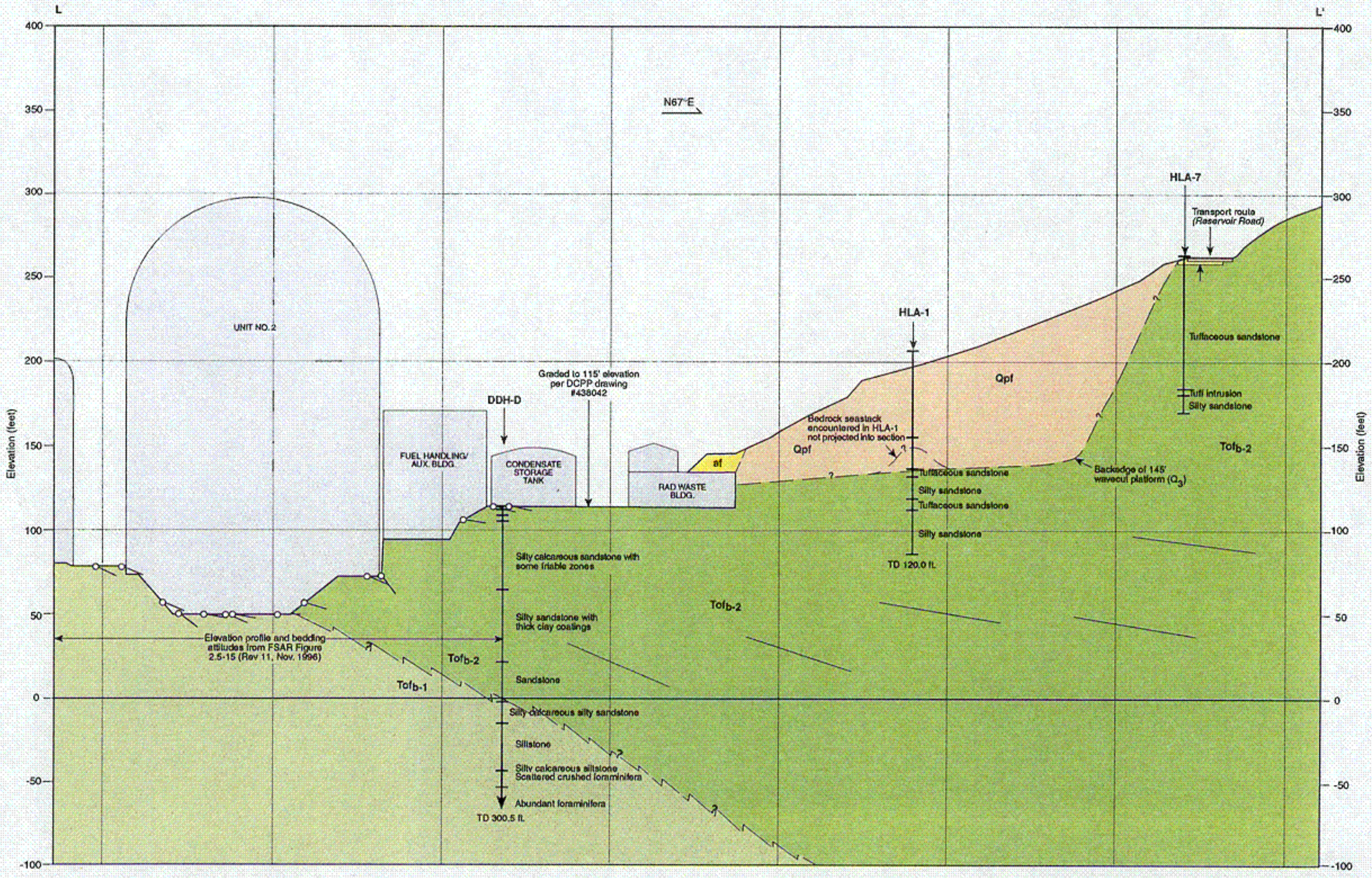
Note: Detailed topography and fill near facilities not shown on Figure 2.6-7



Notes

1. Location of cross section shown on Figures 2.6-7. Nearby borings are projected to cross section.
2. See Figure 2.6-9 for explanation of geologic units.
3. Horizontal scale = vertical scale.

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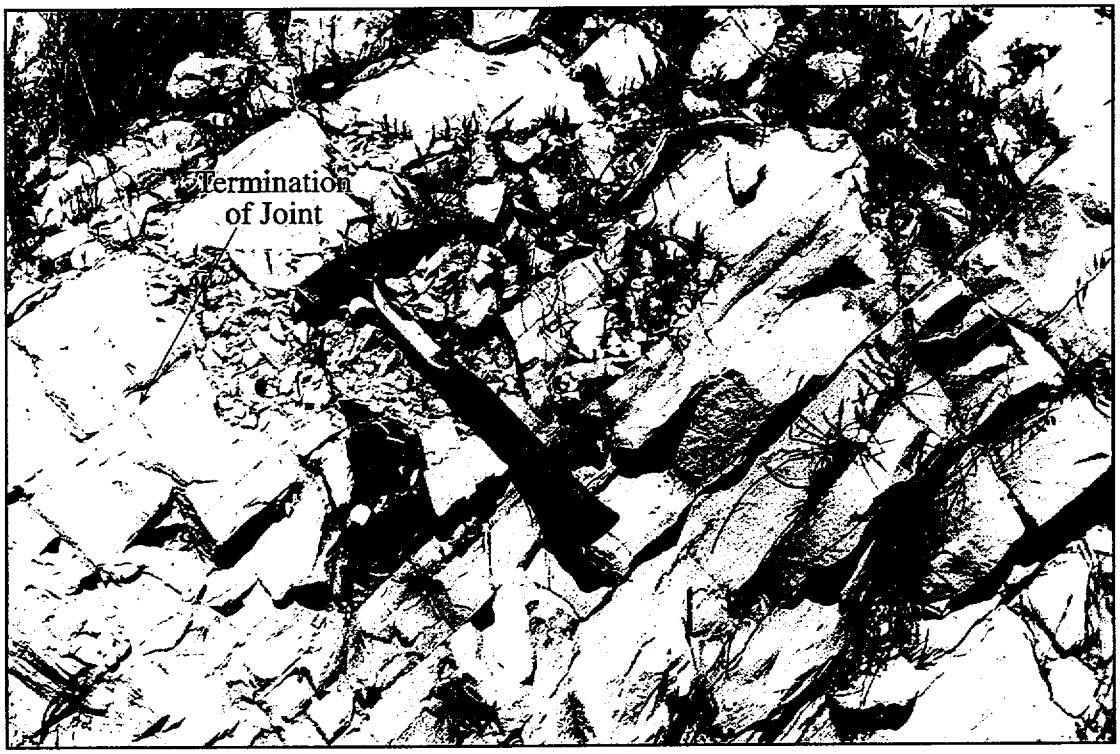
FIGURE 2.6-19 CROSS SECTION L-L'

C01



Dolomite (Tof_{b-1}) exposed along Reservoir Road above parking lot 8. Exposure illustrates well-bedded strata. Some joints terminate at bedding planes (e.g., in left middle). Gray is unweathered, and brown is weathered rock. Photo roll JLB-4.

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FIGURE 2.6-20 CLOSE-UP VIEW OF WELL-BEDDED DOLOMITE ALONG RESERVOIR ROAD

Outcrop of thick to massive bedded, weathered sandstone of unit (Tof_{b-2}), directly west of the ISFSI. Photo roll JLB OLD-2.

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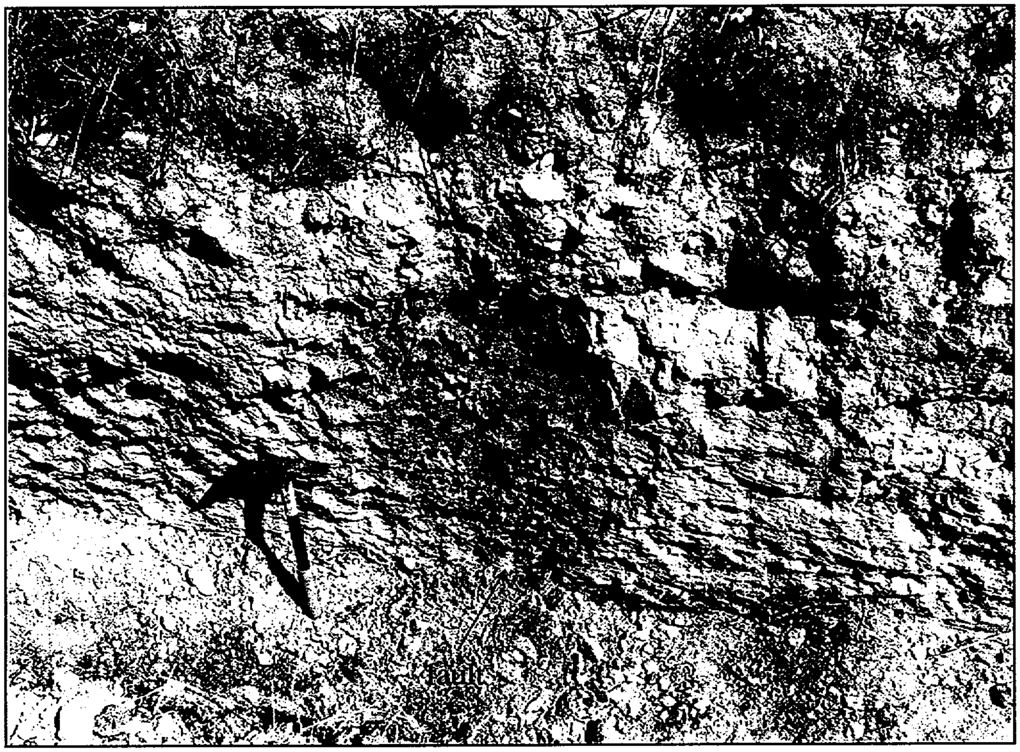
FIGURE 2.6-21 SANDSTONE OUTCROP IN THE ISFSI STUDY AREA



Friable sandstone (Tof_{b-2a}) in trench T-1. The friable sandstone generally is weakly bedded and jointed. A small near-vertical fault is indicated by oxidized clay stringers in the sandstone. Photo roll JLB-3.

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FIGURE 2.6-22 FRIABLE SANDSTONE IN TRENCH T-1

Clay bed within dolomite (Tof_{b-1}) with sample tube in trench T-14B. Photo roll JLB-8.

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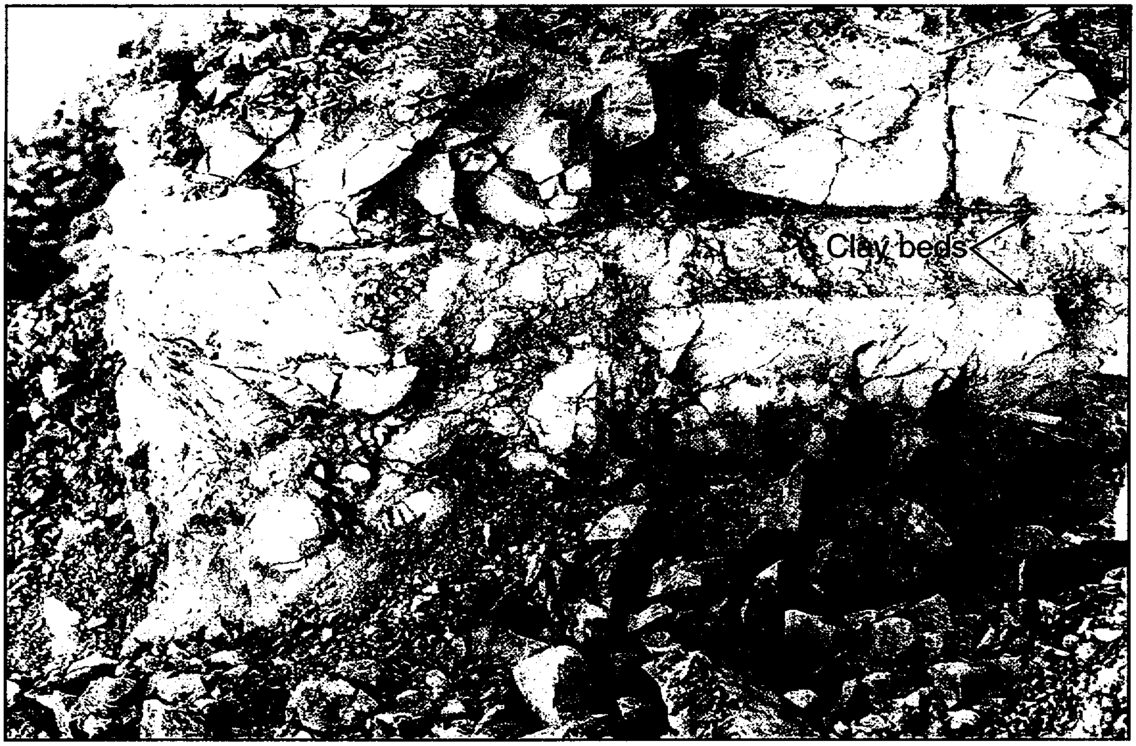
FIGURE 2.6-23 CLAY BED IN TRENCH T-14B



Typical dolomite Tof_{b-1} and thin clay beds exposed in trench T-11C. Clay beds are subhorizontal and define bedding. Photo roll 01JLB-1.

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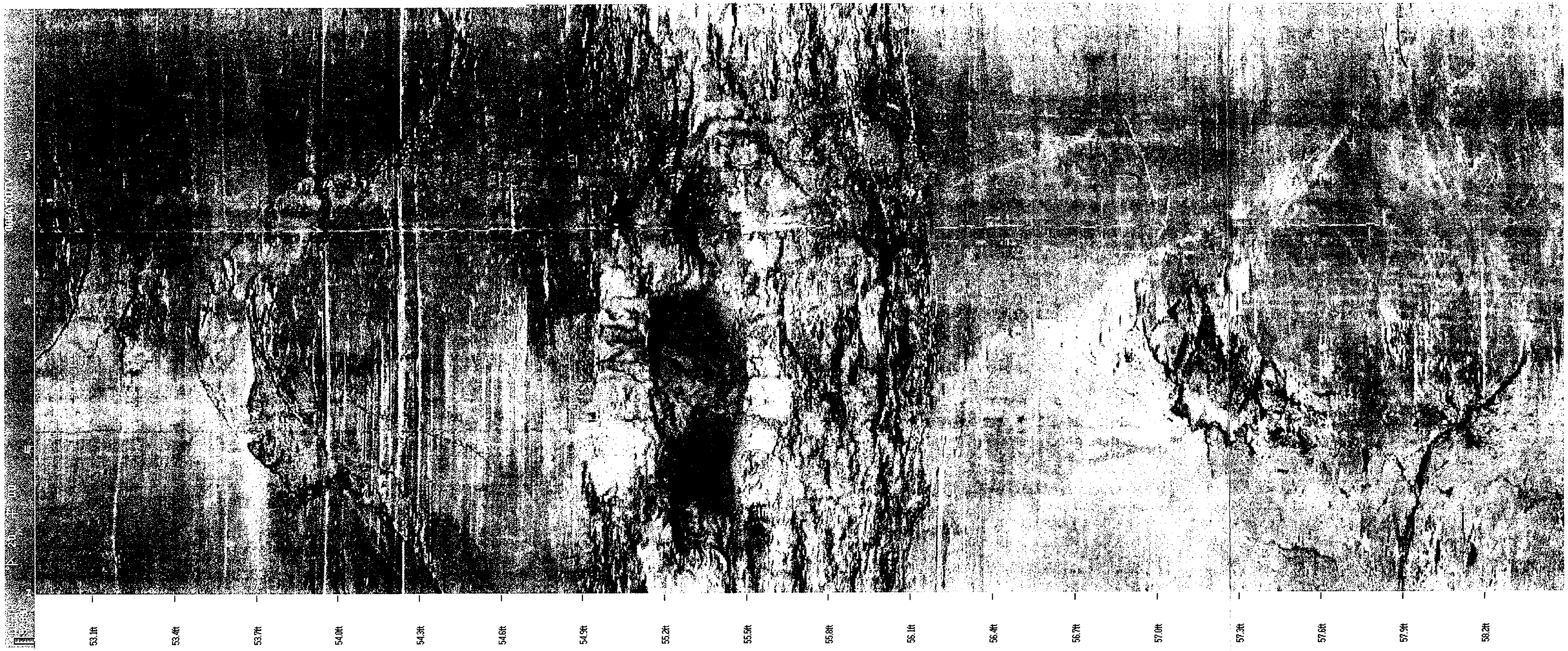
FIGURE 2.6-24 CLAY BEDS AND DOLOMITE IN TRENCH T-11C

Right margin



Left margin

Optical televiewer image of 50.0 to 58.5 feet, boring 00BA-1. Image "unwraps" the round borehole and displays picture as flat; right and left margins are the same vertical line in the boring. Clay bed at 55 feet (center of photo between 54.9 and 56.1 feet) is within the dolomite (Tof_{b-1}). Fractures in the dolomite that intercept the boring at a steep angle appear as sinusoidal shapes. The fracture between 53.7 and 54.6 feet dips 65 degrees and is partly filled with clay where it breaks into two or more joints. Three intersecting joints are present between 57.0 and 58.3 feet; drilling has broken parts of rock between the subparallel joints near 57.3 feet. (12/5/00)

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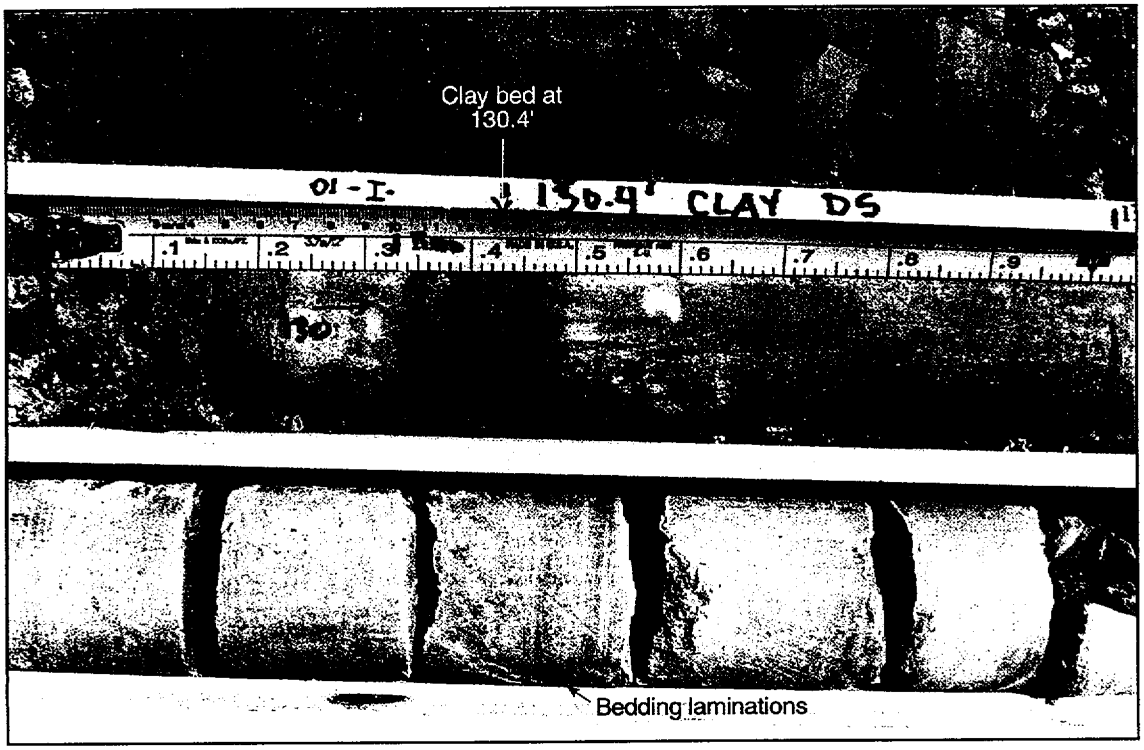
FIGURE 2.6-25
TELEVIEWER IMAGE OF CLAY BED AT 55 FEET, BORING 00BA-1



Typical appearance of clay bed and bedding laminations in a section of core at 130 feet from boring 01-I, south of the ISFSI. Clay bed occurs within Tof_{b-1}.
Photo roll 01JLB-ba.

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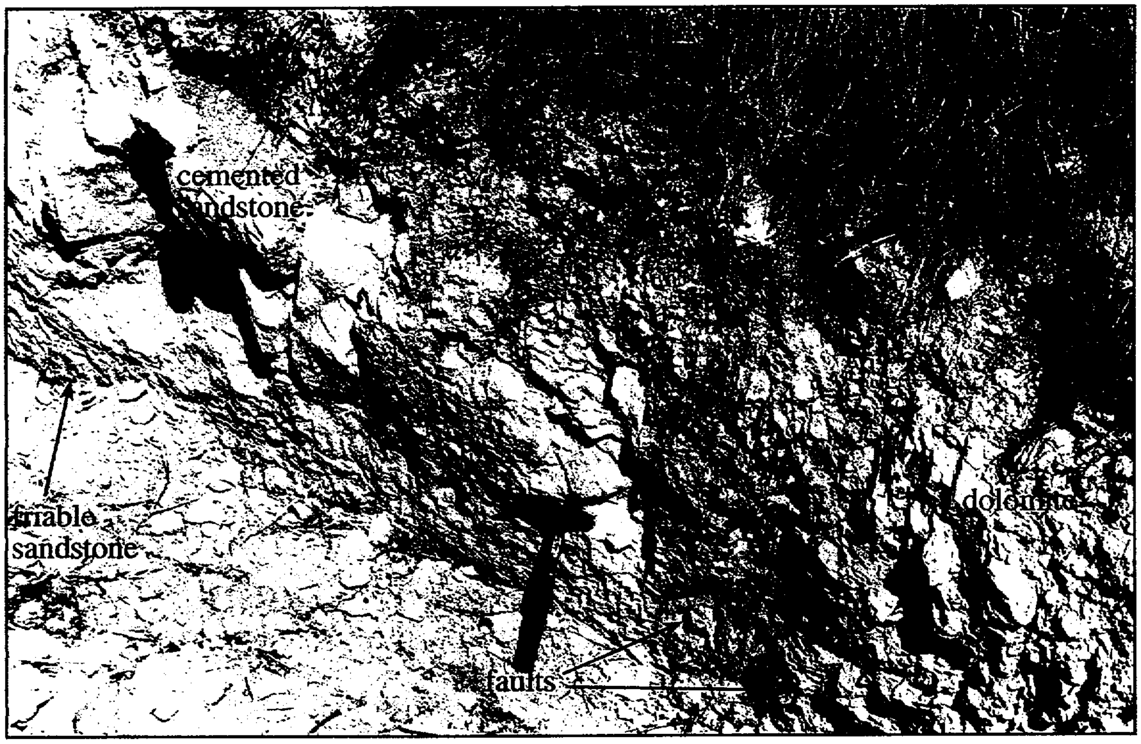
FIGURE 2.6-26 CLAY BED AT 130 FEET IN BORING 01-I



Typical small bedrock faults in trench T-1. The faults juxtapose friable sandstone (Tof_{b-2a}) on left against fractured dolomite (Tof_{b-1}) on right. A remnant of unaltered, cemented sandstone (Tof_{b-2}) remains in upper left. Photo roll JLB-4.

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FIGURE 2.6-27 TYPICAL SMALL BEDROCK FAULTS IN TRENCH T-1

Minor fault in trench T-1 juxtaposing friable sandstone (Tof_{b-2a}) on left against dolomite (Tof_{b-1}). Photo roll JLB-2.

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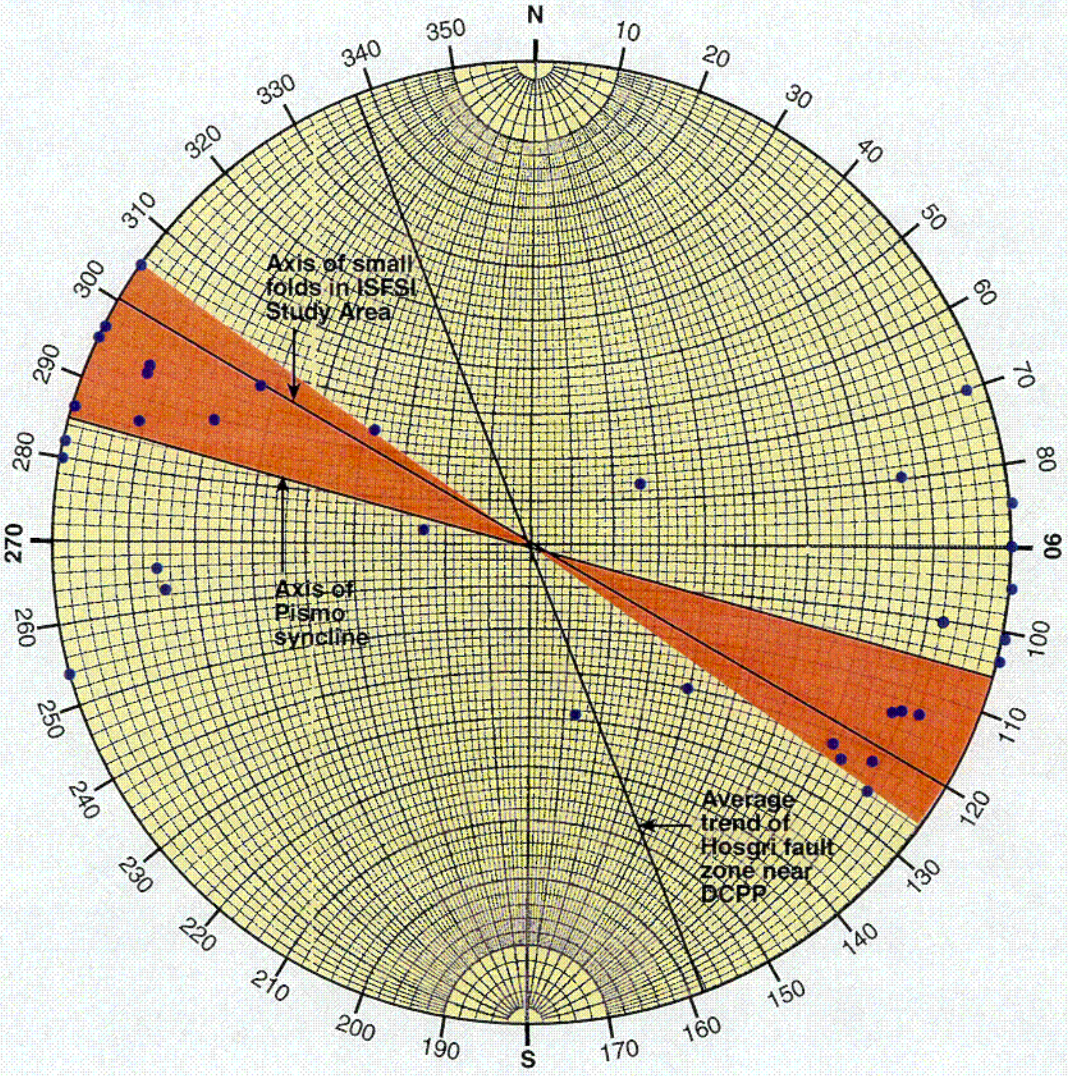
FIGURE 2.6-28 MINOR FAULT IN TRENCH T-1



Explanation

- General range in strike of zone of minor faults.
- Rake of slickenside on fault plane of minor faults

Equal-angle lower hemisphere plot.

