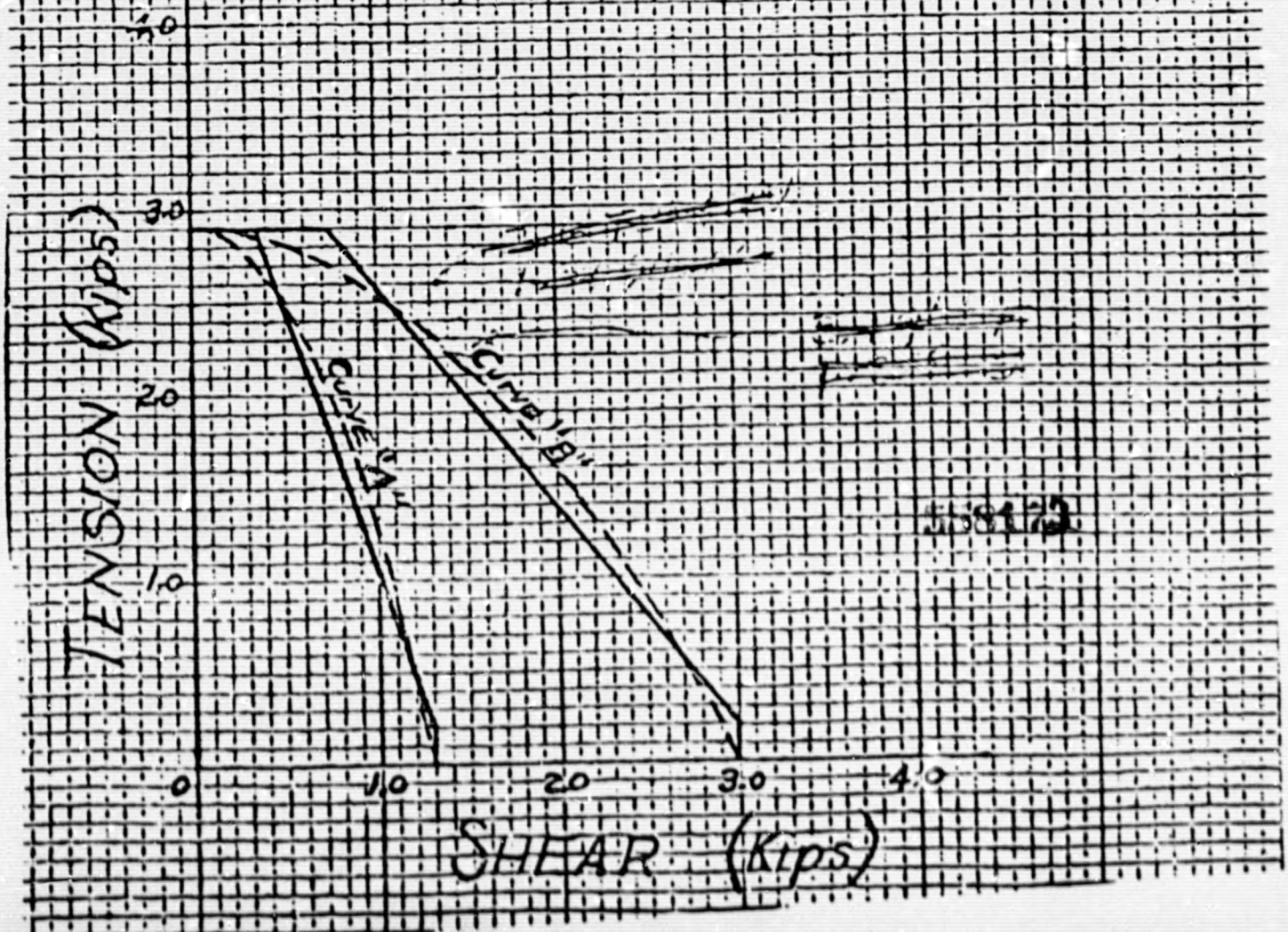
Dec. 14, 1970 Drwn R.D.H.