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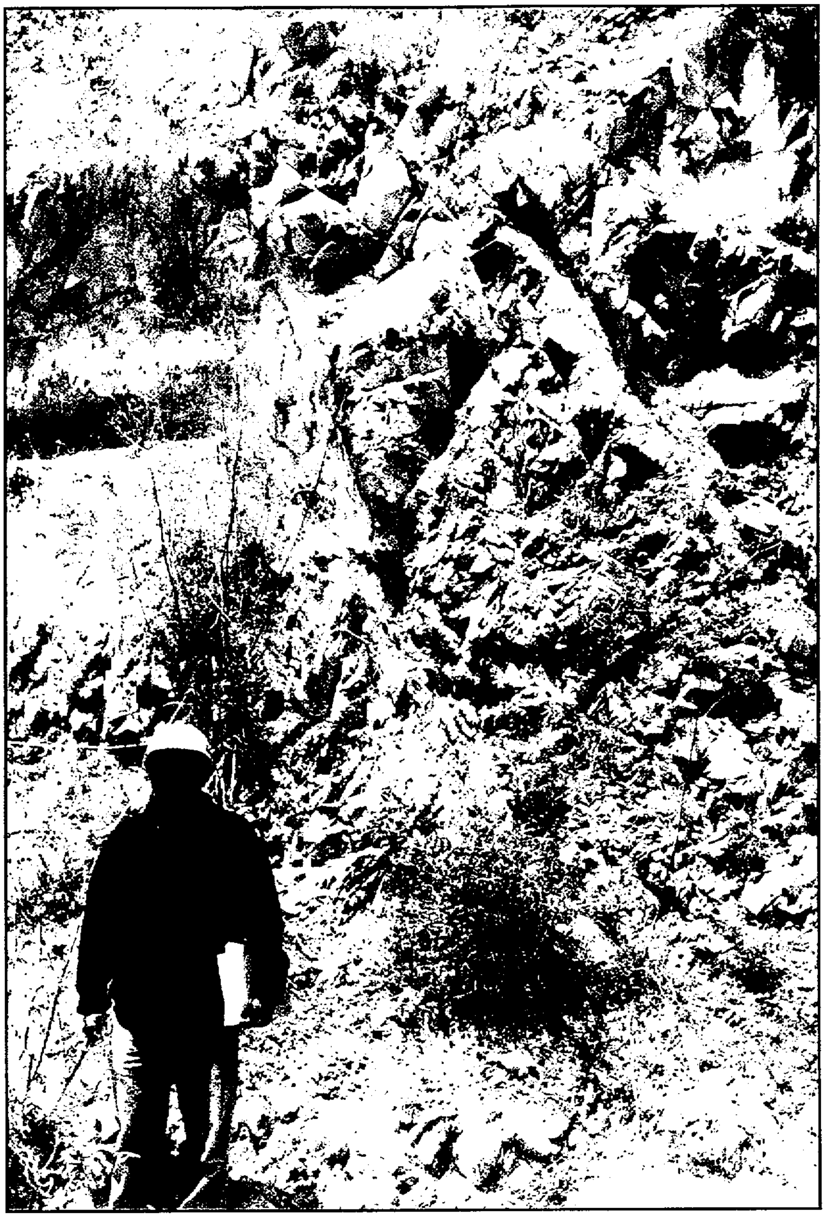
FIGURE 2.6-29 COMPARISON OF ORIENTATIONS OF MINOR FAULTS AND FOLDS IN THE ISFSI STUDY AREA WITH OTHER STRUCTURES

C02



Northward view of Diablo Creek Road cut showing steeply dipping minor faults in dolomite of unit Tof_{b-1}. Slickensides and mullions on the fault plane indicate primarily strike-slip displacement, but bedding also suggests a component of down-to-the- east vertical separation of approximately 3 to 6 feet. These faults are located along projection of faults exposed in trenches at the ISFSI, approximately 800 feet to the southeast, that have similar strike and slickenside/mullion rakes. Photo roll JLB5/16-1.

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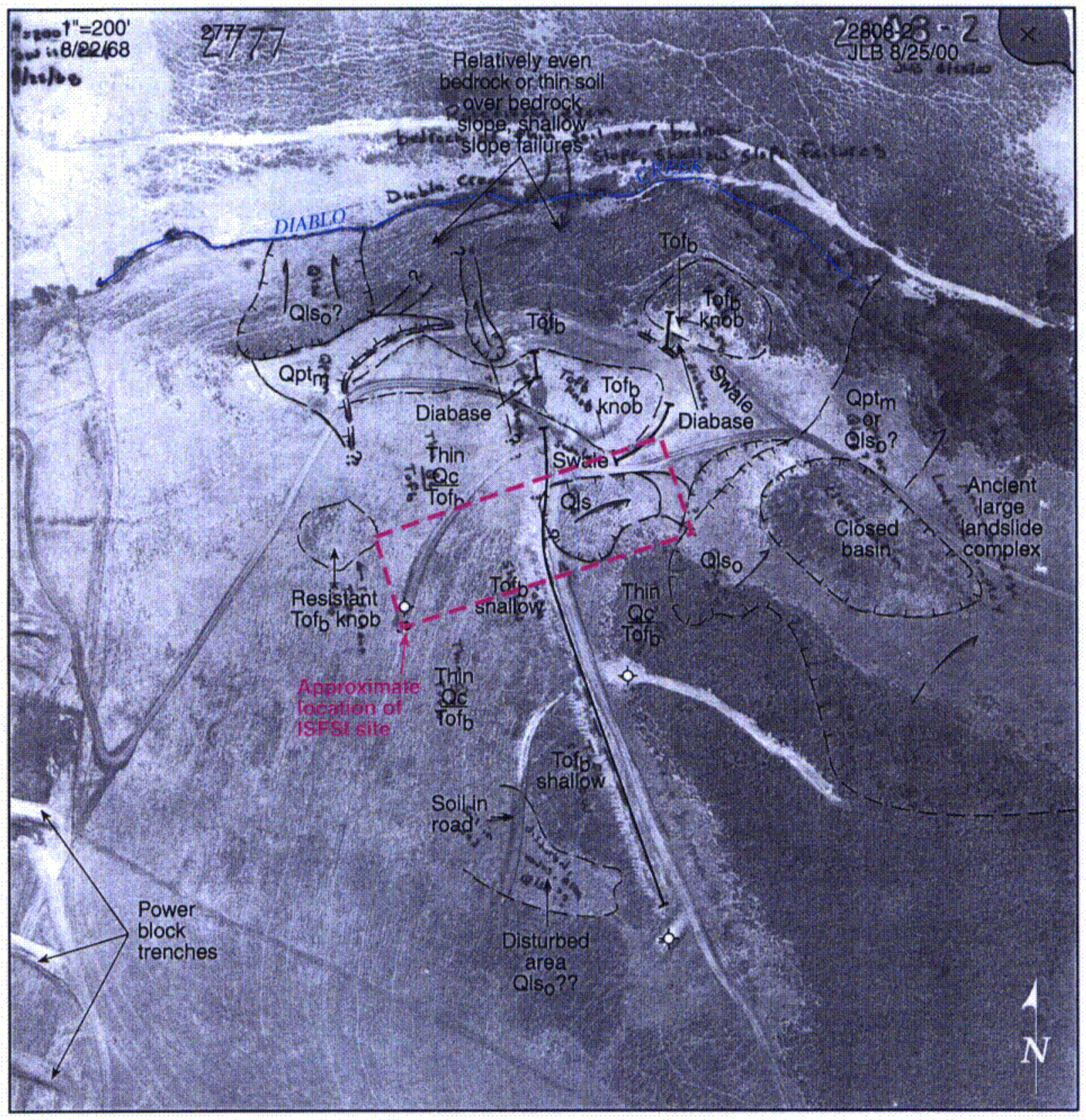
FIGURE 2.6-30 MINOR FAULTS ALONG DIABLO CREEK ROAD



1968 stereo air photos (2777; 2808-1 and 2808-2) of ISFSI study area prior to the 1971 excavation of the borrow site. Diablo Creek traverses the upper (northern) part of the photo. Trenches for the power block are evident in the lower left. The road that follows the ridge crest in center of photo was removed during 1971 excavation of the borrow area. No features indicating deep seated landslides are present at the site; large landslides are evident to the east, however. The small landslide south of the word "swale" is shallow and was removed in the 1971 excavations. See Figure 2.6-7 for unit descriptions. To view with a stereoscope, fold and adjust the photos as necessary.

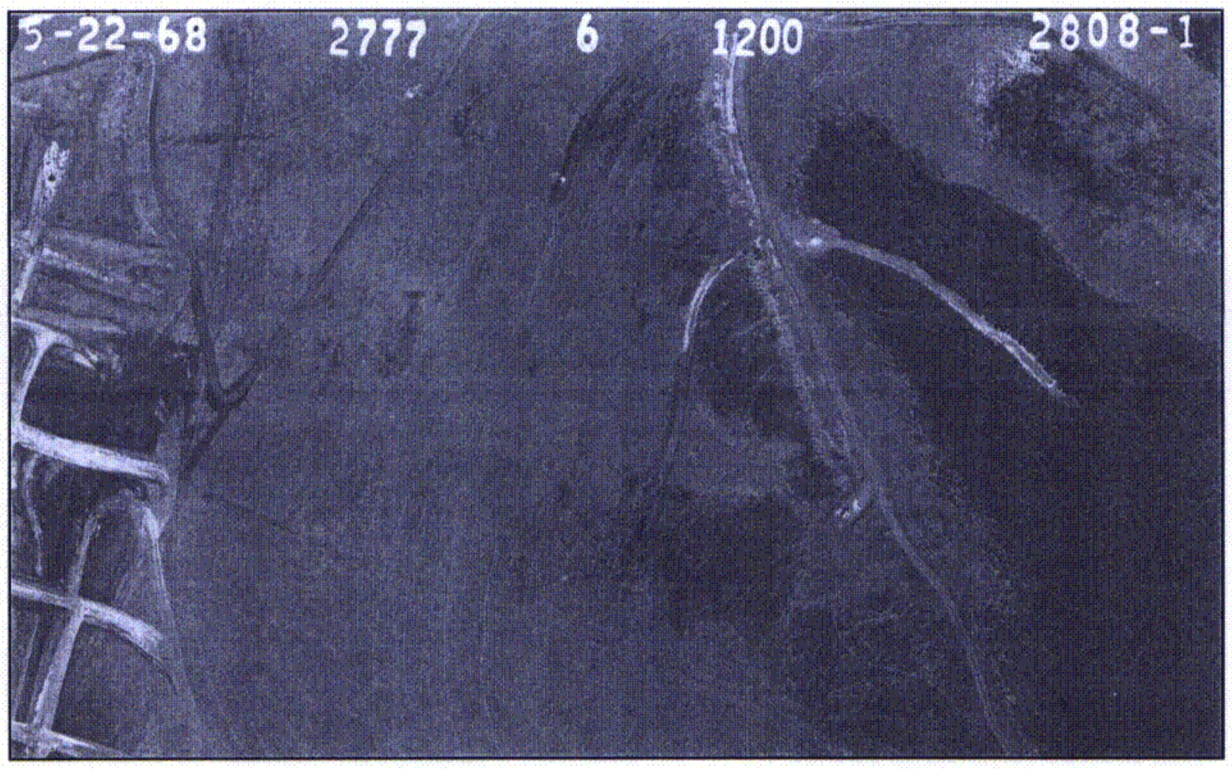


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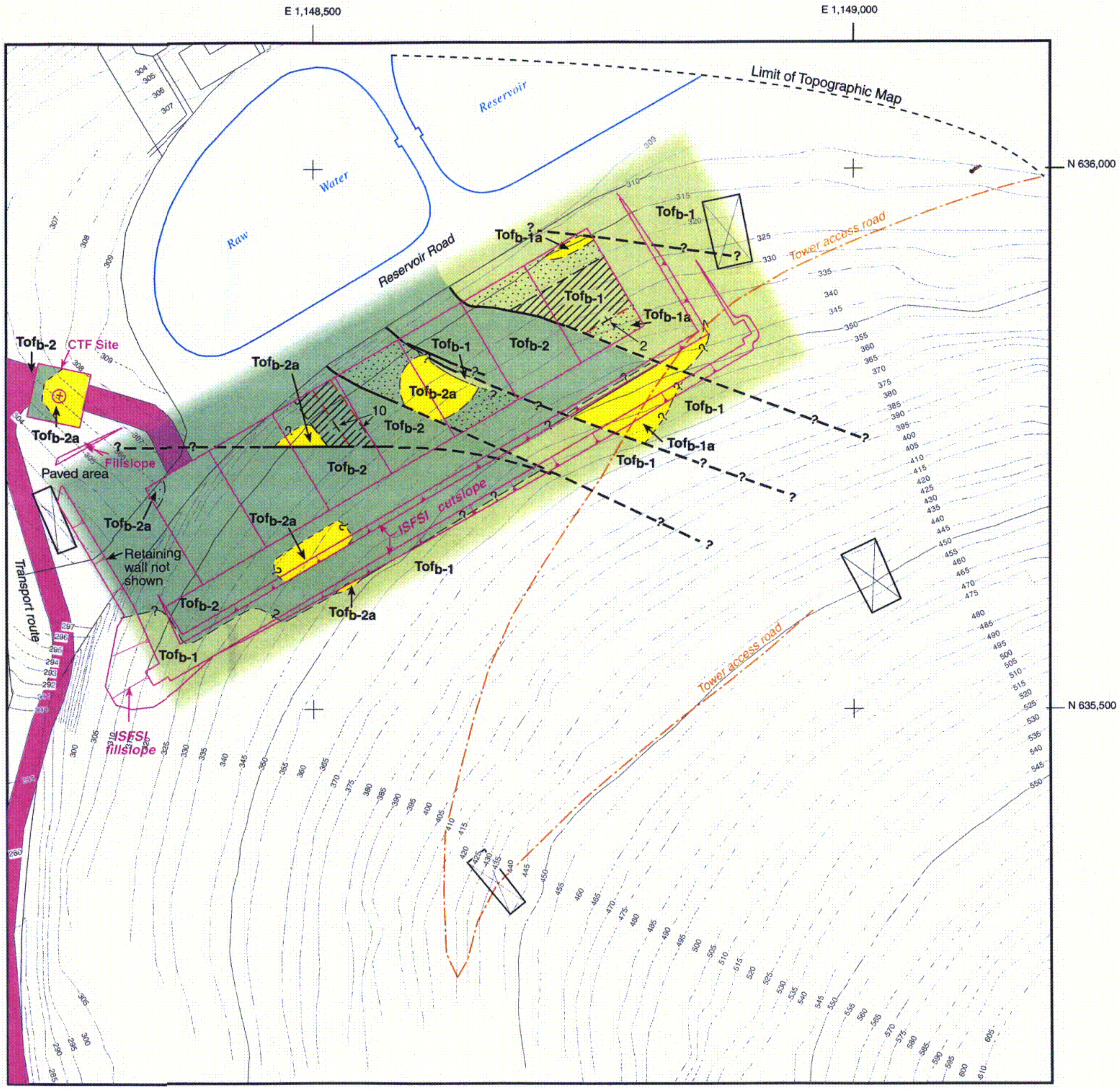
FIGURE 2.6-31 1968 AERIAL STEREO PHOTOGRAPHY OF ISFSI STUDY AREA

C03



Explanation

Footprint of 500-kV tower

Outline of ISFSI pads (subgrade at el. 302') and CTF (subgrade at about el. 286' and 296'.)

Proposed cutslope above and fillslope to the west of ISFSI pads

DOLOMITE UNIT

Tofb-1 Dolomite, clayey dolomite, dolomitic siltstone to fine-grained dolomitic sandstone, and limestone. The unit contains occasional discontinuous to continuous (tens to hundreds of feet) clay beds that are generally 1/32- to 1/2-inch thick, but locally are thicker. Rocks in this unit are moderately to well cemented, moderately hard to hard, moderately to slightly weathered, brittle and typically medium strong.

Tofb-1a Friable dolomite and dolomitic siltstone of unit Tofb-1. These rocks typically have low hardness, are very weak to weak, and occur as discontinuous zones where weathering and/or alteration has been concentrated. Inferred lateral extent of friable zones is schematic.

SANDSTONE UNIT

Tofb-2 Fine to coarse-grained dolomitic sandstone and sandstone (arkosic to arenitic) with lesser dolomite beds. Detrital clasts are composed primarily of dolomitized feldspars, marine fossil fragments, and volcanic rock fragments. Discontinuous clay beds that are generally less than 1/2-inch thick occur locally within the unit. The rocks are of low to medium hardness, moderately to well cemented and typically medium strong.

Tofb-2a Friable sandstone of unit Tofb-2. These rocks typically are of low hardness are very weak to weak, and occur as discontinuous zones where weathering and/or alteration has been concentrated. Inferred lateral extent of friable zones is schematic.

Friable bedrock expected within 5 feet below ISFSI pads subgrade

Clay bed, approximate dip indicated

Clay bed expected within 5 feet below ISFSI pads subgrade

Note: Projection of lithologic units, clay beds, and faults are based on surface mapping and borings, and are considered approximate

N

0 50 100 150 200

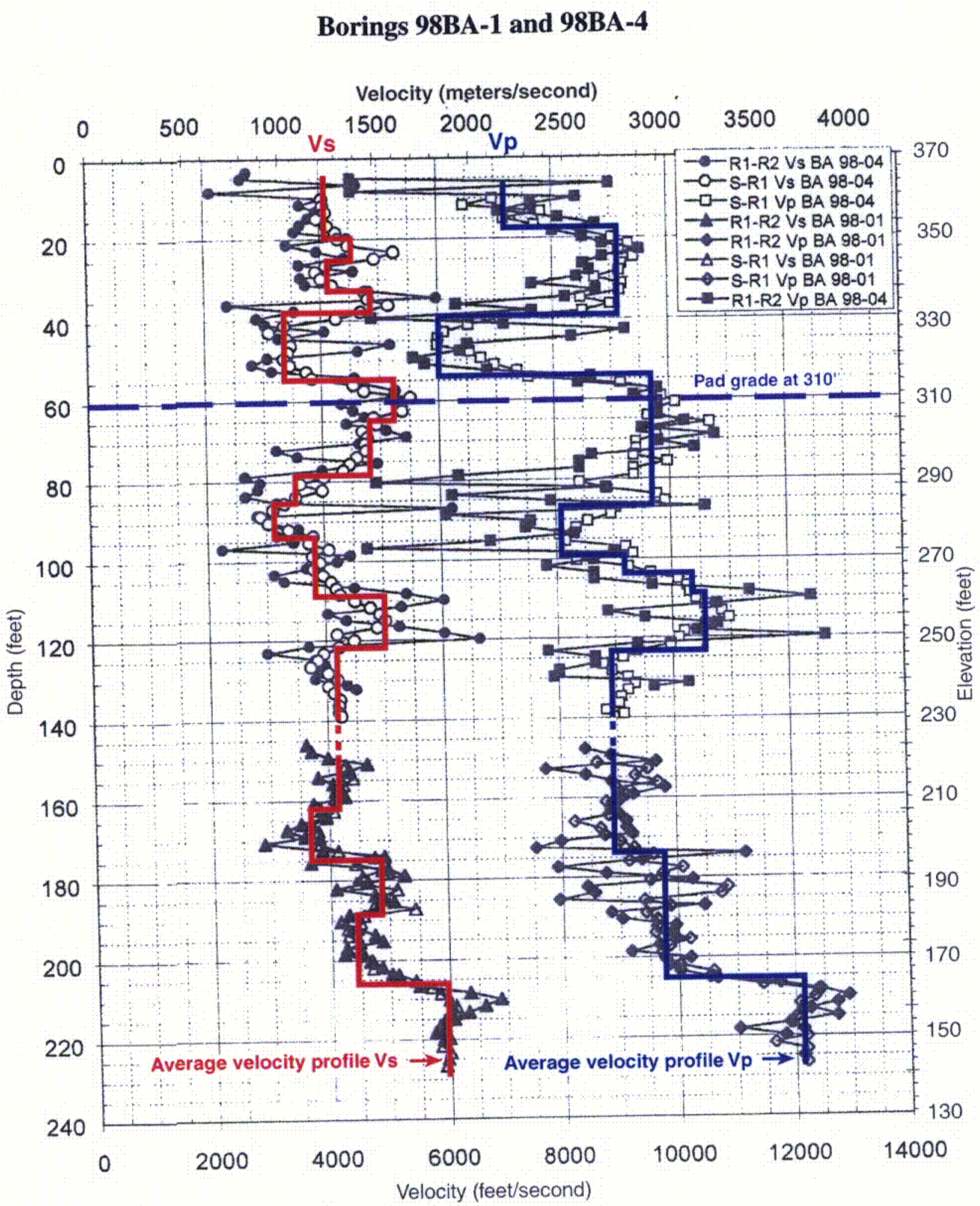
Contour interval = 5 feet

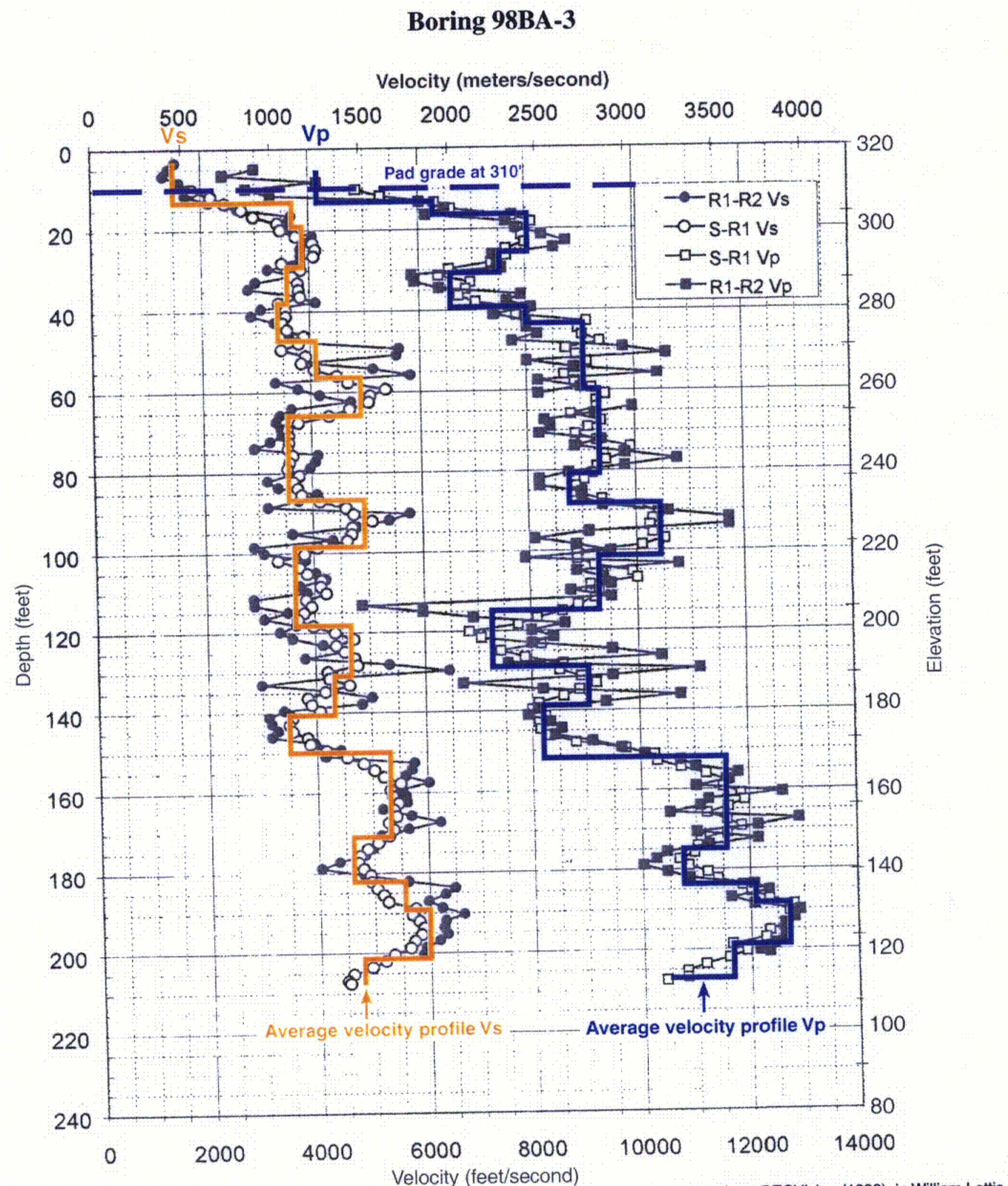
SAFETY ANALYSIS REPORT

DIABLO CANYON ISFSI

FIGURE 2.6-32
GEOLOGY OF ISFSI AND CTF SITES AT PROPOSED FINAL GRADES

C04





Modified from GEOVision (1998), in William Lettis & Assoc. Inc., 2001, DCPP ISFSI Data Report C.

Note: Average velocity profiles interpreted from data

R1 - R2 = Receiver-to-receiver velocity (3.3-foot spacing)
S-R1 = Source-to-receiver velocity (10.3-foot spacing)

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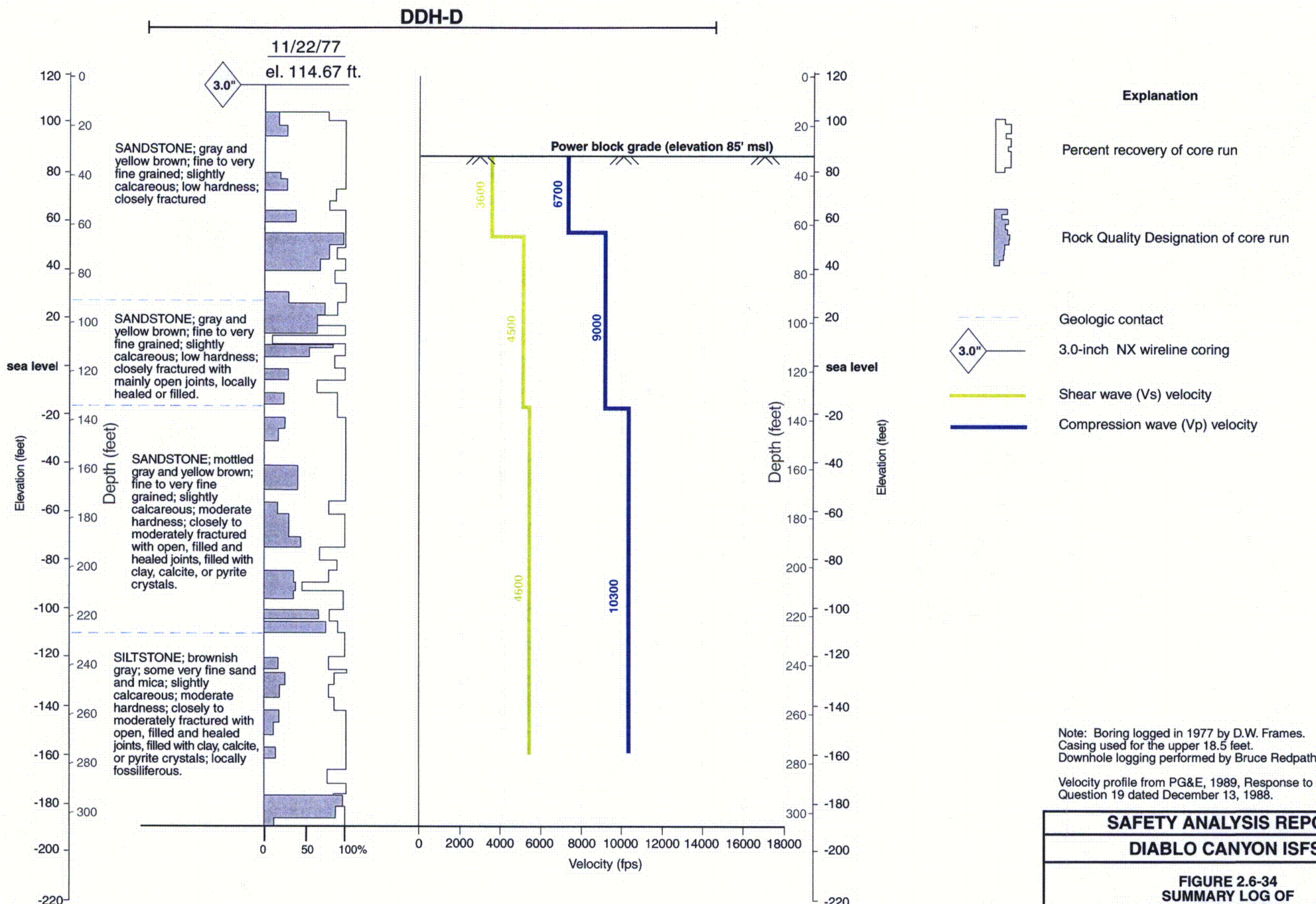
FIGURE 2.6-33
ISFSI SITE SUSPENSION LOGS AND INTERPRETED AVERAGE SEISMIC VELOCITIES



Note: Boring logged in 1977 by D.W. Frames.
Casing used for the upper 18.5 feet.
Downhole logging performed by Bruce Redpath.

Velocity profile from PG&E, 1989, Response to NRC Question 19 dated December 13, 1988.

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FIGURE 2.6-34
SUMMARY LOG OF
1977 POWER BLOCK BORING DDH-D

C06

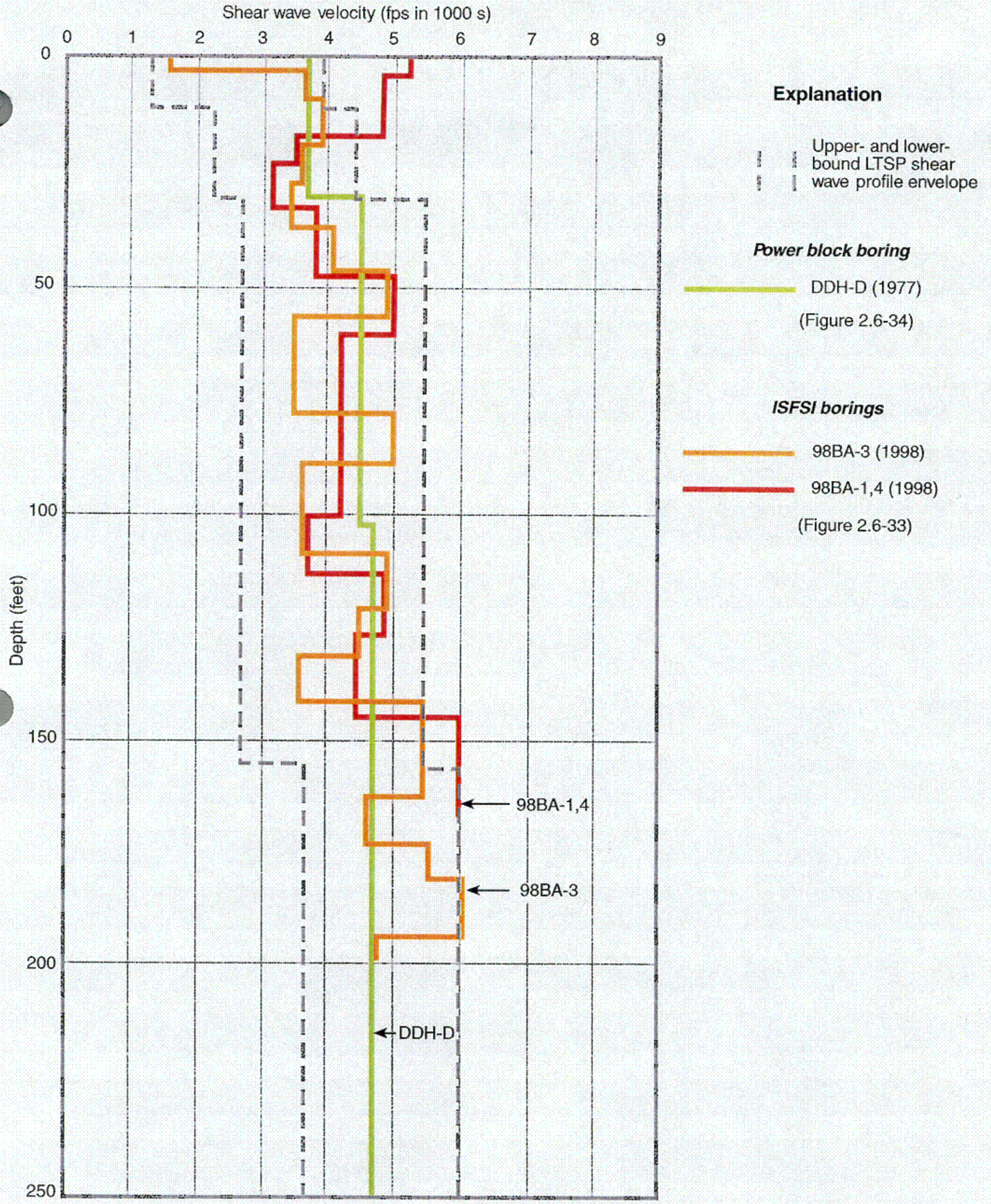

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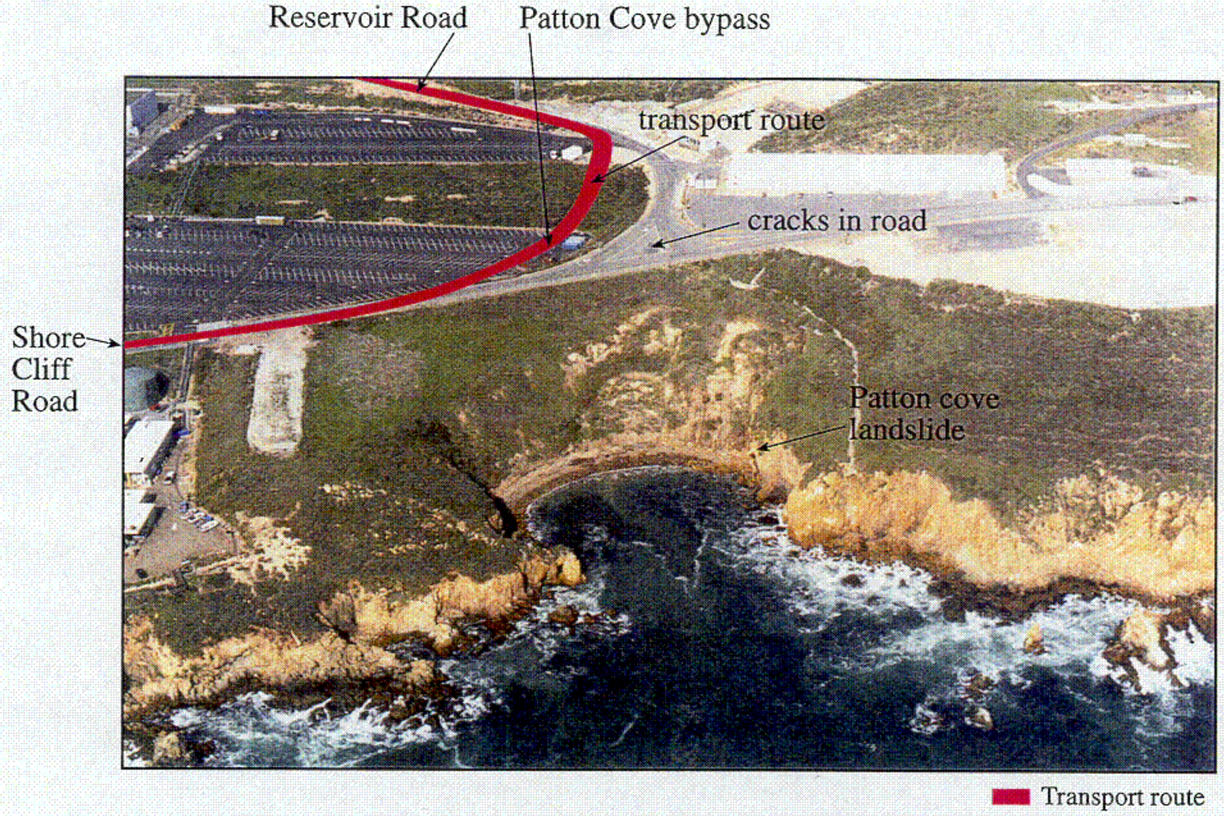
FIGURE 2.6-35 COMPARISON OF SEISMIC SHEAR-WAVE VELOCITIES AT THE POWER BLOCK AND ISFSI SITES C07



Northeast view of the horseshoe curve along the transport route and the Patton Cove landslide. The Patton Cove landslide crosses the width of the cove in the center, and its headscarp encroaches on the existing roadway. The transport route is aligned north of the existing road to avoid the landslide. Photo roll JLB-AR-3.

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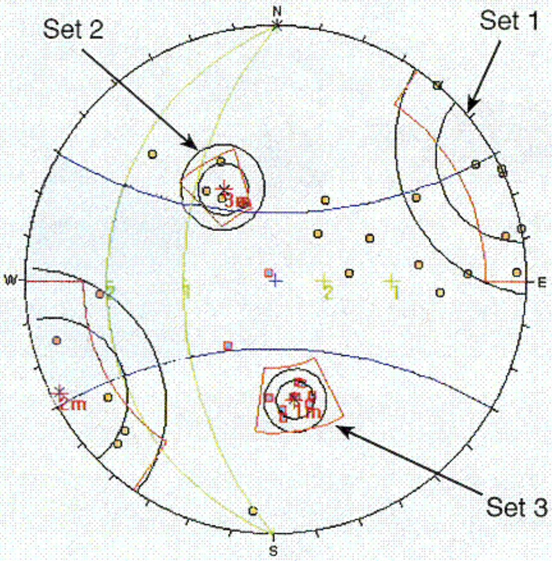
FIGURE 2.6-36 TRANSPORT ROUTE NEAR PATTON COVE LANDSLIDE C08



A. Topple hazard (moderate hazard)

Explanation

Poles

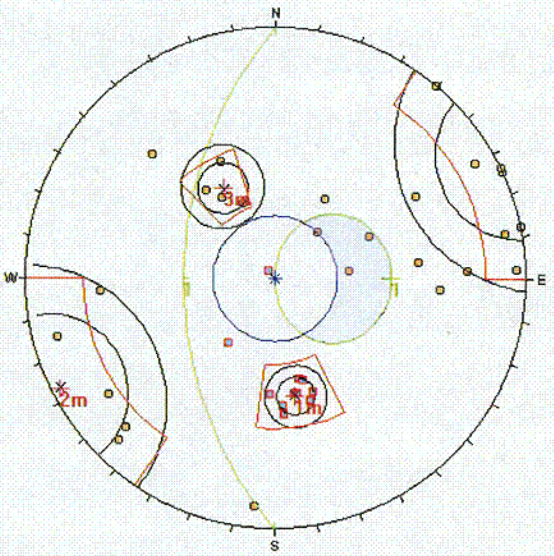
Joint

Bedding

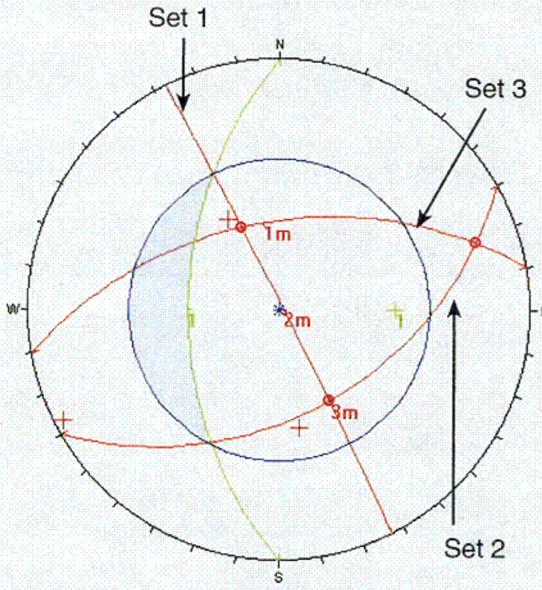
Failure envelope (based on 28° friction angle)

Failure envelope for topple and planar sliding without poles indicates stable conditions.

Failure envelope for wedge sliding without great circle intersections indicates stable conditions.



B. Planar sliding hazard (low hazard)



C. Wedge sliding hazard (very low hazard)

Notes

Analysis performed using computer program DIPS (Rocscience, 1999, DIPS: Plotting analysis, and presentation of structural data using spherical projection techniques, version 5.041, Toronto, 86p).

Fracture data from stations 38+00 to 45+00 applied to north-trending cutslope above Reservoir Road from stations 43+00 to 46+00.

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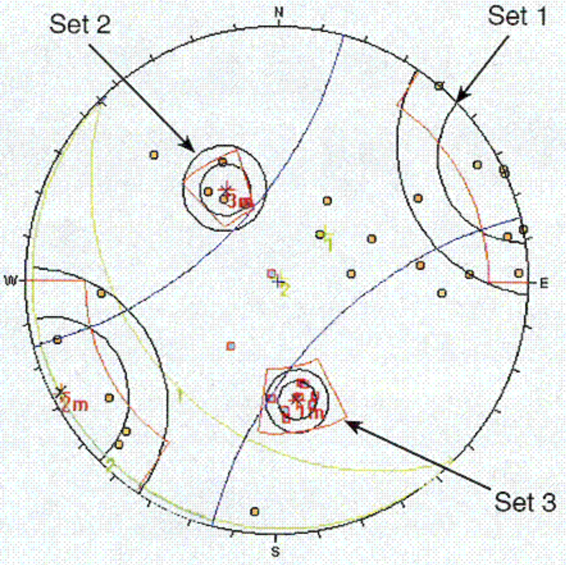
FIGURE 2.6-37 KINEMATIC ANALYSES OF NORTH-TRENDING CUTSLOPE OF TRANSPORT ROUTE (STATIONS 43+00 TO 46+00) C09



A. Topple hazard (low hazard)

Explanation

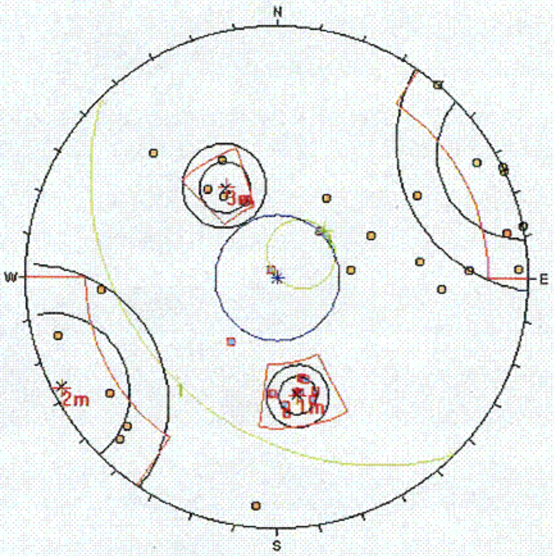
Poles

- Joint
- Bedding

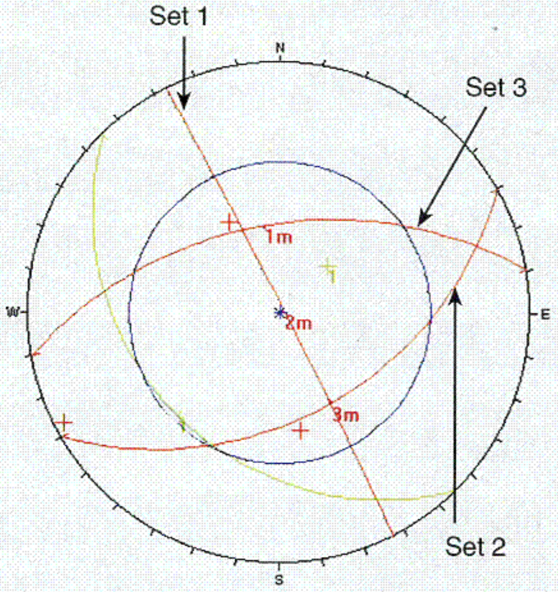
Failure envelope (based on 28° friction angle)

Failure envelope for topple and planar sliding without poles indicates stable conditions.

Failure envelope for wedge sliding without great circle intersections indicates stable conditions.



B. Planar sliding hazard (very low hazard)



C. Wedge sliding hazard (very low hazard)

Notes

Analysis performed using computer program DIPS (Rocscience, 1999, DIPS: Plotting analysis, and presentation of structural data using spherical projection techniques, version 5.041, Toronto, 86p).

Fracture data from stations 38+00 to 45+00 applied to northwest-trending cutslope above Reservoir Road from stations 35+00 to 43+00.

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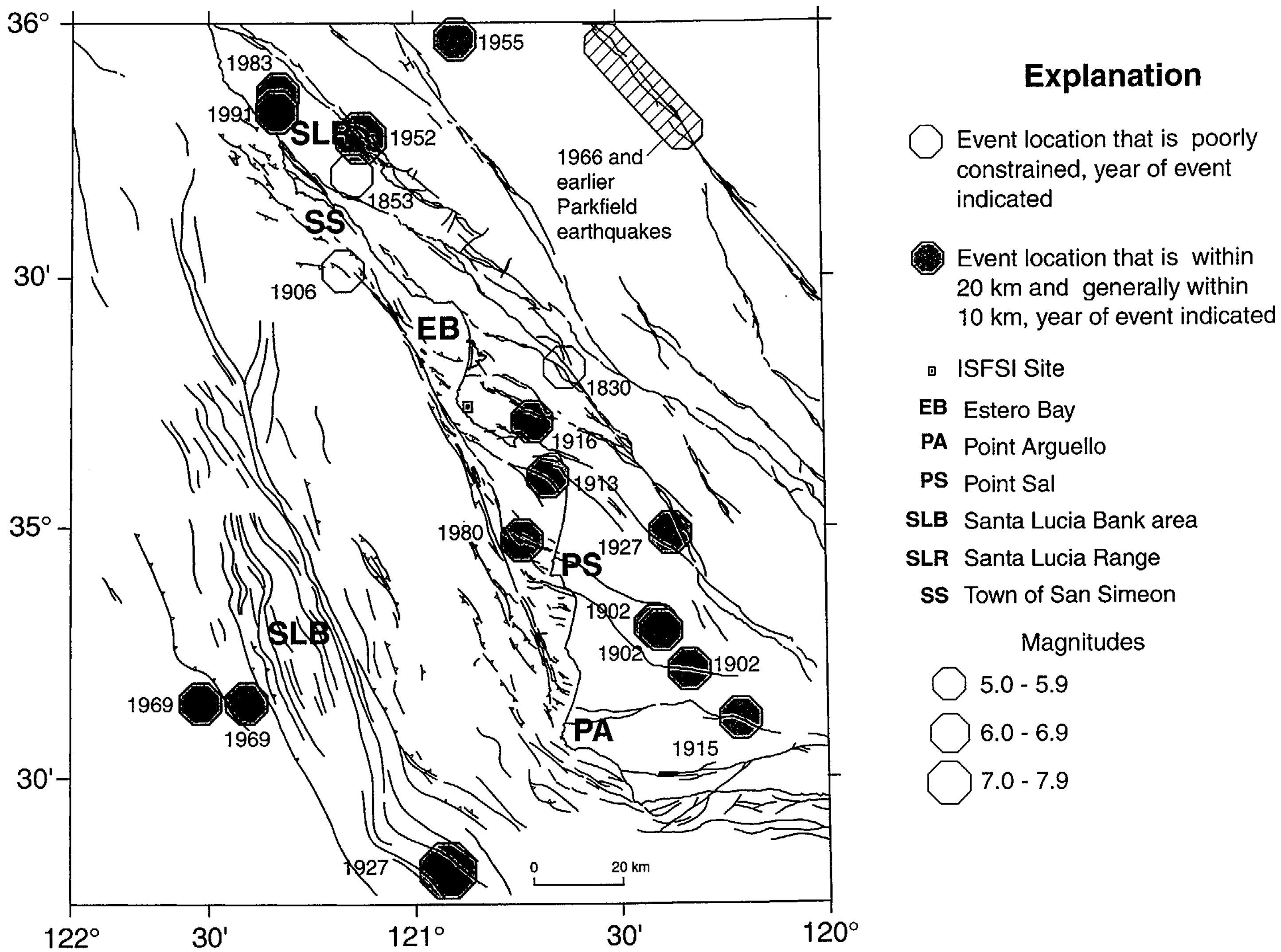
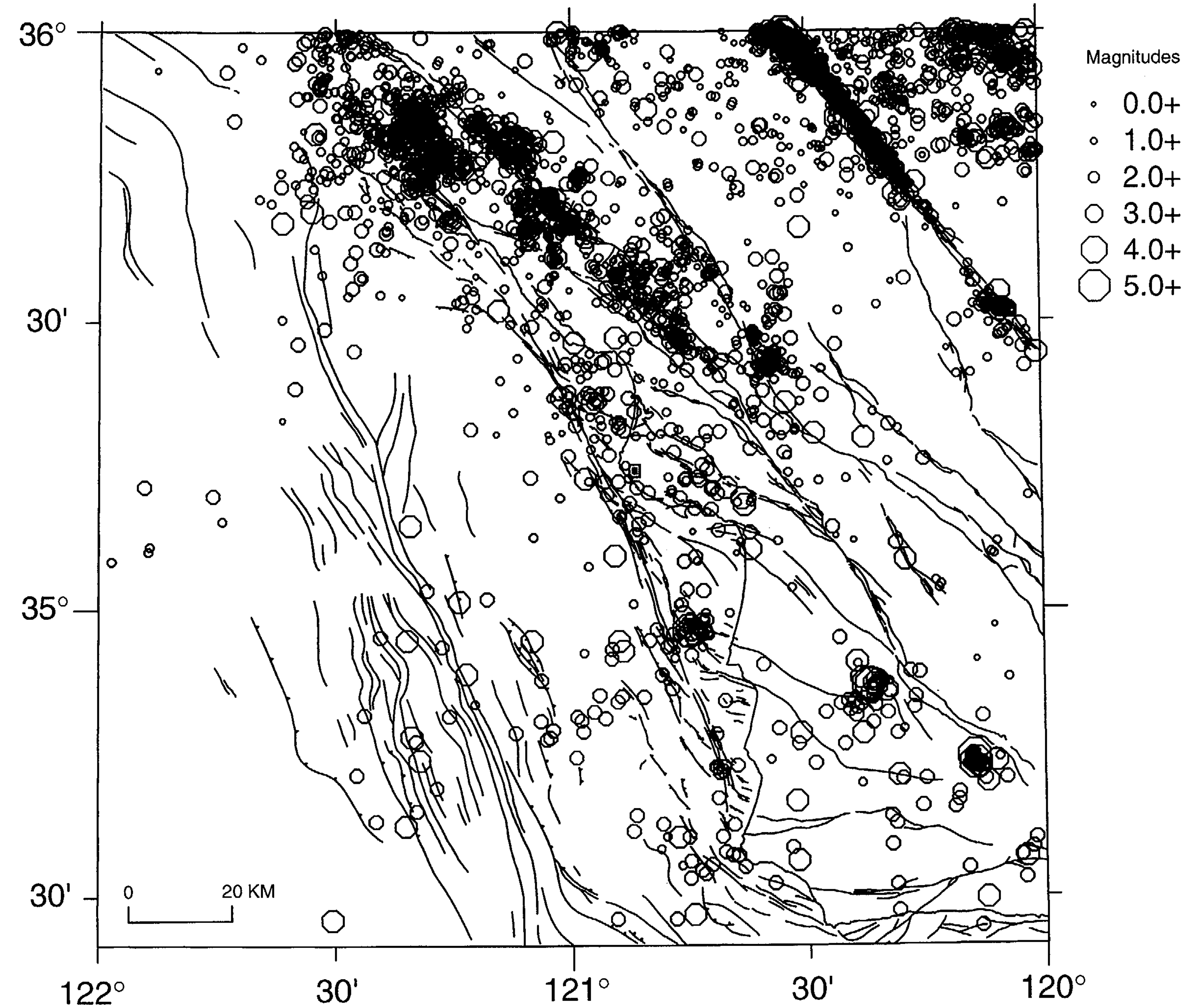
FIGURE 2.6-38 KINEMATIC ANALYSES OF NORTHWEST-TRENDING CUTSLOPE OF TRANSPORT ROUTE (STATIONS 35+00 TO 43+00) C10



A. Historical earthquakes of magnitude 5 and greater since 1830 (PG&E, Final Report of the Diablo Canyon Long Term Seismic Program, 1988.)