Conc. $f_c' = 3000$ #

CURVE "A" - Was general application without regard to anchor manufacturer.

CURVE "B" - Use on Browns Ferry for Phillips "Redhead" Anchors only for Design Basis Earthquake loads.

FIGURE 1



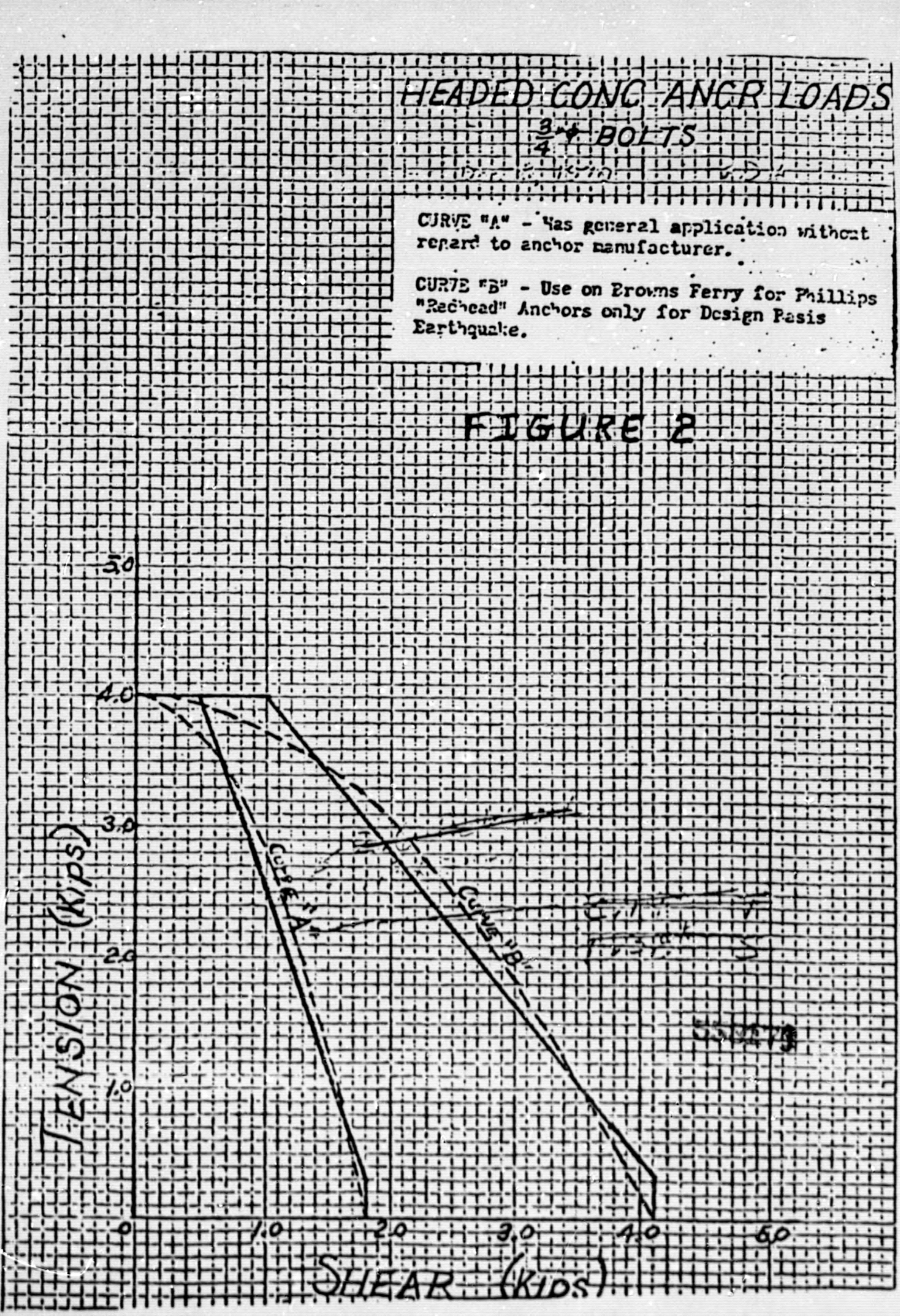
HEADED CONC ANCR LOADS

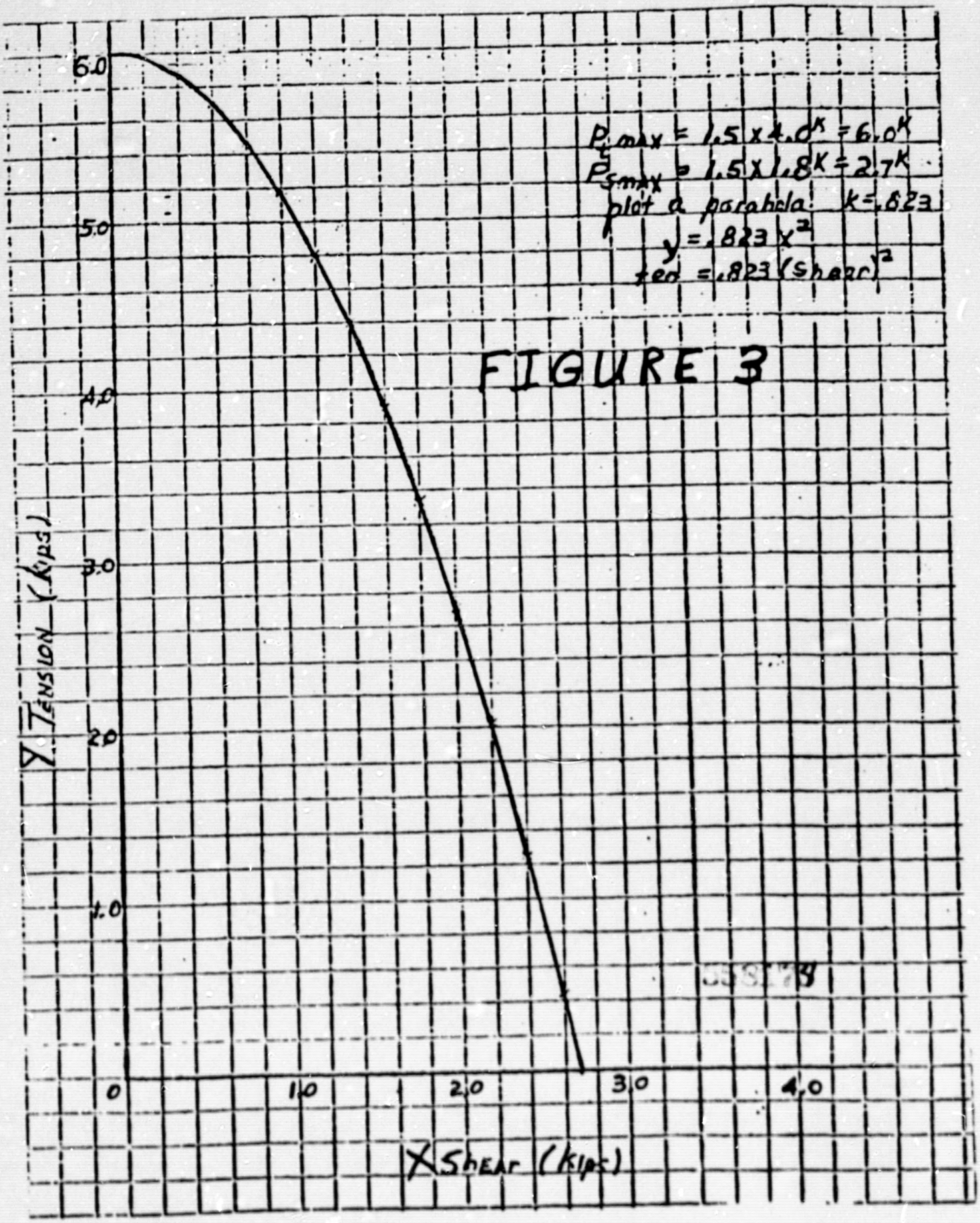
$\frac{3}{4}$" BOLTS

CURVE "A" - Has general application without regard to anchor manufacturer.