B. Instrumentally recorded seismicity from 1973 through September 1987 (PG&E, Final Report of the Diablo Canyon Long Term Seismic Program, 1988.)

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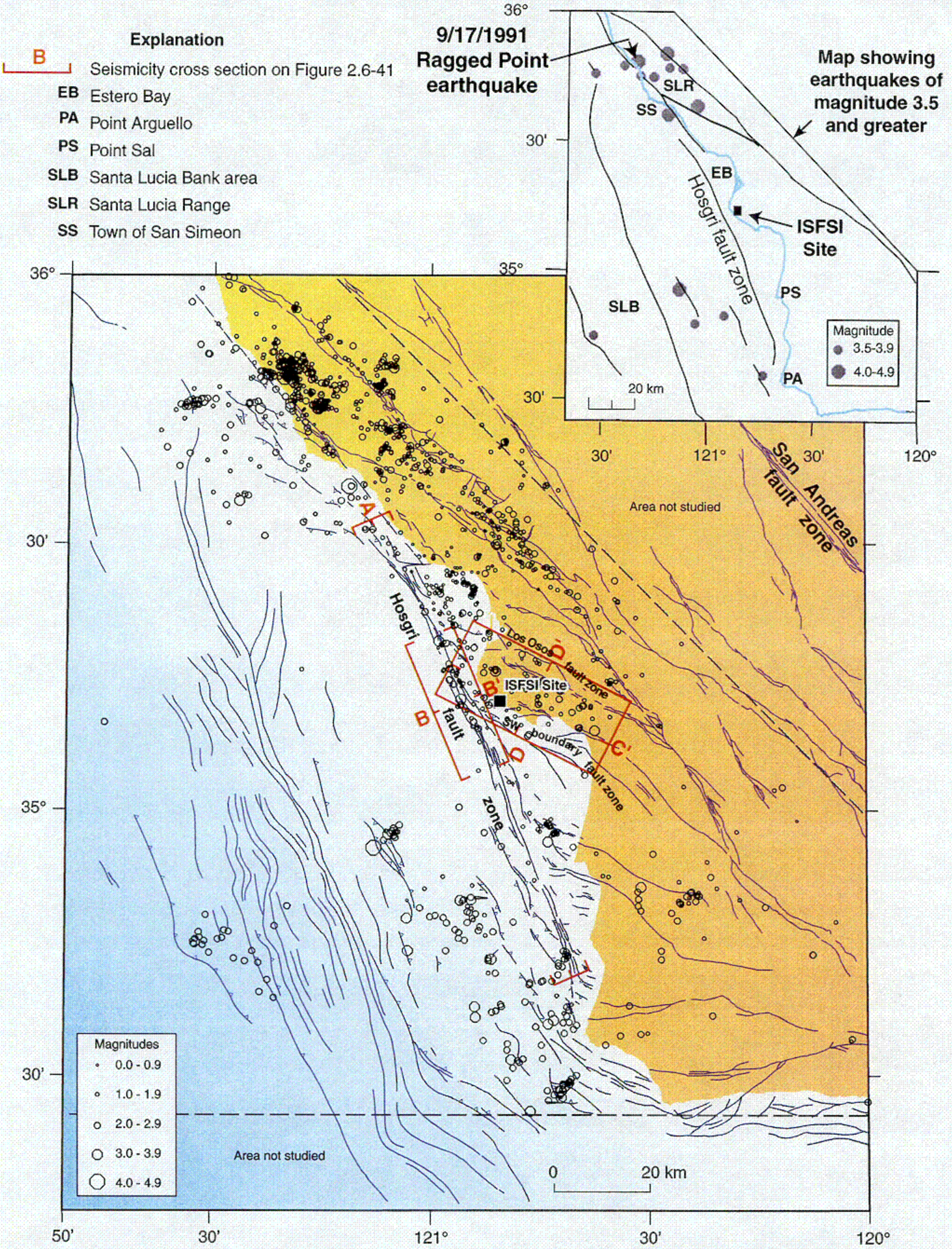
FIGURE 2.6-39
HISTORICAL EARTHQUAKES OF MAGNITUDE 5 AND GREATER SINCE 1830 AND INSTRUMENTALLY RECORDED SEISMICITY FROM 1973 THROUGH SEPTEMBER 1987



(From M.K. Mc Laren and W.U. Savage, Seismicity of south-central coastal California, October 1987 through January 1997, Bulletin of the Seismological Society of America, in press)

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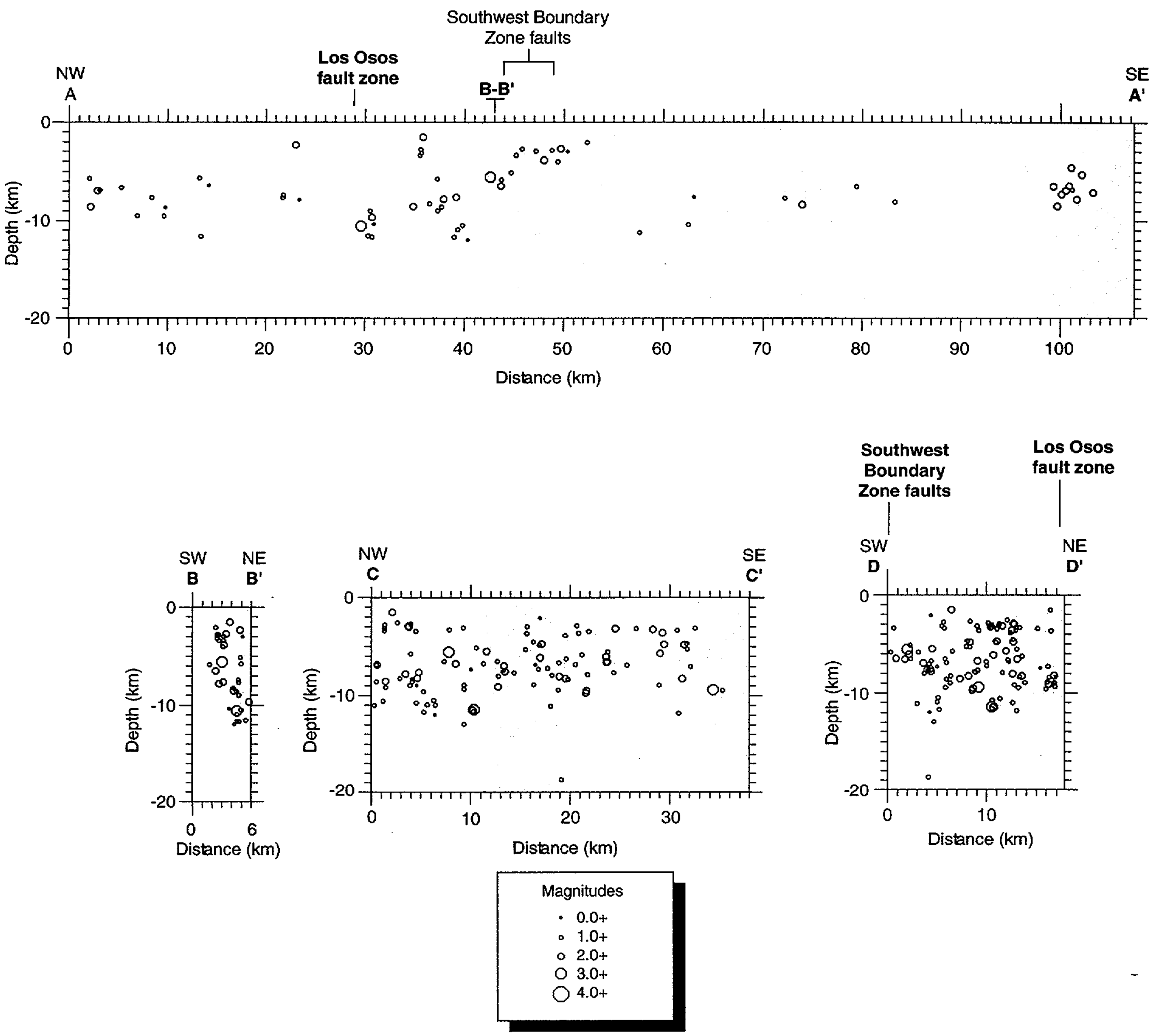
FIGURE 2.6-40
QUATERNARY FAULTS AND SEISMICITY FROM OCTOBER 1987 THROUGH JANUARY, 1997

C11



(From M.K. Mc Laren and W.U. Savage, Seismicity of south-central coastal California, October 1987 through January 1997, Bulletin of the Seismological Society of America, in press)

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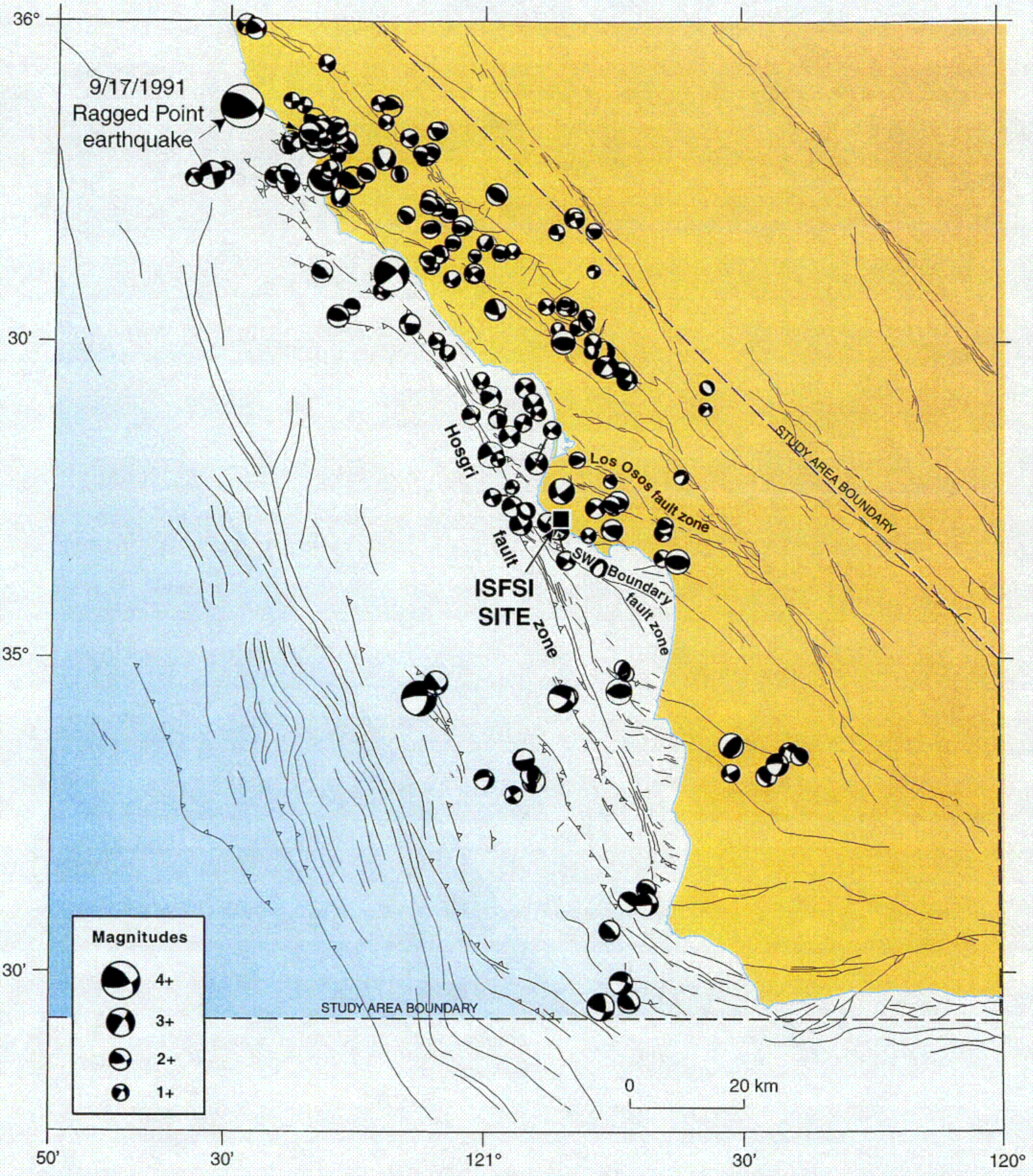
FIGURE 2.6-41
SEISMICITY CROSS SECTION A-A' THROUGH D-D' FOR EARTHQUAKES FROM OCTOBER 1987 THROUGH JANUARY 1997



(From M.K. Mc Laren and W.U. Savage, Seismicity of south-central coastal California, October 1987 through January 1997, Bulletin of the Seismological Society of America, in press)

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FIGURE 2.6-42
LOWER HEMISPHERE, P-WAVE FIRST-MOTION FOCAL MECHANISM PLOTS OF EARTHQUAKES FROM OCTOBER 1987 THROUGH JANUARY 1997

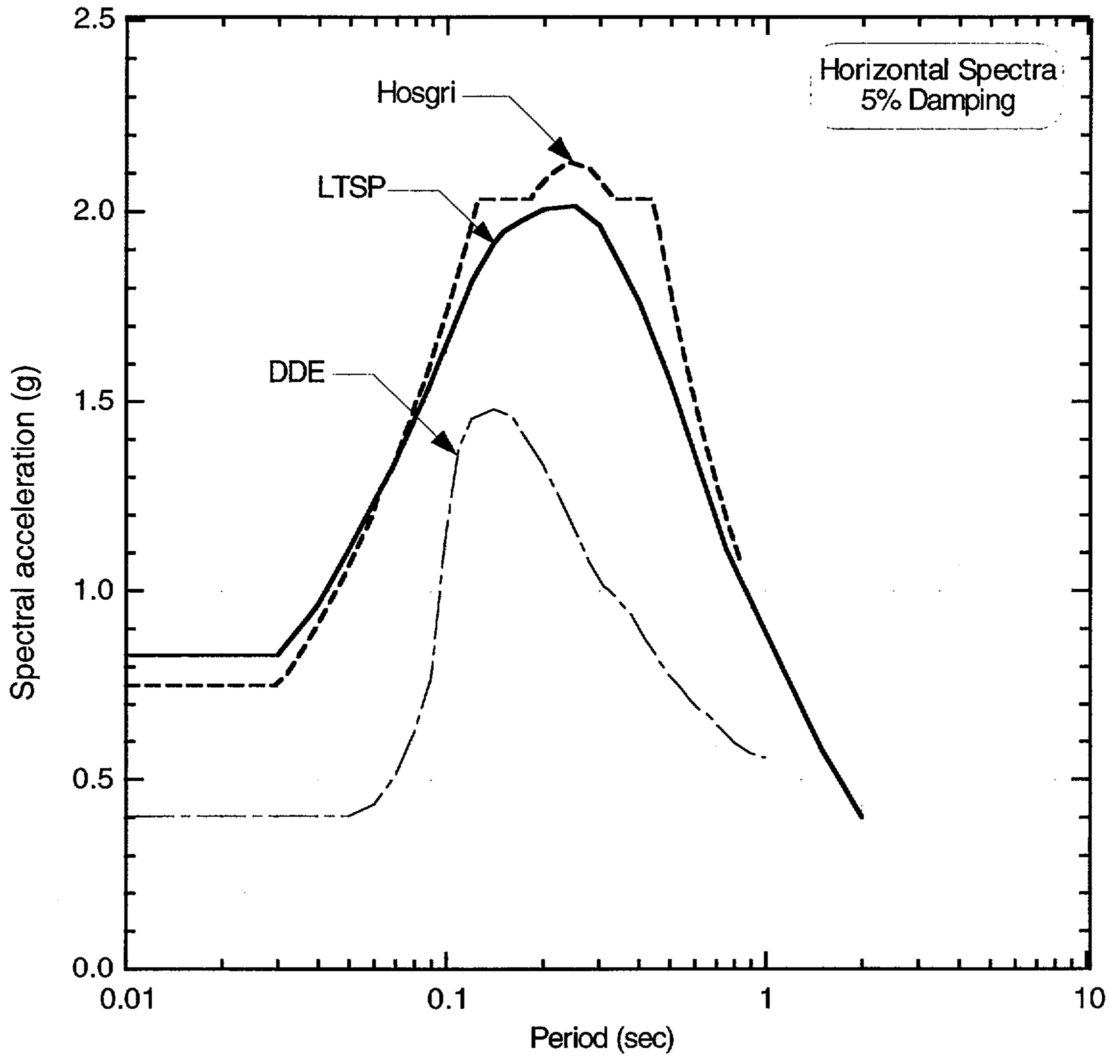

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FIGURE 2.6-43
DDE, HOSGRI, AND LTSP HORIZONTAL SPECTRA

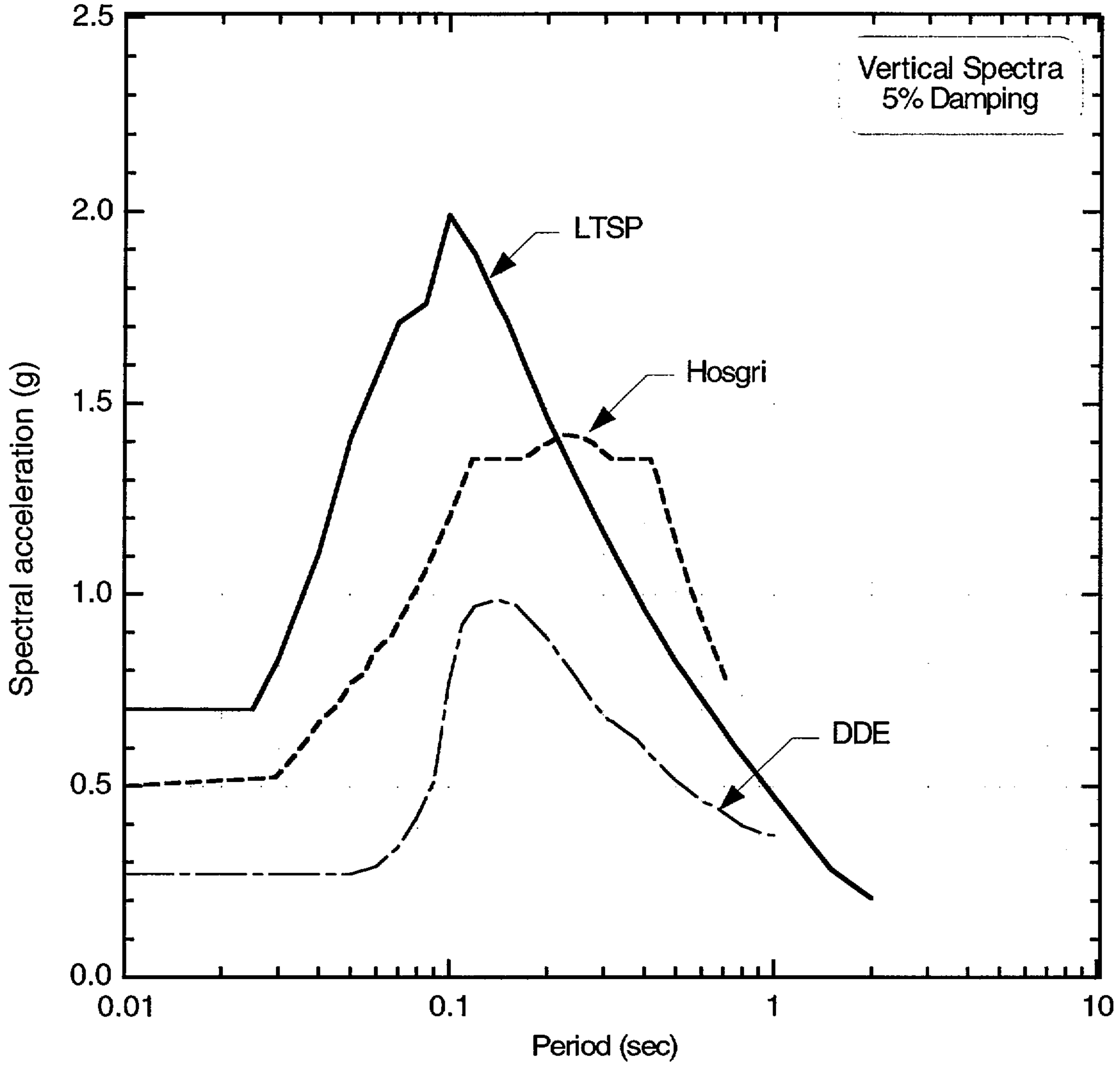

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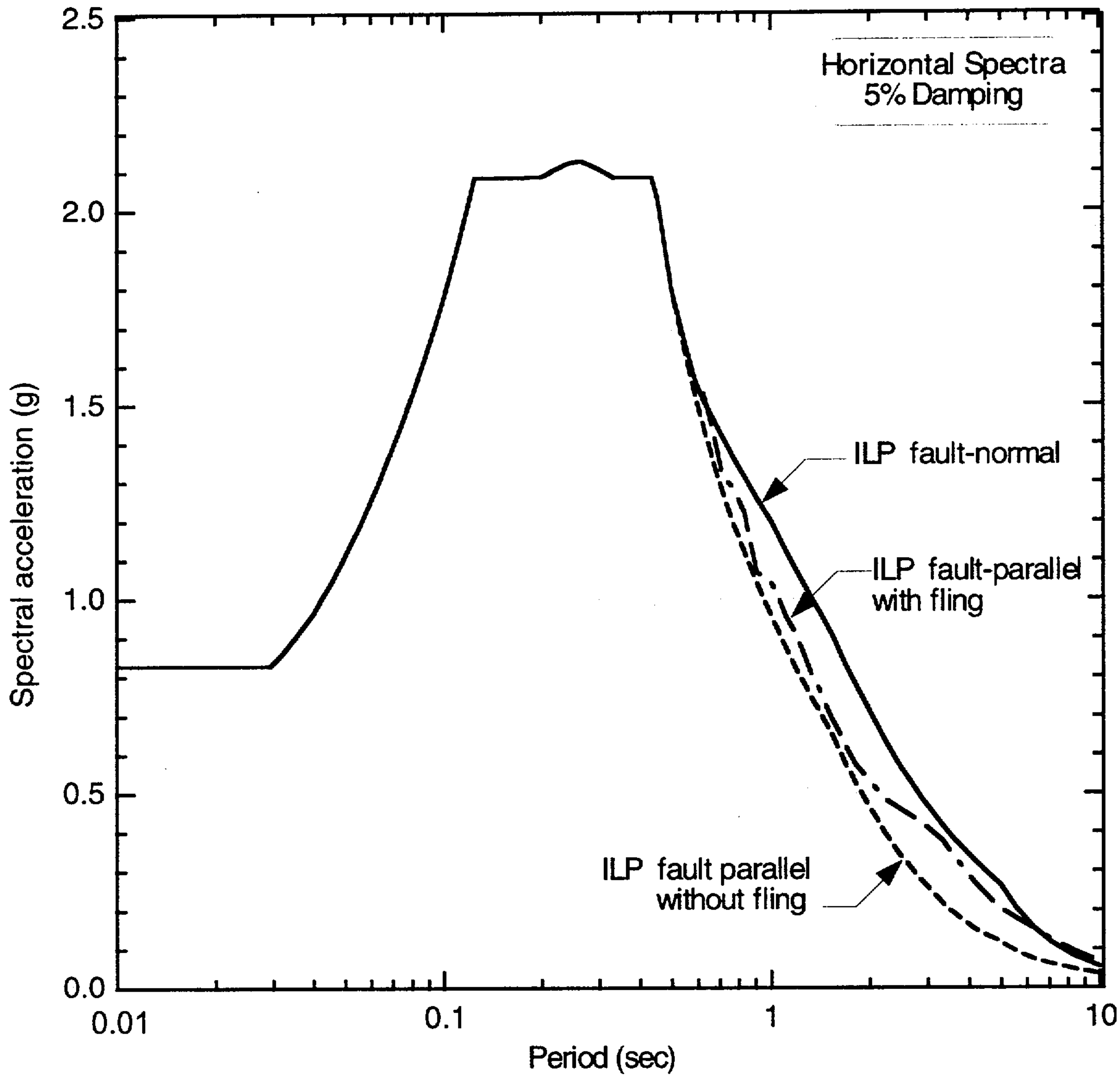
FIGURE 2.6-44 DDE, HOSGRI, AND LTSP VERTICAL SPECTRA