CURVE "B" - Use on Browns Ferry for Phillips "Redhead" Anchors only for Design Basis Earthquake.

FIGURE 2




$P_{t\,max} = 1.5 \times 4.0^K = 6.0^K$
$P_{s\,max} = 1.5 \times 1.8^K = 2.7^K$
plot a parabola: $k = .823$
$y = .823 x^2$
$tension = .823 (shear)^2$
FIGURE 3
Y Tension (Kips)
X Shear (Kips)
6.0
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0

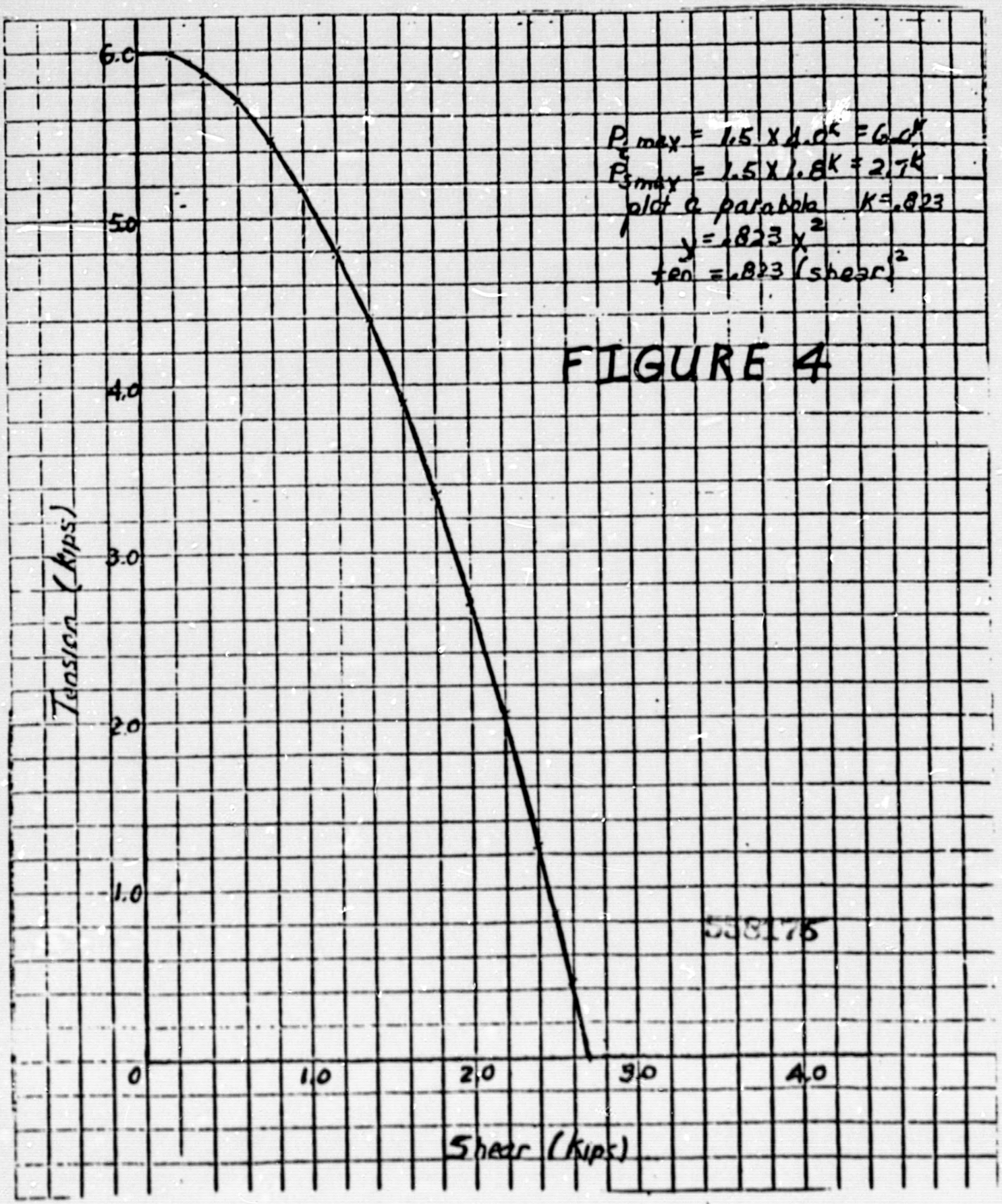


FIGURE 4

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WATTS BAR NUCLEAR PLANT - RESPONSE TO NRC-OIE BULLETIN 79-02

Action Item 1 - Flexible Plates

All anchor plates were assumed rigid in calculating anchor loads for Watts Bar Nuclear Plant. The effects of rigid plate assumptions are discussed in the TVA Generic Response. As indicated in that response, rigid plate assumptions will underestimate anchor loads under service or normal operating load conditions but will not effect system capacity if the safety factor utilized in the design of the anchors is equal or greater than that used in the design of the attachment or attachment plate by a sufficient margin to compensate for any displacement limitations of the anchors. At most the effect of this underestimation would be an increase in system deflections by 20 to 25 percent under service load conditions. This should not be significant considering the relative inaccuracies involved in determining system deflections.

Action Item 2 - Expansion Anchor Factor of Safety

The allowable loads for concrete bolt anchors contained in table 1 were used by TVA engineers prior to the issuance of TVA's Civil Design Standard DS-C6.1 for Concrete Anchorages in September 1975 (see attachment 1). Table 1 indicates a factor of safety of 4 for working loads based on manufacturers' data. For extreme loading conditions load allowables were increased by 60 percent. Only self-drilling type expansion anchors were used at Watts Bar prior to 1976. As indicated in the Generic Response safety factors of 4 for wedge bolts and 4.5 for shell-type anchors based on minimum qualification test requirements were used from 1976, to the present for service load conditions.