SAFETY ANALYSIS REPORT
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FIGURE 2.6-45 ILP HORIZONTAL SPECTRA

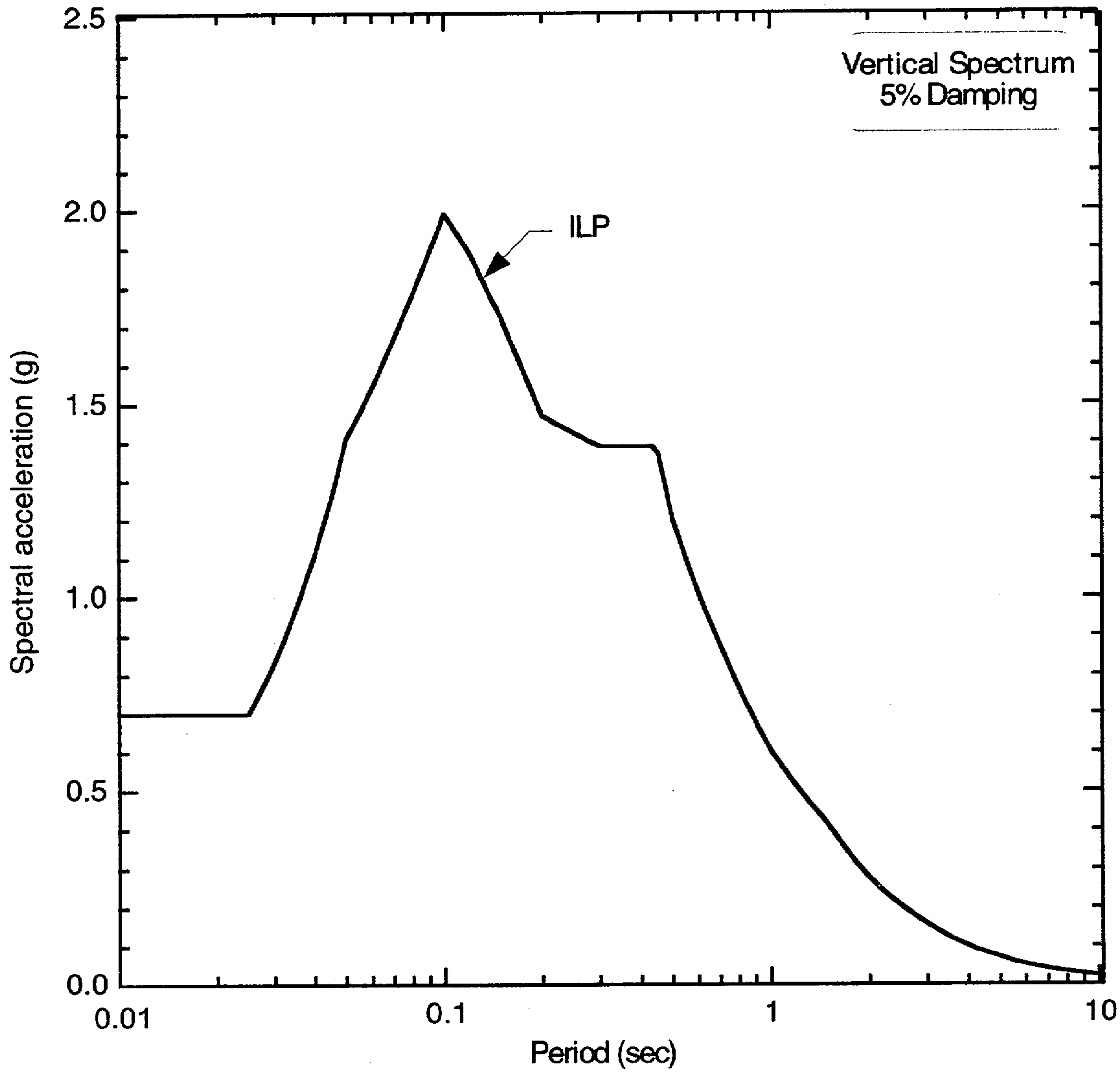

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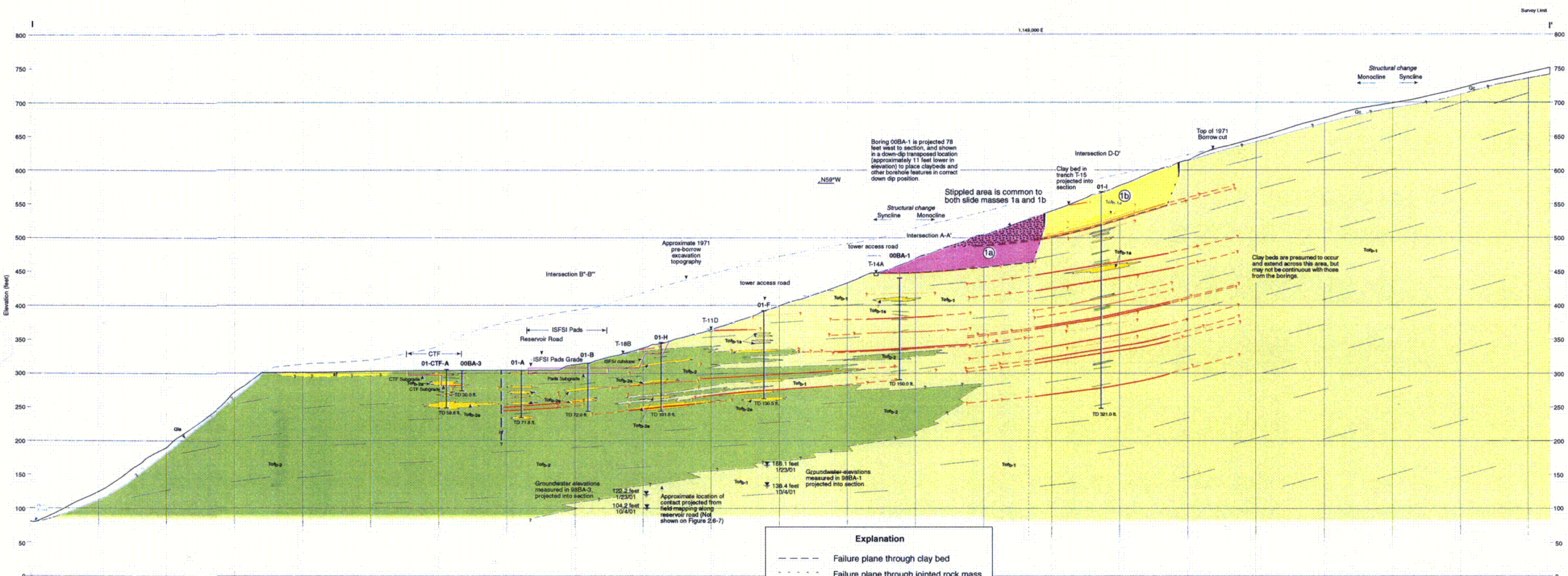
FIGURE 2.6-46
ILP VERTICAL SPECTRUM



Explanation

— — — Failure plane through clay bed

· · · · · Failure plane through jointed rock mass

Assumed 20-foot high tension crack at top of slide mass

Alternative Slide Mass Models

1a

1b

0 25 50 75 100 feet

Scale

Notes

1. Location of cross section shown on Figures 2.6-7 and 2.6-8. Nearby borings are projected to cross section.
2. See Figure 2.6-9 for explanation of geologic units.
3. Horizontal scale = vertical scale.

SAFETY ANALYSIS REPORT

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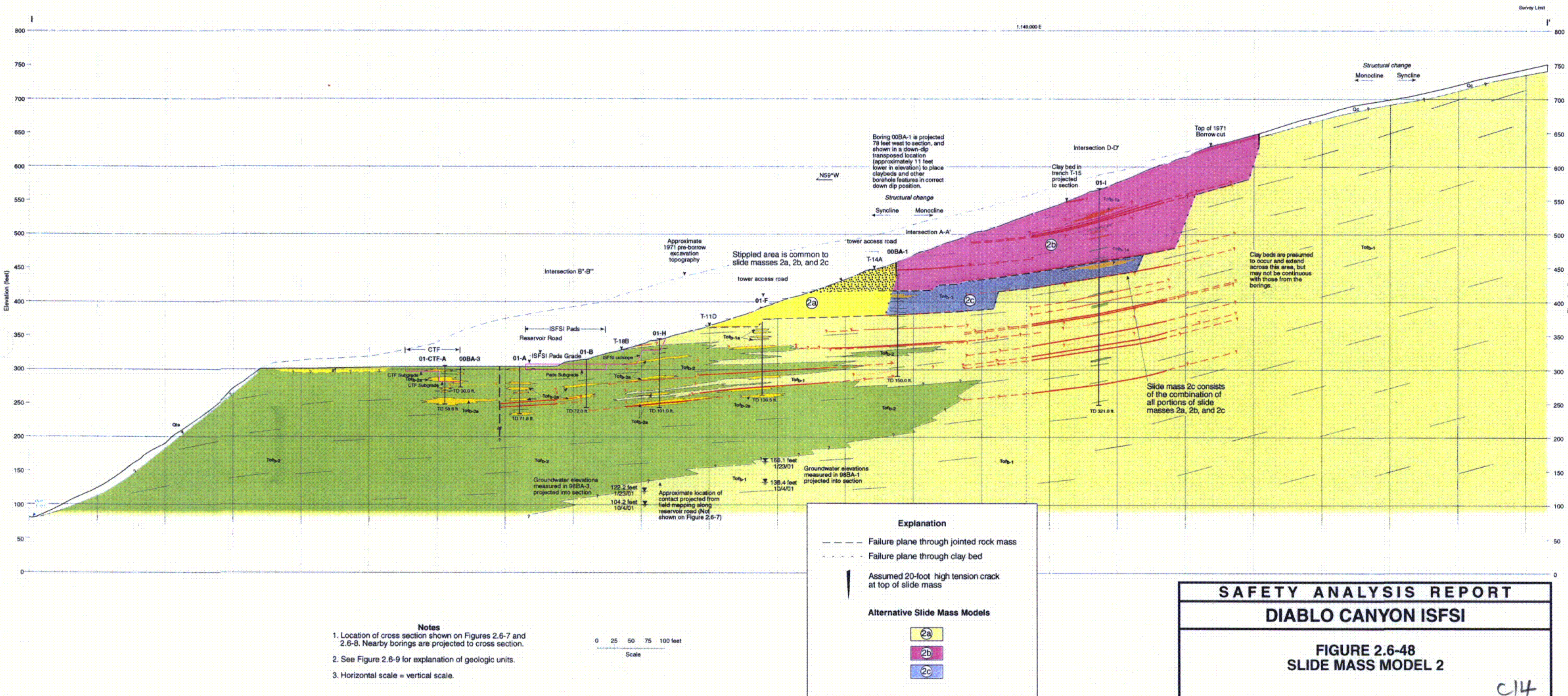
FIGURE 2.6-47
SLIDE MASS MODEL 1

C13



Notes

1. Location of cross section shown on Figures 2.6-7 and 2.6-8. Nearby borings are projected to cross section.
2. See Figure 2.6-9 for explanation of geologic units.
3. Horizontal scale = vertical scale.

0 25 50 75 100 feet
Scale

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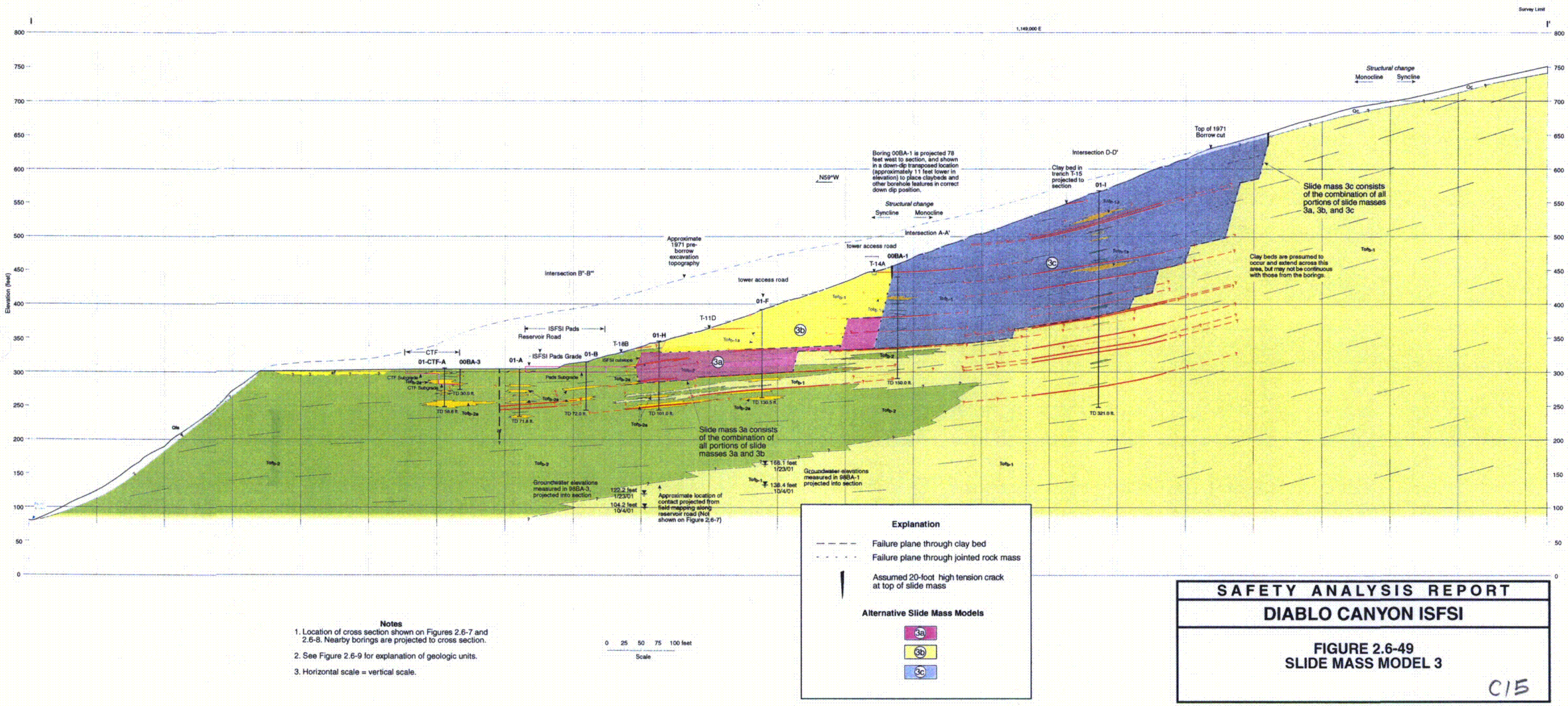
FIGURE 2.6-48
SLIDE MASS MODEL 2

C14



Notes

1. Location of cross section shown on Figures 2.6-7 and 2.6-8. Nearby borings are projected to cross section.
2. See Figure 2.6-9 for explanation of geologic units.
3. Horizontal scale = vertical scale.

0 25 50 75 100 feet
Scale

SAFETY ANALYSIS REPORT

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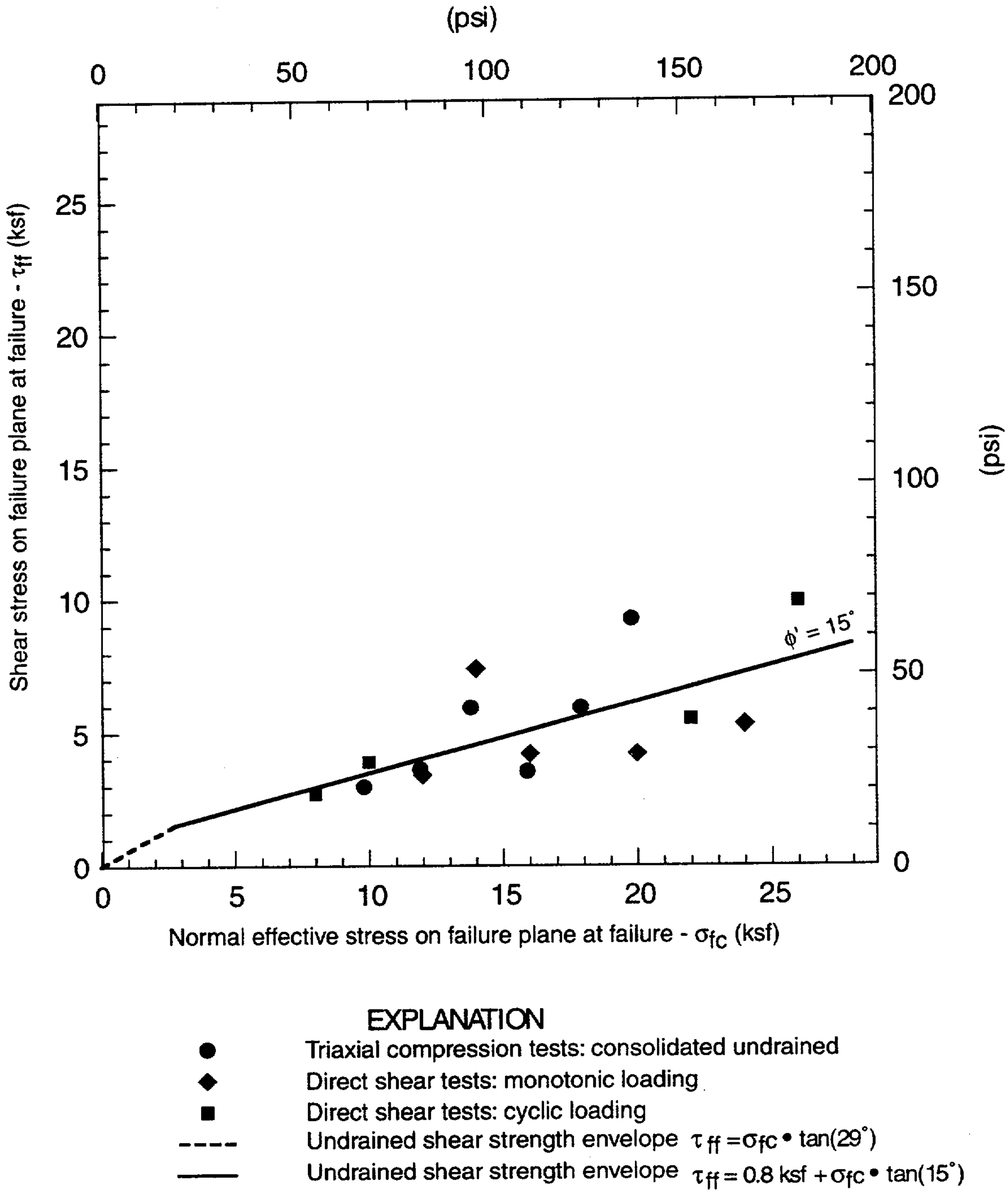
FIGURE 2.6-49
SLIDE MASS MODEL 3

C15



Data from William Lettis & Associates, 2001, Diablo Canyon ISFSI Data Report G, Soil Laboratory Test Data, Cooper Testing Laboratory

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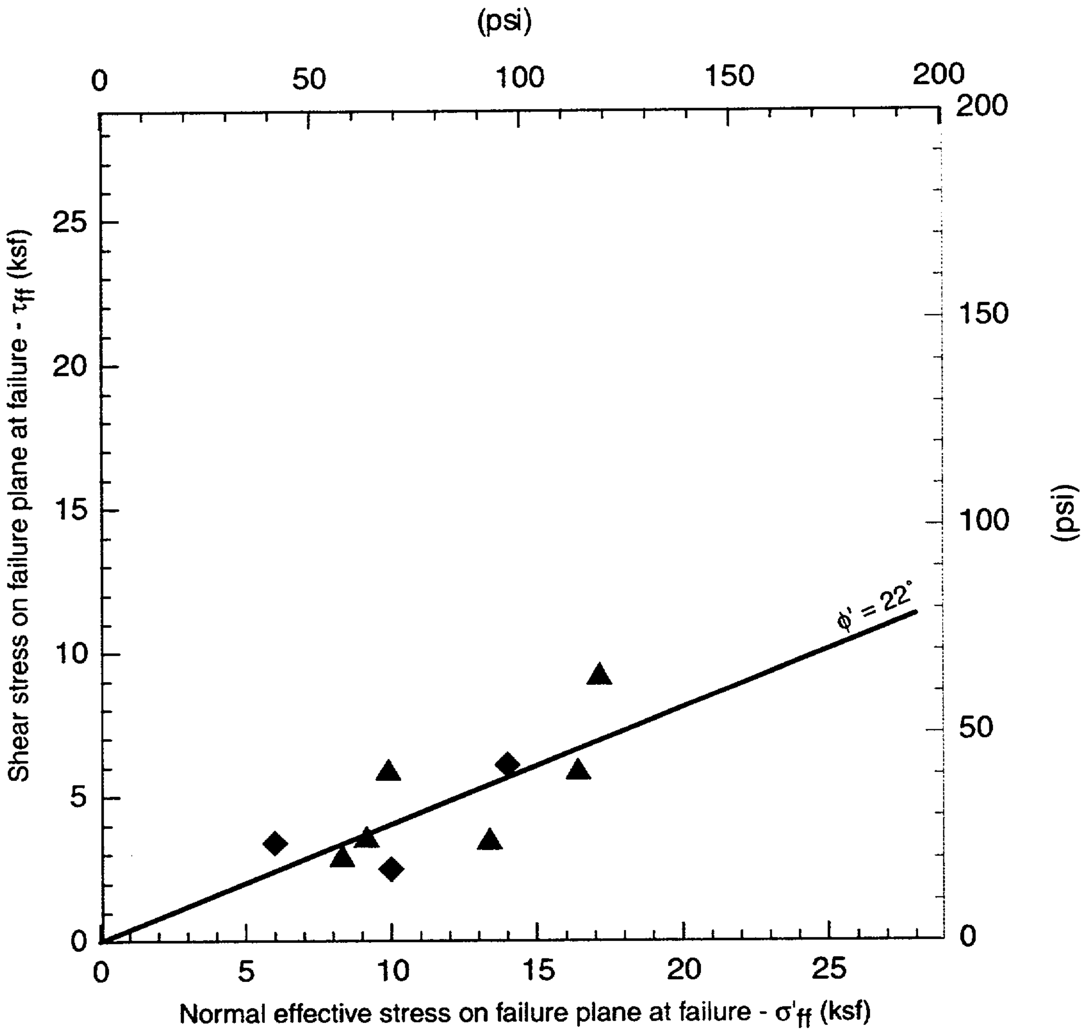
FIGURE 2.6-50
DESIGN UNDRAINED STRENGTH OF CLAY BEDS



EXPLANATION

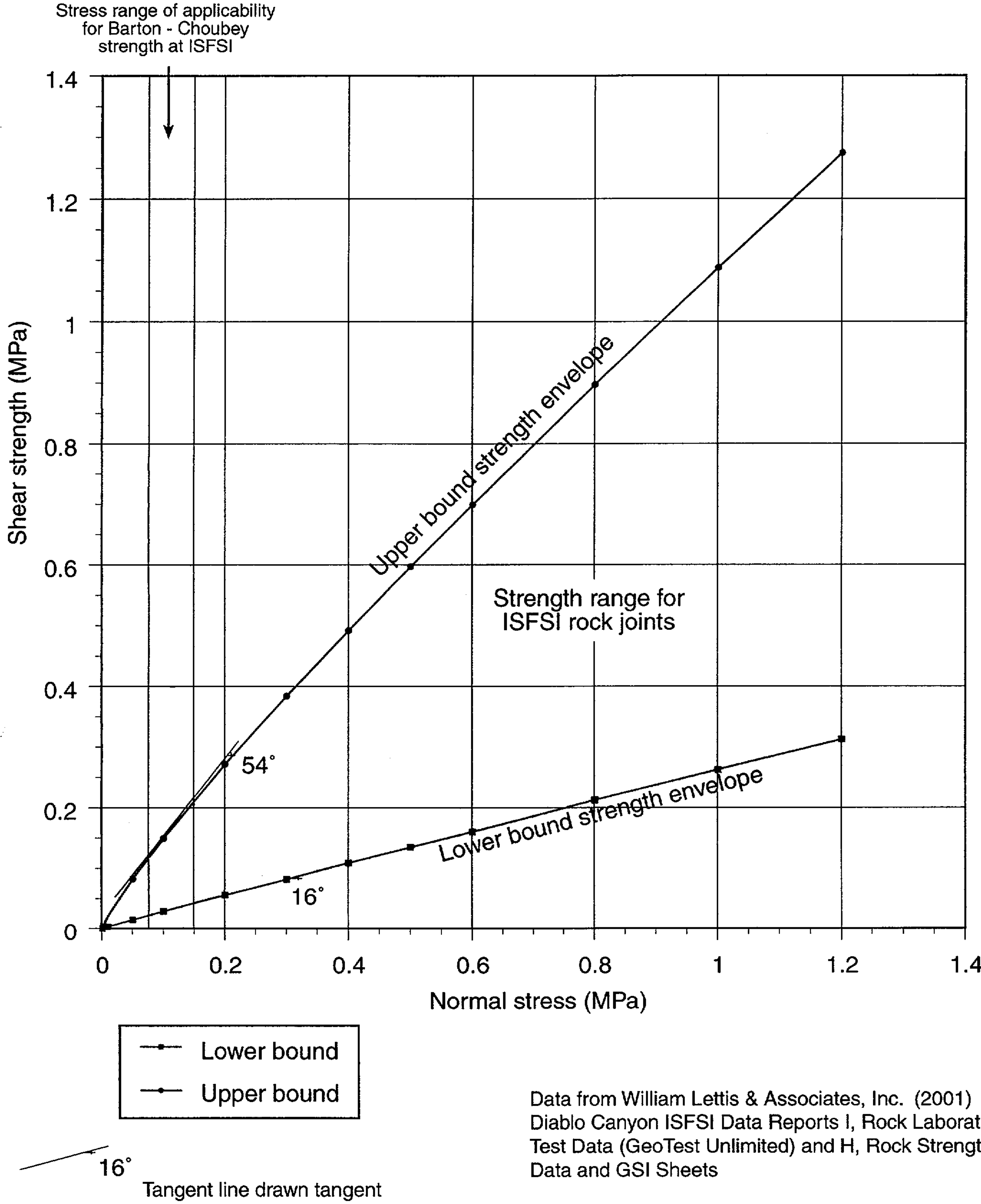
▲ Triaxial compression tests: consolidated undrained

◆ Direct shear tests: drained monotonic loading

—— Effective friction angle (ϕ') = 22 deg, c'= 0 psf

Data from William Lettis & Associates, 2001, Diablo Canyon ISFSI Data Report G, Soil Laboratory Test Data, Cooper Testing Laboratory

SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-51 DESIGN DRAINED STRENGTH OF CLAY BEDS



Tangent line drawn tangent to the curve at the midpoint of normal stress range (0 to 0.15 MPa).