Attached figure 1 was used for combined loads prior to the issuance of DS-C6.1. Thereafter, a linear relationship was used for combining loads. (See Section 2.3.2.2 of DS-C6.1.)

Major piping systems were designed by Bergen-Paterson and EDS Nuclear. For design of anchorage, EDS used a minimum factor of safety of 6 prior to the issuance of DS-C6.1 in September 1975. Afterwards, EDS used DS-C6.1 to design anchorages. Bergen-Paterson has used DS-C6.1 to design anchorages. The factors of safety utilized in DS-C6.1 are discussed in the preceeding paragraphs. A few small piping systems were designed by TVA. On these systems, a minimum factor of safety of 4 for service load conditions was used. All other safety system anchorages were designed by TVA engineers using the above safety factors.

Action Item 3 - Cyclic Loads (Seismic and High Frequency)

No special design requirements were applied prior to DS-C6.1 for seismic or for high frequency vibrating loads. The high amplitude, low frequency, and limited cycles associated with seismic loading do not warrant special consideration. It is assumed that support problems generated by high frequency system vibrations will be quickly identified under operating conditions and that subsequent corrections of the situation are more

critically related to reducing system vibrations than to corrections of anchorages. Wherever system vibrations persist and create problems with shell-type anchors, those anchors can be replaced with deeper setting wedge-type anchors. (See Generic Response to action item 3 for additional discussion.)

Action Item 4 - Testing of Expansion Anchors

All expansion anchor installations at Watts Bar were subject to in-process test requirements of TVA General Construction Specification G-32 as discussed in the Generic Response to action item 4. Watts Bar QCP 1.14, "Production Lot Acceptance Tests of Expansion Type Bolt Anchors," implements the requirements of G-32 at Watts Bar. A representative sampling of those test results is contained in table 2. The percent of failure to the number of tests conducted was approximately 1.2 percent. This sampling does not include testing of defective 1/2-inch size Phillips anchors whose disposition is covered in NCR 1443R.

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TABLE 1

Allowable Loads for Concrete Bolt Anchors

Ultimate loads are taken from the lowest average test load obtained from manufacturers' data.

Bolt Diameter	Bolt Area (gross)	A-307 Bolts		Bolt Anchors			Remarks
		Tension	Shear	Min Units	Tension	Shear	
1/4"	0.049	690#	490#	2	500#	220#	Other types of equiva-strengt! may be substituted.
3/8"	0.110	1,540#	1,110#	2	1,100#	500#	Other types of equiva-strengt! may be substituted.
1/2"	0.196	2,740#	1,960#	2	2,000#	900#	Other types of equiva-strengt! may be subsitutued.
5/8"	0.307	4,300#	3,070#	3	2,900#	1,300#	Other types of equiva-strengt! may be subsitutued.
3/4"	0.442	6,190#	4,420#	3	4,000#	1,800#	Other types of equiva-strengt! may be substituted.
7/8"	0.601	8,420#	6,010#	3	5,000#	2,200#	Other types of equiva-strengt! may be substituted.
1"	0.785	11,000#	7,850#	3	6,100#	2,700#	Limited availability.

F.S. = 4:1 = $\frac{\text{Ult. Ld.}}{\text{Work Ld.}}$ - Using 3000# concrete

Minimum spacing

6 dia. o.c.
3 dia. edge — use 50 percent above values

9 dia. o.c.
6 dia edge — use fill values (linear interpolation)

Applies to following products:

Nall Lead Co. "Cinch Anchor"
Rawl Co. "Multi-Calks"
Star Bt. Co. "Slugin"
Phillips Co. "Redheads"
and other equivalent products

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TABLE 2

Summary of Anchor Test Sampling

Building	Year	Number of Anchors Represented	Tested	Failed Test	Test Failure Percent
AB*	1977	4,167	375	4	1.06
RB	1977	522	52	0	-
DGB	1977	384	67	3	4.5
AB*	1978	18,068	1,726	23	1.3
RB	1978	8,003	658	8	1.2
DGB	1978	4,051	415	2	0.5
Totals			3,293	40	1.2

*Includes additional equipment building.