Data from William Lettis & Associates, Inc. (2001) Diablo Canyon ISFSI Data Reports I, Rock Laboratory Test Data (GeoTest Unlimited) and H, Rock Strength Data and GSI Sheets

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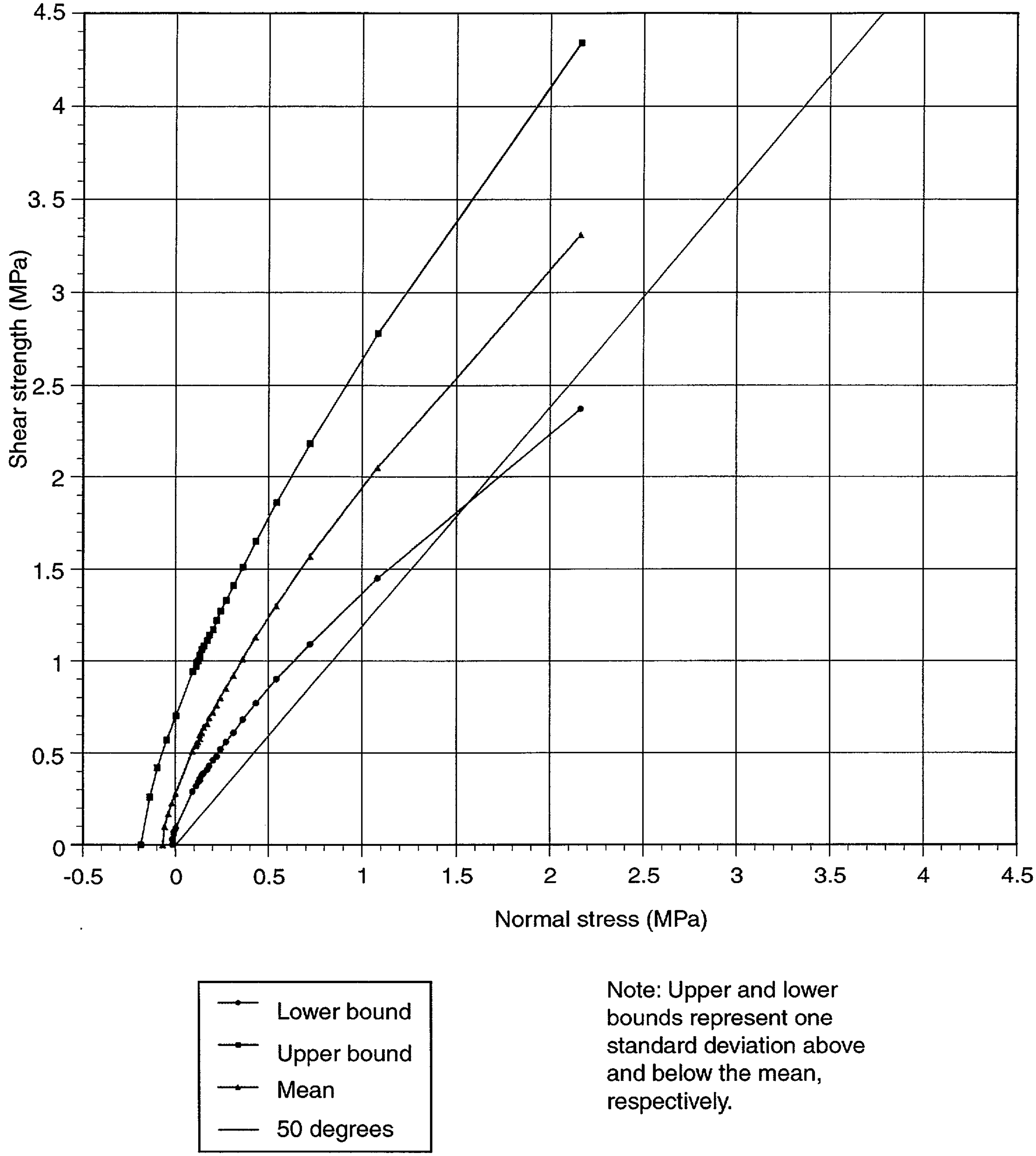
DIABLO CANYON ISFSI

FIGURE 2.6-52
RANGE OF SHEAR STRENGTHS FOR IN SITU DOLOMITE AND SANDSTONE ROCK JOINTS USING THE BARTON-CHOUBEY METHOD

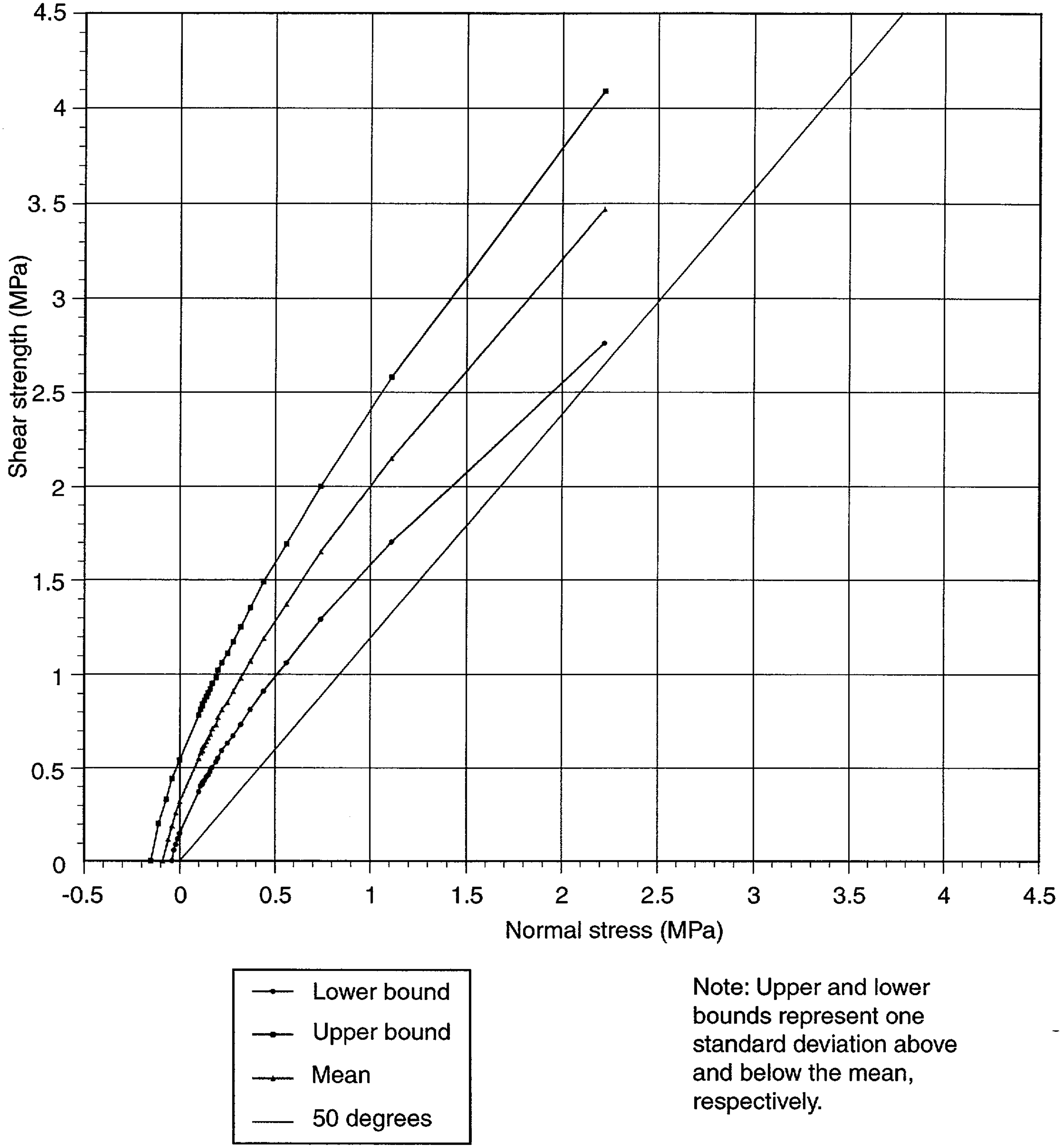


Note: Upper and lower bounds represent one standard deviation above and below the mean, respectively.

SAFETY ANALYSIS REPORT

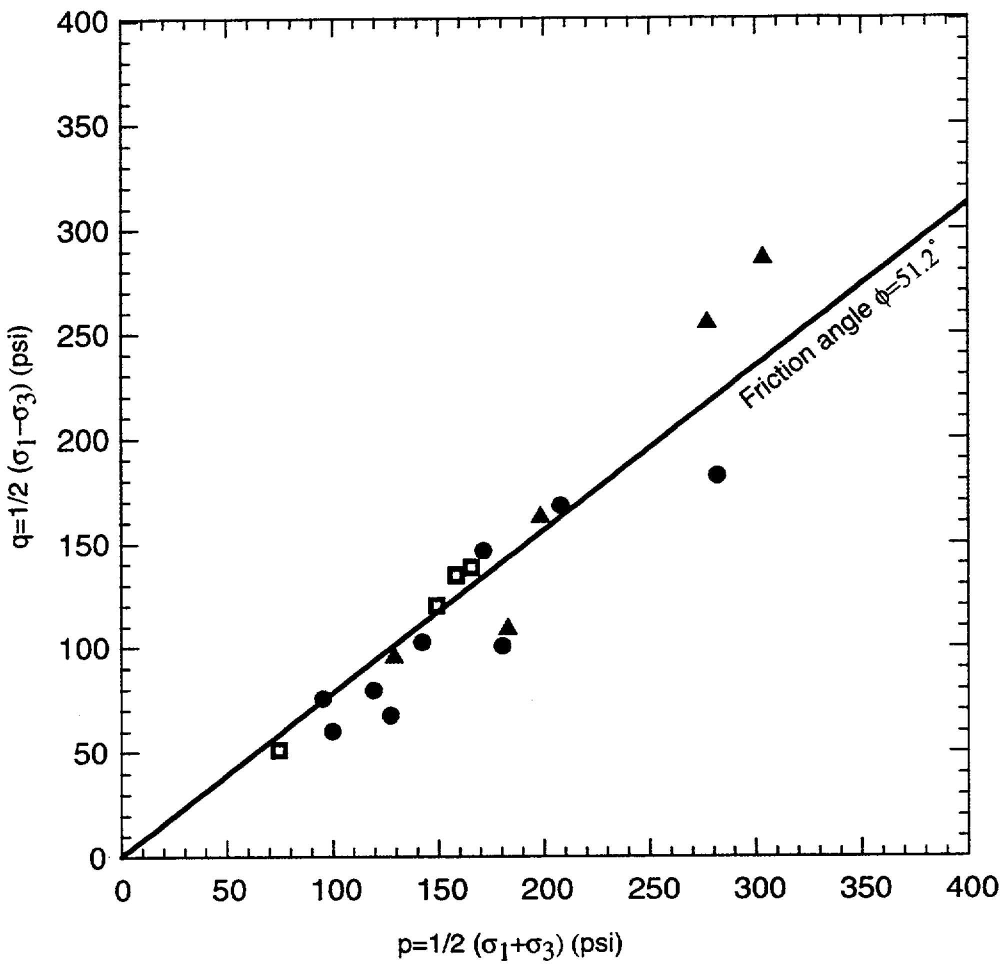
DIABLO CANYON ISFSI

FIGURE 2.6-53
COMPARISON OF HOEK-BROWN ENVELOPE FOR DOLOMITE WITH DESIGN STRENGTH OF 50 DEGREES



Note: Upper and lower bounds represent one standard deviation above and below the mean, respectively.

SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-54 COMPARISON OF HOEK-BROWN ENVELOPE FOR SANDSTONE WITH DESIGN STRENGTH OF 50 DEGREES



EXPLANATION

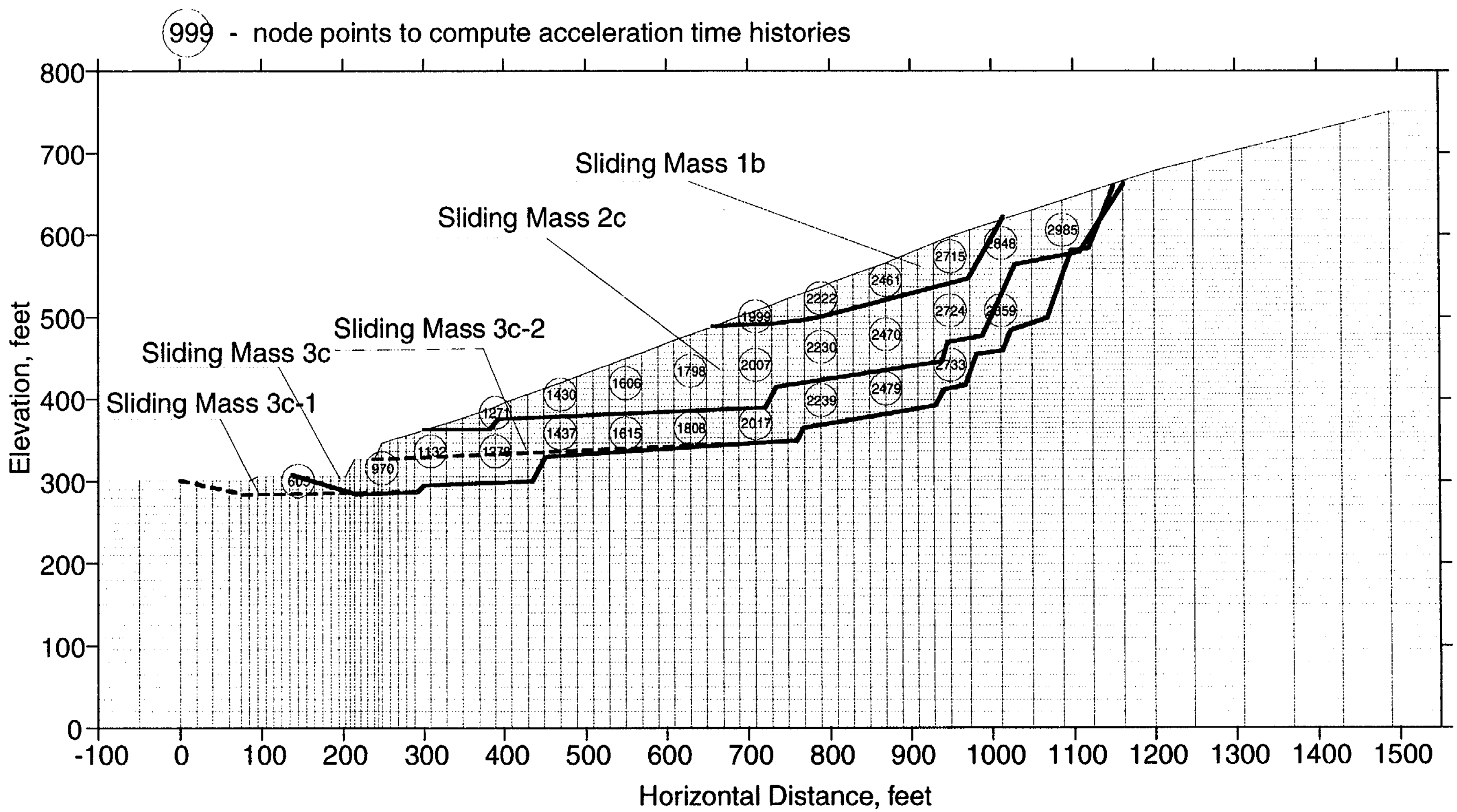
● Multi-stage triaxial tests with pore-water pressure measurements (pad + slope)

▲ Multi-stage triaxial tests without pore-water presure measurements (pad + slope)

◻ Multi-stage triaxial tests without pore-water pressure measurements from boring (00BA-2)

Data from William Lettis & Associates, 2001, Diablo Canyon ISFSI Data Report G, Soil Laboratory Test Data, Cooper Testing Laboratory

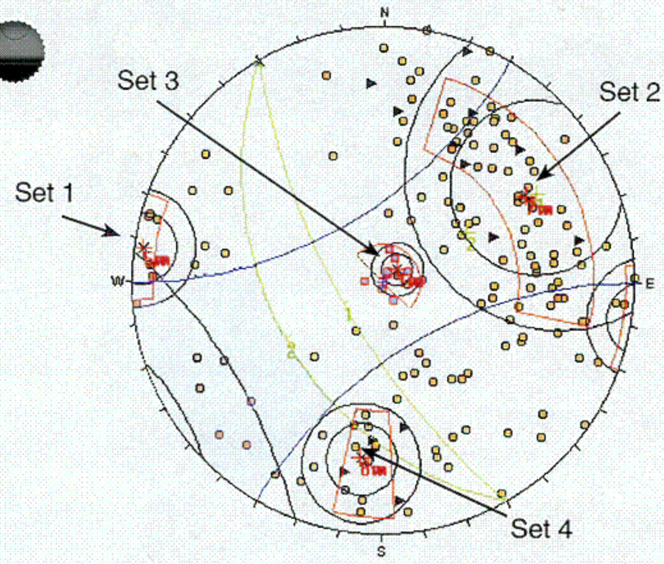
SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-55 TOTAL STRENGTH ANALYSIS OF FRIABLE SANDSTONE BASED ON TRIAXIAL TESTS



SAFETY ANALYSIS REPORT

DIABLO CANYON ISFSI

FIGURE 2.6-56
POTENTIAL SLIDING MASSES AND NODE POINTS FOR COMPUTED ACCELERATION TIME HISTORIES



A. Topple hazard (low hazard)

Explanation

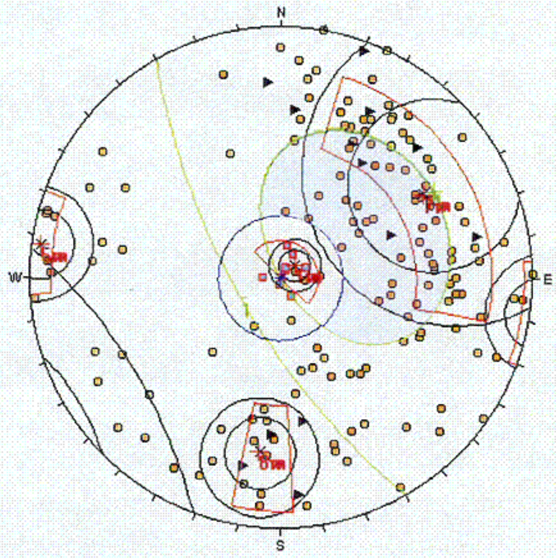
Poles

- Bedding
- Fault
- Joint

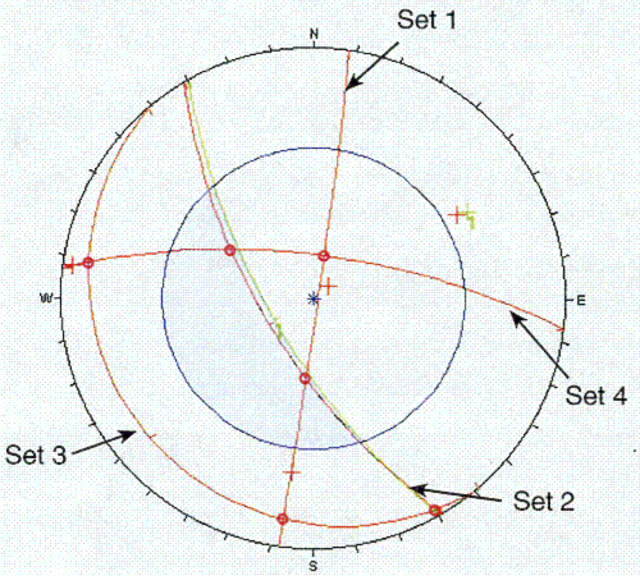
Failure envelope (based on 28° friction angle)

Failure envelope for topple and planar sliding without poles indicates stable conditions.

Failure envelope for wedge sliding without great circle intersections indicates stable conditions.



B. Planar sliding hazard (moderate to high hazard)



C. Wedge sliding hazard (moderate to high hazard)

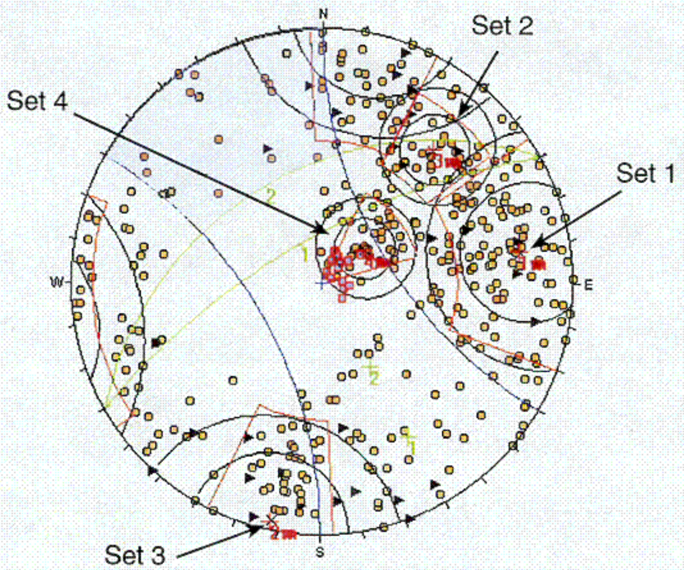
Notes

Analysis performed using computer program DIPS (Rocscience, 1999, DIPS: Plotting analysis, and presentation of structural data using spherical projection techniques, version 5.041, Toronto, 86p).

Data for east cutslope analyses taken from trenches T-3, T-4, T-20, and T-21, and borings 00BA-2, 01-E, and 01-G

SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-57 KINEMATIC ANALYSES OF EAST CUTSLOPE

C16



A. Topple hazard (low hazard)

Explanation

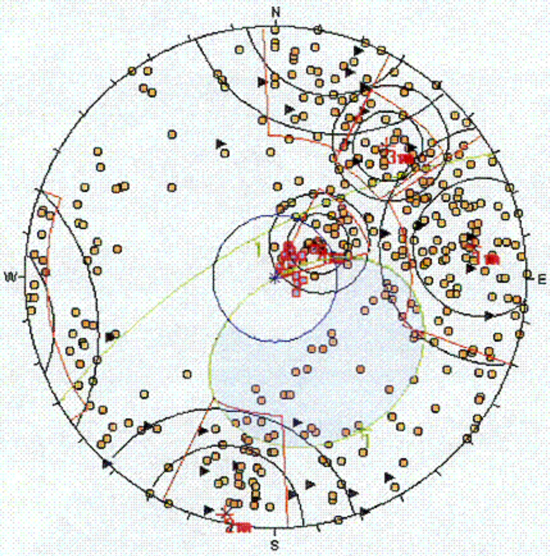
Poles

- Bedding
- Fault
- Joint

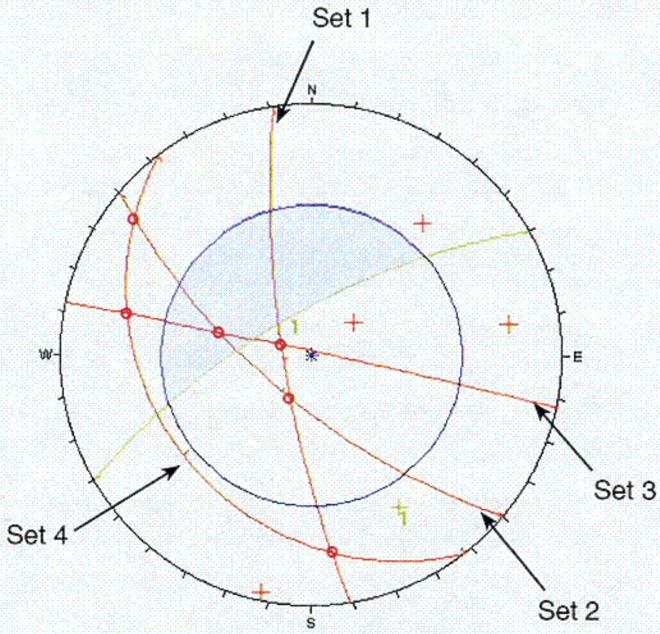
Failure envelope (based on 28° friction angle)

Failure envelope for topple and planar sliding without poles indicates stable conditions.

Failure envelope for wedge sliding without great circle intersections indicates stable conditions.



B. Planar sliding hazard (low to moderate hazard)



C. Wedge sliding hazard (high hazard)

Notes

Analysis performed using computer program DIPS (Rocscience, 1999, DIPS: Plotting analysis, and presentation of structural data using spherical projection techniques, version 5.041, Toronto, 86p).

Data for back cutslope analyses taken from trenches T-3, T-4, T-5, T-6, T-11, T-12, T-18, and T-20, discontinuity survey DS-1, and borings 00BA-2, 01-F and 01-H.

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DIABLO CANYON ISFSI
FIGURE 2.6-58 KINEMATIC ANALYSES OF BACK CUTSLOPE

C17

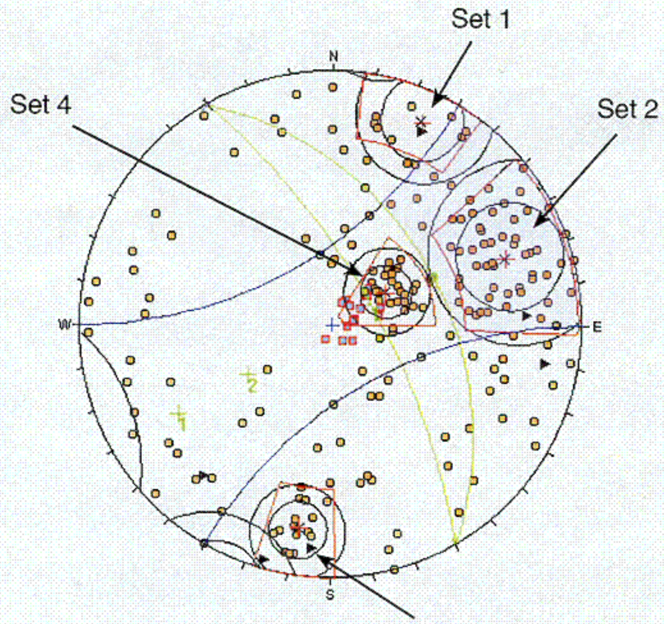
Explanation

Poles
- Bedding
- Fault
- Joint

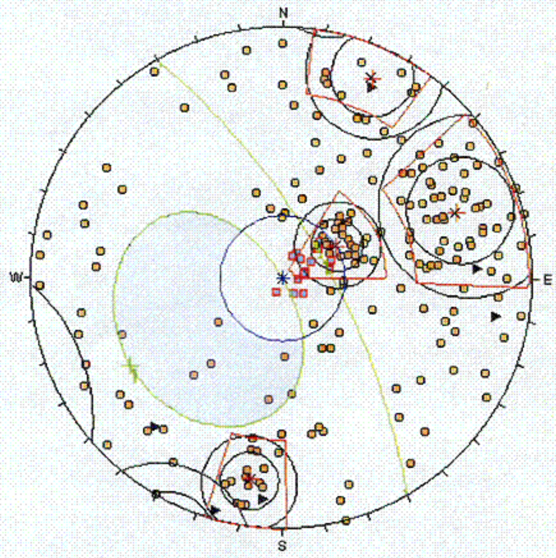
Failure envelope (based on 28° friction angle)

Failure envelope for topple and planar sliding without poles indicates stable conditions.

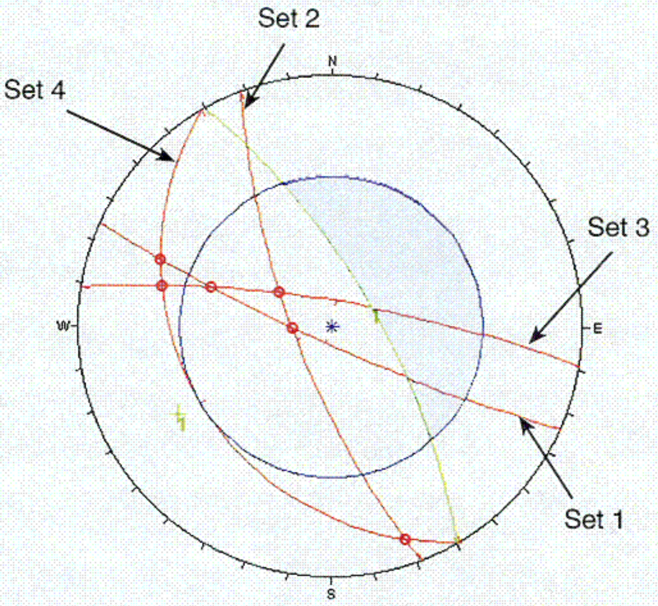
Failure envelope for wedge sliding without great circle intersections indicates stable conditions.