AB = Auxiliary building
DGB = Diesel Generator Building
RB = Reactor Building

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FIGURE 1

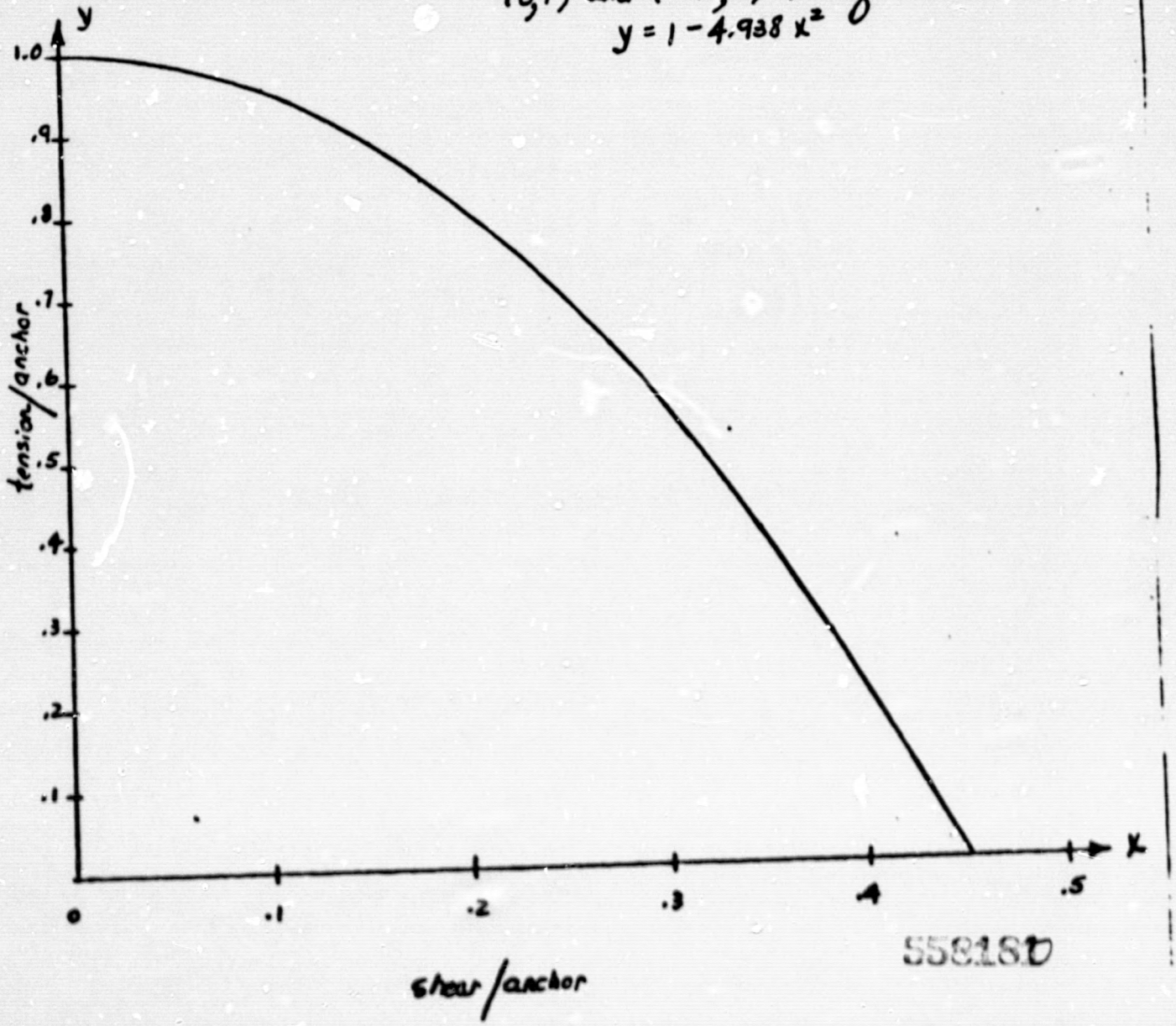
COMPUTED BY KHG DATE 4-11-75 CHECKED BY DATE

From table 3 "Allowable Loads for Concrete Bolt Anchors" it can be shown that for all anchor diameters maximum allowable for shear only is approximately 45% of that allowed for tension only. Furthermore the above ratio will remain constant if the minimum spacing for full allowables is not met since both shear and tension allowables will be reduced by the same percentage.

Then a graph can be drawn relating allowable forces when both tension and shear exist, assuming allowable for tension only equal 1^k, shear only 0.45^k. If larger allowables exist, the graph will be valid if the existing forces per anchor are divided by the respective allowables.

The graph below was obtained by drawing a parabola through point (0,1) and (0.45, 0). The equation is

$$y = 1 - 4.938\,x^2$$



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BELLEFONTE NUCLEAR PLANT - RESPONSE TO NRC-OIE BULLETIN 79-02

Action Item 1 - Flexible Plates

All anchor plates for cable tray supports, heating and ventilation ducts, supports, and piping supports designed by TVA were assumed rigid in calculating anchor loads for Bellefonte Nuclear Plant. The effects of rigid plate assumptions are discussed in the TVA Generic Response. As indicated in that response, rigid plate assumptions will underestimate anchor loads under service or normal operating load conditions but will not effect system capacity if the safety factor utilized in the design of the anchors is equal or greater than that used in the design of the attachment or attachment plate by a sufficient margin to compensate for any displacement limitations of the anchors. At most the effect of this underestimation would be an increase in system deflections by 20 to 25 percent under service load conditions. This should not be significant considering the relative inaccuracies involved in determining system deflections.

Plate flexibility was considered by ITT Grinnel in their design of anchors for piping supports.