A. Topple hazard (high hazard)



B. Planar sliding hazard (low hazard)



C. Wedge sliding hazard (very low hazard)

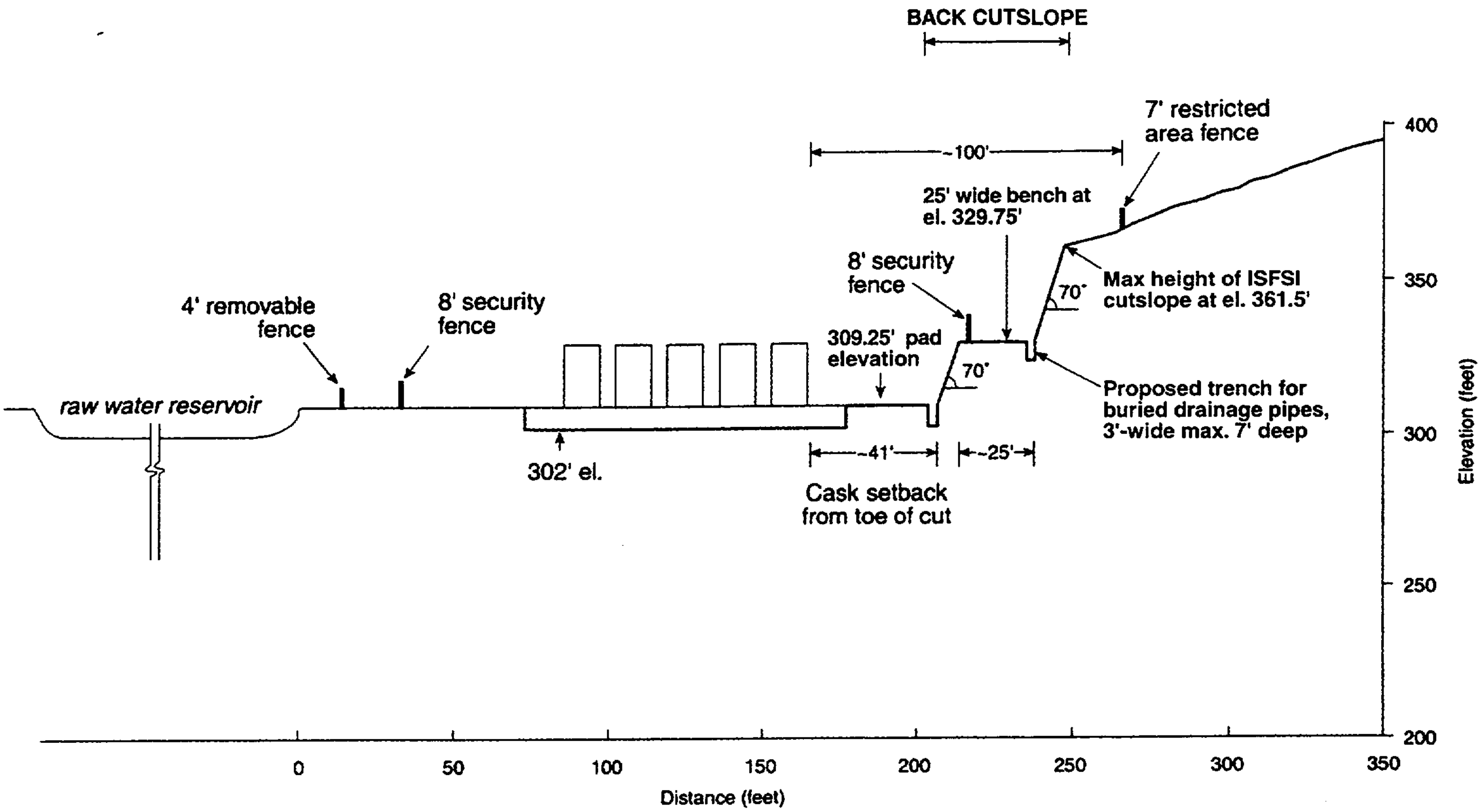
Notes

Analysis performed using computer program DIPS (Rocscience, 1999, DIPS: Plotting analysis, and presentation of structural data using spherical projection techniques, version 5.041, Toronto, 86p).

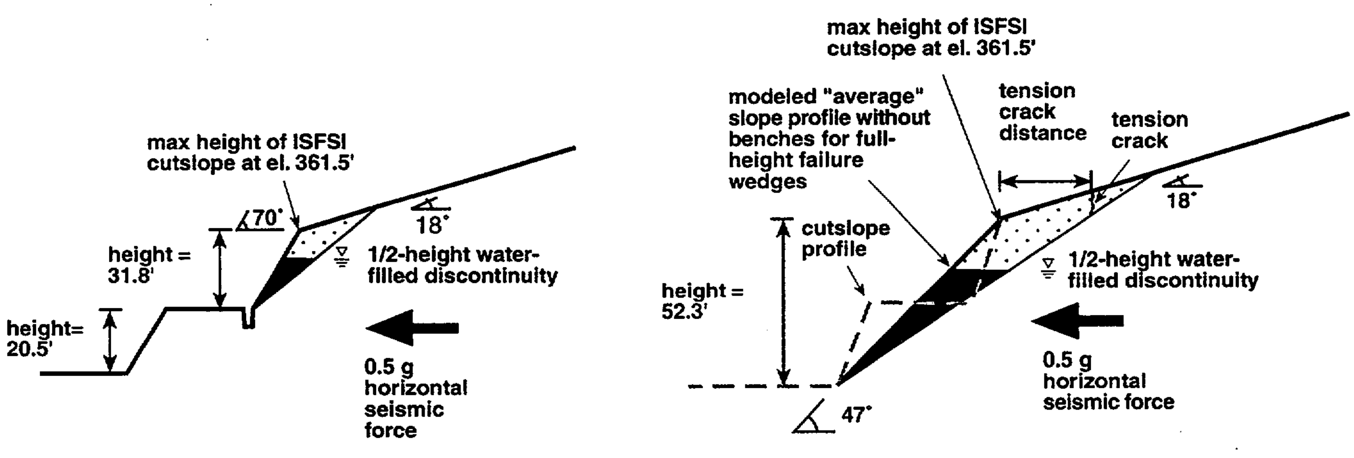
Data for west cutslope analyses taken from trenches T-11 and T-18, borings 01-A, 01-B, and 01-H, and discontinuity survey DS-1.

SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-59 KINEMATIC ANALYSES OF WEST CUTSLOPE

C18



A. Cross section through ISFSI pad and back cut, looking east



Example of riser-height (single bench) wedge

Example of total cut-height wedge as modeled by SWEDGE program

B. SWEDGE analysis cut configurations

SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 2.6-60 CUTSLOPE CONFIGURATION USED IN SWEDGE ANALYSES

CHAPTER 3

PRINCIPAL DESIGN CRITERIA

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CHAPTER 3

PRINCIPAL DESIGN CRITERIA

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CHAPTER 3

PRINCIPAL DESIGN CRITERIA

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CHAPTER 3

PRINCIPAL DESIGN CRITERIA

This chapter describes the design bases and criteria for the Diablo Canyon ISFSI. Section 3.1 provides the purposes of the installation, while Sections 3.2 through 3.4 provide the design criteria for the ISFSI structures, systems, and components (SSCs) classified as important to safety. These SSCs include the multi-purpose canister (MPC), the storage overpack, the HI-TRAC transfer cask, the storage pads, the cask transporter, and the cask transfer facility (CTF). Section 3.2 provides the design criteria for environmental conditions and natural phenomena, while Section 3.3 provides the other design criteria for these SSCs. Section 3.4 summarizes the principal design criteria. Chapter 4 provides the descriptive design information for these SSCs with emphasis on those design features that are important to safety, are covered by the quality assurance program, and are employed to withstand environmental and accident forces. Appendix A to this SAR is a discussion of conformance with NRC Interim Staff Guidance (ISG-15) dated January 10, 2001, on dry cask storage materials.

3.1 PURPOSES OF INSTALLATION

The Diablo Canyon ISFSI is designed for interim, dry, and above-ground storage of intact and damaged spent nuclear fuel assemblies, fuel debris, and nonfuel hardware from DCPP Units 1 and 2. The ISFSI will use the Holtec International HI-STORM 100 System storage system, as discussed in Section 1.1 of this SAR.

The material from the DCPP spent fuel pool (SFP) will be sealed in MPCs, transported to the CTF in the transfer cask, the MPC transferred to the HI-STORM 100SA overpack, and stored in HI-STORM 100SA ventilated storage overpacks arranged on and anchored to a reinforced concrete pad. The stand-alone ISFSI will allow additional spent fuel to be stored in the SFP allowing for continued operation of DCPP. The Diablo Canyon ISFSI is designed to ultimately store up to 4,400 spent fuel assemblies or up to 138 casks, with 2 spare locations. This capacity will facilitate the management of damaged fuel assemblies and fuel debris using a minimal number of MPC-24Es and MPC-24EFs.

The primary MPC type used will be the MPC-32, which can store up to 32 intact fuel assemblies, with or without nonfuel hardware. Three other types of MPCs also can be used as needed, namely: the MPC-24, MPC-24E, and MPC-24EF, all of which can hold up to 24 total fuel assemblies, with or without nonfuel hardware. The MPC-24 can store up to 24 intact fuel assemblies; the MPC-24E can store up to 4 damaged fuel assemblies in damaged fuel containers, with the balance being intact fuel assemblies; and the MPC-24EF can store up to 4 damaged fuel assemblies or fuel debris in damaged fuel containers, with the balance being intact fuel assemblies. All specified MPCs can be stored in the HI-STORM 100SA storage overpack. Since the MPC-32 can accommodate more intact fuel assemblies, it is the preferred storage canister. These MPCs provide the needed flexibility and capability to meet the anticipated spent fuel storage needs for DCPP.

3.1.1 MATERIAL TO BE STORED

The materials to be stored at the ISFSI consist of intact fuel assemblies, damaged fuel assemblies, fuel debris, and nonfuel hardware. Each fuel assembly contains approximately 1,100 pounds (500 kg) of UO_2. Nonfuel hardware may be stored within fuel assemblies and consists of borosilicate absorber rods, wet annular burnable absorber rods (WABAs), thimble plug devices (TPDs), and rod cluster control assemblies (RCCAs). Discussed herein are the characteristics of these materials and how the HI-STORM 100 System storage system design criteria envelopes these characteristics.

While the fuel rod cladding is a confinement barrier, credit is not taken for it in the design of the MPC or in the Diablo Canyon ISFSI Technical Specifications (TS).

3.1.1.1 Physical Characteristics

The spent fuel assemblies to be stored consist of both Westinghouse LOPAR and VANTAGE 5 assemblies. Both types are configured in a 17-by-17 array and the fuel rods consist of UO_2 pellets encapsulated in zirconium alloy tubing that is plugged and seal-welded at the ends. The VANTAGE 5 fuel rods have the same cladding wall thickness as the LOPAR fuel rods, but the fuel rod diameter is reduced to optimize the water-to-uranium ratio. Details of the physical characteristics of the DCPP fuel to be stored are provided in Table 4.1-1 of the DCPP FSAR Update (Reference 1) and are summarized in Table 3.1-1. Also provided in Table 3.1-1 are limiting values from the HI-STORM 100 System Certificate of Compliance (CoC) (Reference 2), as amended by License Amendment Request (LAR) 1014-1 (Reference 3), where applicable. With the exception of DCPP fuel assemblies with annular fuel pellets and Zirlo clad fuel with burnup > 45,000 MWD/MTU, the LOPAR and VANTAGE 5 fuel assemblies are bounded by the 17x17B and 17x17A array/classes of fuel assemblies, respectively, as described in the HI-STORM 100 System CoC, as amended by LAR 1014-1. PG&E anticipates modifying this site-specific license in the future to include additional fuel types and fuel characteristics following their review and approval by the NRC as part of the HI-STORM 100 System CoC.

The following fuel assembly physical characteristics constitute the most significant limiting parameters for storage of intact fuel assemblies at the Diablo Canyon ISFSI:

(1) Initial Fuel Enrichment

The maximum initial fuel enrichment of any fuel that is stored at the ISFSI will be limited to 5 percent as required by the Diablo Canyon ISFSI TS and SAR Section 10.2.

(2) Physical Configuration/Condition

Only fuel and associated nonfuel hardware irradiated at DCPP Units 1 and 2 with the physical configuration described in this section and SAR Section 10.2 will be stored in the Diablo Canyon ISFSI.

Fuel records will be maintained that identify the configuration and initial enrichment of each fuel assembly. Each fuel assembly and associated nonfuel hardware are engraved with a unique identification number. A verification of these numbers will be made to ensure that only approved fuel and associated nonfuel hardware is loaded in MPCs in accordance with the Diablo Canyon ISFSI TS and SAR Section 10.2.

3.1.1.2 Thermal and Radiological Characteristics

Details of the thermal and radiological characteristics of the DCPP fuel to be stored are provided in Table 3.1-2. The following fuel assembly thermal and radiological characteristics constitute the most significant limiting parameters for storage of fuel assemblies at the Diablo Canyon ISFSI.

(1) Heat Generation

The maximum heat generation rate for an assembly that is stored at the Diablo Canyon ISFSI will be less than that specified in SAR Section 10.2.

The heat generation rate of an individual fuel assembly is dependent on four factors: the initial fuel enrichment, the uranium mass, the fuel burnup, and the amount of cooling time. Fuel records will be used to ensure that the heat generation per assembly is less than that specified in SAR Section 10.2.

(2) Fuel Burnup

The maximum average fuel burnup per assembly of any fuel that is stored at the ISFSI will be limited to that specified in SAR Section 10.2. The maximum allowed burnup is a function of the fuel cooling time.

(3) Cooling Time

The cooling time of any fuel that is stored at the ISFSI will be greater than or equal to 5 years as specified in SAR Section 10.2. The minimum required cooling time is a function of the fuel burnup and decay heat.

(4) Surface Dose Rates

The transfer cask and overpack surface dose rates from the fuel assemblies stored in an individual HI-STORM 100SA overpack at the Diablo Canyon ISFSI are dependent on the initial fuel enrichment, uranium mass, burnup, cooling time, and the presence of nonfuel hardware.

Fuel records will be used to verify that, prior to loading, all fuel parameters are in compliance with SAR Section 10.2.

3.1.1.3 Nonfuel Hardware

Nonfuel hardware, consisting of borosilicate absorber rods, wet annular burnable absorber rods, thimble plug devices, and rod cluster control assemblies may be stored integral with the spent fuel assemblies. The nonfuel hardware type, burnup, and cooling time will be limited to that specified in Section 10.2 of this SAR. DCPP neutron sources are not authorized for loading into the HI-STORM 100 System at the present time. Neutron sources will be added to the authorized contents of the HI-STORM 100 System by amendment at a later date.

3.1.2 GENERAL OPERATING FUNCTIONS

The overall operation of the HI-STORM 100 system is summarized in Chapter 1 of the HI-STORM 100 System FSAR (Reference 4). The following major operational sequences include:

- Moving the transfer cask containing the empty MPC into the SFP
- Loading of spent fuel assemblies into the MPC in the SFP
- Removal of the loaded MPC and transfer cask from the SFP
- MPC closure welding and draining, drying, and helium backfill operations
- Transfer of the MPC from the transfer cask to the overpack at the CTF
- Movement of the loaded overpack to the ISFSI storage pad

The above operational sequences are discussed generically in the HI-STORM 100 System FSAR. PG&E will develop site-specific implementing procedures that meet the intent of the HI-STORM 100 System FSAR and consider site-specific needs and capabilities. An overview of HI-STORM 100 System loading operations at Diablo Canyon is provided below. A more detailed discussion of operations is provided in Sections 4.4 and 5.1.

After the HI-STORM 100 System components are received onsite, inspected, and cleaned as necessary, they are prepared for movement into the DCPP fuel handling building/auxiliary building (FHB/AB). The MPC is installed in the transfer cask and the assemblage is moved into the cask washdown area. For movements between the SFP and the cask washdown area, a removable impact limiter will be temporarily affixed to the base of the transfer cask. The transfer cask containing an empty MPC is then lifted and lowered into the SFP. DCPP spent fuel assemblies are loaded into the MPC in the SFP. After the completion of fuel loading and fuel assembly verification, the MPC lid and lid retention system are lowered onto the top of the fuel basket. The transfer cask top lid nuts are installed to secure the MPC lid during subsequent lifting and handling and before lid welding. The loaded transfer cask is lifted vertically out of the SFP and moved laterally to a point above the cask washdown area. The loaded transfer cask is lowered into the cask washdown area, decontaminated to the extent practicable, and prepared for welding operations.

The MPC lid retention system is removed and the MPC lid is welded to the MPC shell. The transfer cask water jacket is filled with water to provide neutron shielding (this may occur before or after lid welding at the discretion of the DCPP radiation protection organization). The MPC is then drained of water, dried by vacuum or by forced helium dehydration, backfilled with helium, and leak tested. After leak testing, the vent and drain port cover plates and the MPC closure ring are welded on, the transfer cask lid is installed, and the loaded transfer cask is lifted and placed vertically onto a cask transport frame. The cask transport frame is used to pivot the transfer cask from the vertical to the horizontal orientation in the receiving/shipping area. The transfer cask is moved in the horizontal orientation just outside of the FHB/AB into a position where the transporter with an engineered lift rig is used to lift the transfer cask and its attached cask transfer frame. The transporter then moves the transfer cask in a horizontal orientation along the transport route to the CTF, near the ISFSI pad. See Section 4.3 of this SAR for additional discussion regarding the cask transport system.

At the CTF, the cask transporter upends the loaded transfer cask and the cask transport frame is detached. The transfer cask is lifted vertically to a height sufficient to place it atop an empty overpack that has been previously placed in a below-grade vault at the CTF. The MPC is lowered from the transfer cask into the overpack and the transfer cask is removed from atop the overpack. The overpack top lid is installed, the overpack is raised by a lifting platform, and the cask transporter is used to lift the overpack and transport it from the CTF to its designated storage location on the ISFSI storage pad where it is anchored in place. Equipment required to be available to mitigate off-normal conditions such as a loss of power is discussed in Chapter 8 of this SAR.

While in its storage configuration, no active components are needed to ensure safe storage of the spent fuel. Cooling is provided by natural convective flow of ambient air into the inlet air vents at the bottom of the overpack and out of the outlet vents at the top of the overpack. No utilities (that is, water, compressed air, electric power) are required to cool the spent fuel during storage. Adequate cooling air is assured through periodic surveillance of the overpack air duct inlet and outlet screens at the ISFSI pad to verify that the air duct screens are not blocked and are intact as required by the Diablo Canyon ISFSI TS.

3.1.3 REFERENCES

1. Diablo Canyon Power Plant Units 1 & 2 Final Safety Analysis Report Update, Revision 14, November 2001.

2. 10 CFR 72 Certificate of Compliance No. 1014 for the HI-STORM 100 System Dry Cask Storage System, Holtec International, Revision 0, May 2000.

3. License Amendment Request No. 1014-1, Holtec International, Revision 2, July 2001 including Supplements 1 through 4 dated August 17, 2001; October 5, 2001; October 12, 2001; and October 19, 2001; respectively.

4. Final Safety Analysis Report for the HI-STORM 100 System, Holtec International Report No. HI-2002444, Revision 0, July 2000.

3.2 DESIGN CRITERIA FOR ENVIRONMENTAL CONDITIONS AND NATURAL PHENOMENA

This section describes the design criteria for the Diablo Canyon ISFSI that are classified as important to safety and designed to withstand the effects of site-specific environmental conditions and natural phenomena. Regulatory requirements and guidance were drawn, as applicable, from 10 CFR 72 (Reference 1), Regulatory Guide 3.62 (Reference 2), the Standard Review Plan for ISFSIs (Reference 3), and the Standard Review Plan for Dry Cask Storage Systems (Reference 4). Diablo Canyon site-specific information for environmental conditions and natural phenomena was taken primarily from other parts of this SAR and from the DCPP FSAR Update (Reference 5). Holtec storage system design information was taken primarily from the HI-STORM 100 System Certificate of Compliance (CoC) (Reference 6), the HI-STORM 100 System FSAR (Reference 7), and Holtec International License Amendment Request (LAR) No. 1014-1 (Reference 8).

As discussed in Section 4.5 of this SAR, the ISFSI structures, systems, and components (SSCs) are classified as important-to-safety (ITS) or not important-to-safety (NITS) based on their design function. Among the SSCs classified as important to safety are the multi-purpose canisters (MPCs), the HI-STORM 100SA overpack, the storage pad, the HI-TRAC transfer cask, the onsite cask transporter, and the cask transfer facility (CTF). The ITS classification indicates that at least one subcomponent of the main component is classified as ITS. Other subcomponents may be classified as NITS, based on the function of the subcomponent. Design criteria for environmental conditions and natural phenomena for these entire key ISFSI SSCs are described in this section. Other design criteria for these key ISFSI SSCs are contained in Section 3.3.

Environmental conditions and natural phenomena specific to the Diablo Canyon ISFSI and DCPP sites are described and characterized in Chapters 2 and 3 of this SAR and in the DCPP FSAR Update. The DCPP FSAR Update is maintained up to date by PG&E and is, for the most part, directly applicable to the Diablo Canyon ISFSI. Some natural phenomena are different for the ISFSI site than for the power plant site. For example, flooding is not a credible event at the ISFSI site because of drainage and elevation differences between the power plant and the ISFSI site. Such differences are appropriately considered in this and other parts of the ISFSI SAR.

The storage system selected for the Diablo Canyon ISFSI, the HI-STORM 100 System, is designed to ensure that fuel criticality is prevented, fuel cladding and confinement integrity are maintained, the fuel remains retrievable, and reasonable radiation shielding is maintained under all Diablo Canyon site-specific design-basis loadings due to environmental conditions and natural phenomena.

The safe storage of the spent fuel assemblies depends upon the capability of the HI-STORM 100 System to perform its design functions. The HI-STORM 100 System is a self-contained, independent, passive system that does not rely on any other system for operation. At Diablo Canyon, the shortened and anchored version of the HI-STORM 100 System overpack, known as the HI-STORM 100SA, will be used. A description of the HI-STORM 100SA overpack is provided in Section 4.2.3. Stability under design-basis seismic loadings at the Diablo Canyon ISFSI is ensured by anchoring the HI-STORM 100SA overpack to the ISFSI pads, as described in Section 4.2.1. The overpack anchorage is the only required interface between the HI-STORM 100SA overpacks and other ISFSI components. Except for the anchorage details, all other overpack design features and functions are identical to the freestanding version of the system described in the HI-STORM 100 System FSAR. Therefore, the text of this section will refer to HI-STORM 100 System for simplicity.

The criteria used for the design of the HI-STORM 100 System were developed for generic certification of the HI-STORM 100 System under 10 CFR 72, Subpart L. The design criteria were chosen to bound the site-specific design criteria for most nuclear power plants in the United States, so that virtually any 10 CFR 50 licensee could use the HI-STORM 100 System at an onsite ISFSI under the general license provisions of 10 CFR 72. The principal design criteria for the HI-STORM 100 System meet all requirements of 10 CFR 72 and are described in Chapter 2 of the HI-STORM 100 System FSAR.

Environmental conditions and phenomena are summarized in this section for the important-to-safety SSCs, and include:

- Tornado and wind loadings, including tornado-borne missiles
- Water level (flood) design
- Seismic design
- Snow and ice loadings
- Combined load criteria
- Lightning
- Temperature and solar radiation.

The HI-STORM 100 System design features are evaluated in detail for fuel handling activities in the DCPP FHB/AB in a 10 CFR 50 LAR planned for submittal to the NRC in early 2002. The LAR describes MPC fuel loading in the spent fuel pools; draining, drying, sealing, helium filling, and helium leak testing the MPC while inside the HI-TRAC transfer cask; and loading the transfer cask onto the cask transporter for onsite transfer to the CTF.

3.2.1 TORNADO AND WIND LOADINGS

3.2.1.1 Applicable Design Parameters

As stated in Section 2.3.2, the highest recorded peak wind gust at the DCPP site was 84 mph. For storage system design purposes, a wind velocity of 80 mph is used (Section 3.3.1 of the DCPP FSAR Update) with a gust factor of 1.1, which envelopes the recorded, peak-gust value of 84 mph.

Tornado winds and outdoor tornado-borne missiles for the DCPP site are included in Section 3.3.2.1 of the DCPP FSAR Update. Specific wind speeds, pressure drops, and missile descriptions applicable to the operating configurations associated with the ISFSI site are presented in Tables 3.2-1 and 3.2-2. As shown in Table 3.2-1, the Diablo Canyon ISFSI tornado wind speeds are based on the DCPP FSAR Update and are bounded by those evaluated for licensing of the HI-STORM 100 System.

The HI-STORM 100 System, which includes all operating configurations applicable to the Diablo Canyon ISFSI, is generically designed to withstand pressures, wind loads, and missiles generated by a tornado as described in Section 2.2.3.5 of the HI-STORM 100 System FSAR. The design-basis tornado and wind loads for the HI-STORM 100 System are consistent with Regulatory Guide 1.76 (Reference 9), ANSI/ANS 57.9 (Reference 10), and ASCE 7-88 (Reference 11).

The tornado wind and missile evaluations for the DCPP ISFSI are based on the DCPP site licensing-basis wind speed of 200 mph shown in Table 3.2-1, and are considered representative of the ISFSI site. The tornado missiles evaluated for the Diablo Canyon ISFSI are listed in Table 3.2-2 and are a compilation of those from the DCPP FSAR Update; NUREG-0800, Section 3.5.1.4 (Reference 12) Spectrum II missiles; and three 500-kV tower missiles specific to the Diablo Canyon ISFSI site. Several of these missiles differ from those identified in the HI-STORM 100 System FSAR. The effects of these missiles are evaluated for Level D stress limits and cask penetration. The evaluation is consistent with the design criteria, as specified in NUREG-0800, Section 3.5.1.4, to withstand tornados in accordance with 10 CFR 72.120(a) and 72.122(b).