Action Item 2 - Expansion Anchor Factor of Safety

Prior to issue of TVA's Civil Design Standard DS-C6.1 allowable loads for expansion bolt anchors were obtained from manufacturers' literature. The allowable loadings were based on a factor of safety of 4 for service load conditions. For extreme loading conditions load allowables were increased by 60 percent. As indicated in the Generic Response safety factors of 4 for wedge bolts and 4.5 for shell-type anchors based on minimum qualification test requirements were used from 1976, to the present for service load conditions.

Major piping systems were designed by ITT Grinnell. ITT Grinnell used manufacturers' allowable loads based on a factor of safety of 4 for service load conditions.

Action Item 3 - Cyclic Loads (Seismic and High Frequency)

No special design requirements were applied prior to DS-C6.1 for seismic or for high frequency vibrating loads. The high amplitude, low frequency, and limited cycles associated with seismic loading do not warrant special consideration. It is assumed that support problems generated by high frequency system vibrations will be quickly identified under operating conditions and that subsequent corrections of the situation are more critically related to reducing system vibrations than to corrections of anchorages. Wherever system vibrations persist and create problems with shell-type anchors, those anchors can be replaced with deeper setting wedge-type anchors. (See Generic Response to action item 3 for additional discussion.)

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Action Item 4 - Testing of Expansion Anchors

All expansion anchor installations at Bellefonte were subject to inprocess test requirements of TVA General Construction Specification G-32 as discussed in the Generic Response to action item 4. Bellefonte Quality Control Procedure BNP-QCP 2.8 and Field Construction Procedure BNP-FCR 2.8.1 implement the requirements of G-32 at the construction site. A representative sampling of those test results is contained in table 1. The percent of failures to the number of tests conducted was approximately 4.26 percent.

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TABLE I

SUMMARY OF ANCHOR TEST SAMPLING

Date	Number of Anchors Represented	Tested	Failed Test	Test Failure Percent
10/76 - 12/77	5,531	1,027	59	5.74
1/78 - 12/78	12,271	2,134	135	6.32
1/79 - 3/79	5,576	1,032	14	1.36
4/79 - 5/79	1,416	370	6	1.62
5/79 - 6/79	2,640	525	3	0.6
Total	27,434	5,088	217	4.26

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HARTSVILLE AND PHIPPS BEND NUCLEAR PLANTS - RESPONSE TO NRC-OIE BULLETIN 79-02

Balance of Plant (BOP)

Expansion anchorages for BOP safety-related structures will be designed using TVA Design Standard DS-C6.1. Installation, testing, and inspection of anchorages by the construction project will be in accordance with TVA General Construction Specification G-32. The action items identified in OIE Bulletin are adequately discussed in the TVA Generic Response for the BOP structures at Hartsville and Phipps Bend.

STRIDE Structures

Action Item 1 - Flexible Plates

Plate flexibility was considered in the anchorage design by C. F. Braun and Company.

Action Item 2 - Expansion Anchor Factor of Safety

The minimum factor of safety utilized in the STRIDE design for wedge type expansion anchors was 4.8.

Action Item 3 - Cyclic Loads (Seismic and High Frequency)

Seismic loads were not considered to be sustained vibratory loads. Accordingly, the minimum factor of safety of 4.8 also applies to seismic loads. In addition expansion anchors are not to be used where significant amounts of vibratory loads are present.

Action Item 4 - In-Process Testing of Expansion Anchors

Installation, testing, and inspection of anchorages will be in accordance with TVA General Construction Specification G-32 (see item 4 of the Generic Response).

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YELLOW CREEK NUCLEAR PLANT - RESPONSE TO NRC-OIE BULLETIN 79-02

Yellow Creek Nuclear Plant expansion anchorages will be designed using TVA Design Standard DS-C6.1. Installation, testing, and inspection of anchorages by the construction project will be accomplished in accordance with TVA General Construction Specification G-32. The actions items identified in OIE Bulletin 79-02 are adequately discussed for Yellow Creek in the TVA Generic Response.

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