3.2.1.2 Determination of Forces on Structures

Tornado wind loads include consideration of the following, as applicable: (a) tornado wind load, (b) tornado differential pressure load, and (c) tornado missile impact load. The method of combining the applicable effective tornado wind, differential pressure, and missile impact loads to determine the total tornado load is done in accordance with NUREG-0800, Section 3.3.2.

3.2.1.3 Tornado Missiles

The HI-STORM 100 System, including the overpack and the transfer cask, is generically designed to withstand three types of tornado-generated missiles in accordance with NUREG-0800, Section 3.5.1.4, as noted in Table 3.2-2. The design basis for these missiles is discussed in Section 2.2.3.5 of the HI-STORM 100 System FSAR. The mass and velocity of these missiles, along with the design-basis tornado missiles for the Diablo Canyon ISFSI site are presented in Table 3.2-2. Table 3.2-2 also lists the DCPP licensing-basis tornado missiles. Due to the proximity of a 500-kV transmission tower to the ISFSI site, other missiles were evaluated as shown in Table 3.2-2. Missile evaluations are described in detail in Section 8.2.2 for cask transport from the FHB/AB, activities at the CTF, and at the ISFSI storage pad.

3.2.2 WATER LEVEL (FLOOD) DESIGN

The Diablo Canyon ISFSI pad is located at elevation +310 ft mean sea level (MSL). The Diablo Canyon ISFSI site surface hydrology is described in Section 2.4. It is concluded in Section 2.4 that there is no potential for flooding in the vicinity of the ISFSI. Therefore, flooding is not a consideration for ISFSI operations or on the capability of the dry storage cask system to safely store the spent fuel. Likewise, due to the elevation of the ISFSI site, tsunami is not a threat to the HI-STORM 100 Systems that are stored on the pad. Since the CTF is located adjacent to the ISFSI, these conclusions are also applicable for the potential flooding and tsunami impact on the CTF. A design-basis flooding event occurring during movement of the cask to or from the CTF along the transport route is not considered credible. Flooding of the overpack while it is located in the underground vault at the CTF is precluded by the use of a sump designed to remove any significant accumulation of water in the vault.

Therefore, while the HI-STORM 100 System is designed to withstand pressure and water forces associated with floods, such design features are unnecessary for the Diablo Canyon ISFSI and do not need to be evaluated. In conclusion, the ISFSI design is consistent with the design criteria of NUREG-0800 and ASCE 7-88 and can withstand floods as required by 10 CFR 72.120(a) and 72.122(b).

3.2.3 SEISMIC DESIGN

In accordance with 10 CFR 72.102(f)(1), the seismic design of the important-to-safety ISFSI SSCs, which include the HI-TRAC transfer cask, the HI-STORM 100SA overpack, the MPC, the CTF, the onsite cask transporter, and ISFSI storage pads, is based on design-earthquake ground motions that have been established for the plant site. Site seismic characteristics and vibratory ground motion are discussed in Sections 2.6.1 and 2.6.2.

The ISFSI SSCs are designed to withstand seismic loads during: (a) onsite transport of the loaded transfer cask, (b) transfer operations at the CTF, (c) transport of loaded overpack to the storage pad, and (d) storage of the overpack on the ISFSI pad. The design bases for the ISFSI SSCs, including analyses and design procedures, are discussed in Sections 4.2, 4.3, 4.4.5, and 8.2.1. Seismic design for the loading and handling of the transfer cask while in the

FHB/AB are addressed as part of a 10 CFR 50 LAR submittal to the NRC.

The HI-STORM 100SA is the short, anchored version of the HI-STORM 100S System. In contrast to a freestanding cask, the HI-STORM 100SA relies upon the anchorage hardware and its embedment into the ISFSI pad for resistance to overturning and sliding. The primary structural difference between the freestanding and anchored overpacks is the enlargement of the overpack base-plate diameter to accommodate a flange bolt circle, an upper ring, and a number of vertical gussets (Figure 4.2-7). Pretensioned anchor bolts are used to secure the overpack to an embedment in the pad. The ISFSI pads and associated embedments are an integral part of the seismic design of the cask system.

3.2.4 SNOW AND ICE LOADINGS

As noted in Section 2.3.2 of this SAR, essentially no snow or ice occurs at the ISFSI site. Therefore, even though the HI-STORM 100 System is designed to accommodate snow and ice loadings typical of the contiguous United States and Alaska, such design features are unnecessary for the Diablo Canyon ISFSI and do not need to be evaluated. In summary, the ISFSI meets the requirements of 10 CFR 72.120(a) and 72.122(b) for snow and ice loadings.

3.2.5 COMBINED LOAD CRITERIA

The HI-STORM 100 System is designed for normal, off-normal, and accident conditions, the definitions and design criteria for which are described in HI-STORM 100 System FSAR Sections 2.2.1, 2.2.2, and 2.2.3, respectively, as amended by LAR 1014-1. The service limits, design loads, and load combinations are described in Sections 2.2.5, 2.2.6 and 2.2.7 of the HI-STORM 100 System FSAR as amended by LAR 1014-1, respectively.

HI-STORM 100 System FSAR Section 3.1.2 provides additional detail regarding the generic analyses performed using the design criteria, loads and load combinations. This section also includes discussion of the methodologies used in the analyses. Load combinations for the CTF steel structure and equipment are discussed in Section 2.3.3.1 of the HI-STORM 100 System FSAR. The load combinations for the concrete portions of the CTF are in Section 3.3.4.2.7.1. Load combinations for the ISFSI pad concrete and HI-STORM 100SA anchor studs are in Section 3.3.2.3.1 and 3.3.2.3.2, respectively. As noted in Section 3.3.3.2.3, the cask transporter meets the applicable load criteria for the CTF, which are delineated in Section 2.3.3.1 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1. Therefore, the load combinations specified by the design criteria are appropriately considered for the design of ITS SSCs, as required by 10 CFR 72.122(b).

3.2.6 LIGHTNING

As noted in Section 2.3.1, thunderstorms at west-coast sites are rare phenomena. However, potential lightning strikes have been evaluated for the HI-STORM 100 System. This evaluation is described in Section 11.2.12.2 of the HI-STORM 100 System FSAR and in Section 8.2.8 of this SAR. The HI-STORM 100 System is a large, metal/concrete cask designed to be stored on an unsheltered ISFSI pad. As such, it may be subject to lightning strikes. If the HI-STORM 100 SYSTEM overpack is struck by lightning, the charge will travel through the steel shell of the overpack into the pad and ultimately into the ground. The overpack outer shell is made of a conductive material (carbon steel). This same shell will have two copper ground cables attached to it providing a direct path to the ground grid. The anchors associated with the HI-STORM 100SA overpack would further enhance grounding. The MPC is protected by the overpack and not subject to direct lightning strikes, which will be absorbed by the overpack. The possibility of lightning striking the cask during transport to and from the CTF is addressed in Sections 4.3 and 8.2.8. Therefore, the lightning design criteria meet the requirements of 10 CFR 72.122(b).

3.2.7 TEMPERATURE AND SOLAR RADIATION

Ambient temperature and incident solar radiation (insolation) values applicable to the ISFSI site are summarized in Section 2.3.2 of this SAR. The highest recorded hourly temperature at the Diablo Canyon site is 97°F and the lowest temperature was below freezing for a few hours. The annual average temperature is approximately 55°F. The maximum insolation values for the ISFSI site are estimated to be 766 g-cal/cm^2 per day for a 24-hour period and 754 g-cal/cm^2 for a 12-hour period.

Table 2.2.2 of the HI-STORM 100 System FSAR provides the design environmental and soil temperatures for the HI-STORM 100 System. This includes temperatures and insolation (or lack thereof), as applicable for normal, off-normal, and extreme (accident) conditions. The design temperature for normal conditions is an annual average temperature of 80°F. The extreme (three-day average) temperature limits for the HI-STORM 100 System are -40°F and 125°F, although cask loading, transport, and unloading operations must be conducted with a working area ambient temperature greater than or equal to 0°F (Reference 6, Appendix B, Section 3.4.8).

Sections 4.4.1.1.8 and 4.5.1.1.3 of the HI-STORM 100 System FSAR describe how the HI-STORM 100 System design meets the 10 CFR 71.71(c) insolation requirements (that is, 800 g-cal/cm^2 for flat surfaces and 400 g-cal/cm^2 for curved surfaces) for normal storage conditions and normal handling and transport conditions, respectively. By meeting the insolation requirements of 10 CFR 71.71(c), the HI-STORM 100 System design bounds the maximum insolation values expected for the ISFSI site.

In summary, the HI-STORM 100 System design bounds both the temperature and insolation values expected at the Diablo Canyon ISFSI site. Evaluation of the thermal design for the cask system was carried out during licensing of the HI-STORM 100 System and is documented in the NRC's HI-STORM 100 System Safety Evaluation Report supporting the HI-STORM 100 System CoC.

3.2.8 CRITERIA FOR SLOPE STABILIZATION MEASURES

The ISFSI site is designed to provide a pad site and slopes that are: (a) stable in the long-term under seismic conditions, and (b) conform to the requirements in Appendix A of 10 CFR 100, 10 CFR 72.102, and guidance in NUREG-1567. The design is based on site conditions, field investigations, laboratory testing, material properties, slope analyses, and recommendations discussed in SAR Section 2.6. Surface and overall stability of cut slopes were evaluated using kinematic, limit equilibrium, pseudostatic, and dynamic analyses.

Slope anchorage will conform to Post Tensioning Institute guidelines (Reference 13) and the manufacturer design, installation, and proof testing criteria. Anchor design shall provide a factor of safety over rock block seismic forces of 1.3, as determined in Section 2.6.5.2.2.5. Locations and numbers of anchors will be adjusted as necessary to accommodate any change in site conditions encountered during excavation and installation.

Measures will be taken as required to prevent raveling and limit weathering of the surface and to drain water from inside the hillside to limit buildup of hydrostatic pressure. Design, installation, and testing are to be per ACI 211.2-1998, 214-1997, 304.24-1996, and 506.2-1995; and ASTM A185-1997, C39-2001, and C1116-2000 (References 14 through 20), at a minimum.

Measures will be taken to mitigate any debris or rock falls from the slopes. The rockfall barrier will be designed to withstand a level of rockfall energy and volume to be determined by an approved rockfall analyses, for example, as approved by CALTRANS, and will be manufactured to ISO 9001 quality standards (Reference 21).

In addition, a retaining wall (approximately 10 ft high) will be used as shown in Figure 4.1-1 to ensure compacted fill materials remain stable.

A drainage system will divert and collect water from slopes, benches, and ISFSI pads in a controlled fashion and convey it to site drainage. Erosion control measures will protect vegetated slopes around the perimeter of the excavated slopes.

3.2.9 REFERENCES

1. 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.

2. Regulatory Guide 3.62, Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks, USNRC, February 1989.

3. Standard Review Plan for Spent Fuel Dry Storage Facilities, USNRC, NUREG-1567, March 2000.

4. Standard Review Plan for Dry Cask Storage Systems, USNRC, NUREG-1536, January 1997.

5. Diablo Canyon Power Plant Units 1 & 2 Final Safety Analysis Report Update, Revision 14, November 2001.

6. 10 CFR 72 Certificate of Compliance No. 1014 for the HI-STORM 100 System Dry Cask Storage System, Holtec International, Revision 0, May 2000.

7. Final Safety Analysis Report for the HI-STORM 100 System, Holtec International Report No. HI-2002444, Revision 0, July 2000.

8. License Amendment Request 1014-1, Holtec International, Revision 2, July 2001, including Supplements 1 through 4 dated August 17, 2001; October 5, 2001; October 12, 2001; and October 19, 2001; respectively.

9. Regulatory Guide 1.76, Design Basis Tornado for Nuclear Power Plants, USNRC, April 1974.

10. ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (dry type), American National Standards Institute.

11. Standard ASCE 7-88, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, 1988.

12. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, USNRC, NUREG-0800, July 1981.

13. Recommendations for Prestressed Rock and Soil Anchors, Post Tensioning Institute, 1996.

14. ACI-211.2-98, Standard Practice for Selecting Proportions for Lightweight Concrete, American Concrete Institute.

15. ACI-214-97, Recommended Practice for Evaluation of Strength Test Results of Concrete, American Concrete Institute.

16. ACI-304.24-96, Placing Concrete by Pumping Methods, American Concrete Institute.

17. ACI-506.2-95, Specification for Shotcrete, American Concrete Institute.

18. ASTM A185-97, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement, American Society for Testing and Materials.

19. ASTM C39-2001, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, American Society for Testing and Materials.

20. ASTM C1116-2000, Standard Specification for Fiber-Reinforced Concrete and Shotcrete, American Society for Testing and Materials.

21. ISO 9001 Quality Standards, Quality Management Systems Requirements, Third Edition, 2000.

3.3 DESIGN CRITERIA FOR SAFETY PROTECTION SYSTEMS

The Diablo Canyon ISFSI is designed for safe storage of spent nuclear fuel and associated nonfuel hardware. The ISFSI storage facility in general, and the HI-STORM 100 System storage casks in particular, are designed to protect the MPC contents and prevent release of radioactive material under normal, off-normal, and accident conditions in accordance with applicable regulatory requirements contained in 10 CFR 72 (Reference 1). Section 3.2 provides the design criteria for environmental conditions and natural phenomena for ISFSI SSCs. This section provides the other design criteria for the ISFSI SSCs.

3.3.1 HI-STORM 100 SYSTEM

3.3.1.1 General

The primary safety functions of each of the major components comprising the Diablo Canyon ISFSI are summarized below, with appropriate references to the HI-STORM 100 System FSAR (Reference 2) or other sections of this SAR for additional information.

3.3.1.1.1 Multi-Purpose Canister

The MPC is comprised of a cylindrical, strength-welded shell, fuel basket, lid, vent and drain port cover plates, and a welded closure ring. The MPC provides criticality control, decay heat removal, shielding, and acts as the primary confinement boundary for the storage system. The MPC may contain, at prescribed fuel basket locations, a damaged fuel container (DFC) that provides confinement, structural support, and retrievability for damaged fuel assemblies or fuel debris. A detailed description, design drawings, and a summary of the design criteria for the MPCs are provided in Sections 1.2.1.1, 1.5, and 2.0.1, respectively, of the HI-STORM 100 System FSAR, as amended by LAR 1014-1 (Reference 3).

3.3.1.1.2 HI-STORM 100SA Overpack

The HI-STORM 100SA overpack is a rugged, heavy-walled, cylindrical, steel structure. The structure is comprised of inner and outer concentric, carbon-steel shells, a baseplate, and a bolted top lid (comprised of steel plates and a concrete shield) with integral outlet vents. The annulus between the inner and outer shells is filled with concrete. A shortened, seismically-anchored version of the overpack, denoted as the HI-STORM 100SA, is used at the Diablo Canyon ISFSI

The overpack provides support and protection for the MPC during normal, off-normal, and accident conditions including natural phenomena such as tornadoes and earthquakes; provides radiation shielding; and facilitates rejection of decay heat from the MPC to the environs to ensure fuel cladding temperatures remain below acceptable limits. Detailed descriptions, design drawings, and a summary of the design criteria for the overpack are provided in

Sections 1.2.1.2.1, 1.5, and 2.0.2, respectively, of the HI-STORM 100 System FSAR, as amended by LAR 1014-1.

3.3.1.1.3 HI-TRAC 125 Transfer Cask

The HI-TRAC 125 transfer cask is a rugged, heavy-walled, cylindrical steel vessel weighing a maximum of 125 tons during use. The cask guides, retains, protects, and supports the MPC during load handling and transfer operations, including submersion in the SFP where the MPC is loaded. During load handling operations to and from the SFP with a loaded MPC, the transfer cask retains the unwelded MPC lid using a top lid retention device. The transfer cask also limits MPC vertical dynamic loading to within acceptable design-basis limits in the event of a postulated load drop inside the FHB/AB by using a removable bottom-mounted impact limiter. The transfer cask also features a single bottom lid that is removed at the CTF to facilitate the transfer of the MPC to or from the overpack. While submerged, the transfer cask prevents most of the exterior surfaces of the MPC from becoming contaminated by preventing contact with the SFP water.

Upon removal from the SFP, the transfer cask provides shielding to maintain personnel exposure ALARA, and facilitates heat transfer from the MPC to the environs. A more detailed description, and a summary of the design criteria for the transfer cask are provided in Sections 1.2.1.2.2, and 2.0.3, respectively, of the HI-STORM 100 System FSAR; and in Sections 5.1 and 10.2 of this SAR. A modified version of the HI-TRAC 125 transfer cask, known as HI-TRAC 125D, will be used to support Diablo Canyon ISFSI operations. See Section 4.2.3.2.4 for more detailed discussion of HI-TRAC 125D.

3.3.1.2 Protection by Multiple Confinement Barriers and Systems

3.3.1.2.1 Confinement Barriers and Systems

The HI-STORM 100 System provides several confinement barriers for the radioactive contents. Intact fuel assemblies have cladding that provides the first boundary within the MPC preventing release of the fission products. (The MPC confinement and radiological evaluations do not take credit for the cladding.) A DFC prevents the dispersal of gross particulates within the MPC for any fuel assemblies classified as damaged fuel or fuel debris. The MPC is a strength-welded enclosure that provides the confinement boundary for all normal, off-normal and accident conditions, including natural phenomena. The MPC confinement boundary is defined by the MPC baseplate, shell, lid, port cover plates, and the welds joining these components, as shown in Figure 3.3-1. The closure ring provides a redundant boundary. Refer to the drawings in Section 1.5 of the HI-STORM 100 System FSAR for details of the MPC confinement boundary design.

3.3.1.2.2 Cask Cooling

The HI-STORM 100 System provides decay heat removal both during processing and final storage of the MPC. As described previously, the transfer cask conducts heat from the MPC until the MPC is transferred to the overpack where convective cooling is established as depicted in Figure 3.3-2. The thermal design of the HI-STORM 100 System is discussed in detail in Chapter 4 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1, and in Section 4.2.3.3.3 of this SAR.

3.3.1.3 Protection by Equipment and Instrumentation Selection

3.3.1.3.1 Equipment

The cask transporter and CTF provide protection functions to the MPC and are discussed in Sections 3.3.3 and 3.3.4, respectively.

3.3.1.3.2 Instrumentation

No instrumentation is required for storage of spent nuclear fuel and associated nonfuel hardware at the Diablo Canyon ISFSI. Due to the welded closure of the MPC, the passively-cooled storage cask design, and the Diablo Canyon ISFSI TS requirement for periodic checks of the casks, the loaded overpacks do not require continuous surveillance and monitoring or operator actions to ensure the safety functions are performed during normal, off-normal or postulated accident conditions.

3.3.1.4 Nuclear Criticality Safety

The HI-STORM 100 System is designed to ensure the stored fuel remains subcritical with k_{eff} less than 0.95 under all normal, off-normal, and accident conditions. A detailed discussion of the criticality analyses for the HI-STORM 100 System is provided in Chapter 6 of the HI-STORM 100 System FSAR, as amended by Holtec LAR 1014-1. Section 4.2.3.3.5 of this SAR includes a summary discussion of the HI-STORM 100 System criticality design.

3.3.1.4.1 Control Methods for Prevention of Criticality

The design features and control methods used to prevent criticality for all MPC configurations are the following:

(1) Incorporation of permanent neutron absorbing material (Boral) attached to the MPC fuel basket walls with a minimum required loading of the ^{10}B isotope.

(2) Favorable geometry provided by the MPC fuel basket.

(3) Loading of certain fuel assemblies is performed in water with a soluble boron content as specified in the Diablo Canyon ISFSI TS.

There are a number of conservative assumptions used in the HI-STORM 100 System criticality analyses, including not taking credit for fuel burnup, fuel-related burnable neutron absorbers, and only crediting 75 percent of ^{10}B isotope loading in the Boral neutron absorbers. A complete list of the conservative assumptions in the HI-STORM 100 System criticality analyses is provided in Section 6.1 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1.

3.3.1.4.2 Error Contingency Criteria

Provisions for error contingency are built into the criticality analyses discussed in Chapter 6 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1. Because biases and uncertainties are explicitly evaluated in the analyses, it is not necessary to introduce additional contingency for error.

3.3.1.4.3 Verification Analyses

The criticality analyses for the HI-STORM 100 System were performed using computer codes validated for use in this application under the Holtec International Quality Assurance Program. A discussion of the analysis and the applicable computer codes is provided in Section 6.1 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1. Criticality benchmark experiments are discussed in Section 6.5 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1.

3.3.1.5 Radiological Protection

Radiation exposure due to the release of material from the storage system is precluded by the confinement boundary design, as discussed in Section 3.3.1.2. The confinement boundary is designed to maintain its integrity during all normal, off-normal, and accident conditions including natural phenomena. Radiation exposure due to direct and sky shine radiation is minimized to the extent practicable through the use of the "time, distance, and shielding" philosophy. This philosophy is implemented at the Diablo Canyon ISFSI through access control, minimization of required maintenance, and the design of the HI-STORM 100 System.

3.3.1.5.1 Access Control

The Diablo Canyon ISFSI storage pads are surrounded by two fences. The inner is a protected area fence in compliance with the requirements of 10 CFR 73.55. The outer is a restricted area fence in compliance with 10 CFR 20. Only authorized personnel with a need to be in these areas will be permitted entrance. These areas do not require the continuous presence of operators or maintenance personnel. During normal storage operations, the HI-STORM 100 System requires only infrequent, short-duration personnel activity to perform necessary checks on the material condition of the casks and to ensure the overpack air ducts are free of blockage. Higher occupancy times with a greater number of personnel will occur during placement of loaded overpacks at the storage pads and during construction of any additional storage pads. These activities will be governed by the DCPP radiation protection program to ensure occupational radiation exposures are maintained ALARA. Chapter 7 and Section 9.6 provide additional details regarding the implementation of access control at the Diablo Canyon ISFSI.

3.3.1.5.2 Shielding

The HI-STORM 100 System is designed to minimize radiation doses to DCPP personnel and the public through the use of a combination of concrete, lead, and steel shielding. The HI-STORM 100 System is designed to meet the annual dose limit of 25 mrem specified in 10 CFR 72.104 for annual dose at the DCPP owner-controlled-area boundary. The steel shell of the overpack includes concentric inner and outer shells. The annulus between the shells is filled with unreinforced concrete. The requirements for the unreinforced concrete used for shielding are stated in Appendix 1.D to the HI-STORM 100 System FSAR. The steel overpack lid is designed with steel-encased concrete shields to minimize the dose contribution due to sky shine.

The transfer cask is also fabricated from concentric steel shells. The annulus between the shells is filled with lead to provide significant gamma shielding while maintaining the diameter of the transfer cask small enough for loading into the SFP. The transfer cask also includes a water jacket surrounding the main body of the cask. The water jacket is filled with water after the loaded MPC and transfer cask are removed from the SFP to allow as much structural shielding as possible to be designed into the transfer cask without exceeding the 125-ton design weight. Water is not required in the water jacket to provide adequate shielding while there is water inside the MPC cavity. The water in the water jacket provides necessary shielding for neutrons after the water is drained from the inside of the MPC. The MPC lid, the transfer cask top lid, and the bottom shield are designed to provide necessary shielding during onsite transport of the transfer cask in the horizontal position.

The objective of shielding is to ensure that radiation dose rates at the following locations are below acceptable levels for those locations:

- Immediate vicinity of the storage cask
- Restricted area boundary
- Controlled area (site) boundary

Dose rates in the immediate vicinity of the loaded overpack are an important factor in consideration of occupational exposure. A design objective for the maximum average radial surface dose rate has been established as 60 mrem/hr. Areas adjacent to the inlet and exit vents that pass through the radial shield are limited to 60 mrem/hr. The average dose rate at the top of the overpack is limited to less than 60 mrem/hr.

A detailed discussion of the HI-STORM 100 System generic shielding evaluation, including modeling, source-term assumptions, and resultant dose rates is provided in Chapter 5 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1 (Reference 3). The site-specific shielding analysis is discussed in Section 7.3. Estimated occupational exposures and offsite doses for fuel loading, cask handling activities, and storage at the Diablo Canyon ISFSI have been evaluated for DCPP fuel and are discussed also in Sections 7.4 and 7.5.

3.3.1.5.3 Radiological Alarm Systems

The HI-STORM 100 System, when used outside the FHB/AB, does not produce any solid, liquid, or gaseous effluents. Release of loose contamination is not a factor because the HI-STORM overpack is not submerged in the SFP or otherwise subject to contamination. The transfer cask and MPC are submerged in the SFP, but contamination of the MPC is limited to the top of the MPC lid by the annulus seal, which prevents SFP water from coming into contact with the sides and bottom of the MPC. Upon removal from the SFP, the transfer cask and top of the MPC will be decontaminated. Therefore, the inadvertent release of loose contamination from the transfer cask produces a negligible dose effect.

The dose rates for a given storage cask at the Diablo Canyon ISFSI will be stable and decreasing over time due to the decay of the fuel sources stored inside. There is no credible event that could cause an increase in dose rate from the casks.

Based on the foregoing, there is no need for either airborne or area radiological alarms at the Diablo Canyon ISFSI storage pads or CTF. Radiological alarms, if required for operations inside the FHB/AB, will be implemented under the DCPP radiological protection program.

3.3.1.6 Fire and Explosion Protection

There are no combustible or explosive materials associated with the HI-STORM 100 System, except for the fuel contained in the cask transporter fuel tank. Such materials will not be permanently stored within the Diablo Canyon ISFSI protected area. The cask transporter may be parked within the ISFSI, which has been evaluated. However, for conservatism, several hypothetical fire and explosion events were evaluated for the Diablo Canyon ISFSI. Design criteria for fires and explosions are discussed in Section 2.2 and summarized in Section 3.4.

The generic fire evaluations for both the loaded overpack and the loaded transfer cask are described in Section 11.2.4 of the HI-STORM 100 System FSAR. The fire evaluations assume a maximum of 50 gallons of combustible fuel. Therefore, any transport vehicle used to move the loaded overpack or transfer cask is limited by the Diablo Canyon ISFSI TS to 50 gallons. A site-specific fire evaluation for the Diablo Canyon ISFSI site is provided in Section 8.2.5.

Small overpressures may result from accidents involving explosive materials that are stored or transported near the storage site. Explosion is an accident loading condition evaluated in Section 3.4.7.2 of the HI-STORM 100 System FSAR. An instantaneous overpressure of 10 psig and a steady-state overpressure of 5 psig for the storage cask were evaluated and found to be acceptable. A Diablo Canyon ISFSI explosion evaluation for transport to and from the CTF, at the CTF, and at the ISFSI storage pads is discussed in Section 8.2.6.

3.3.1.7 Materials Handling and Storage

3.3.1.7.1 Spent Fuel Handling and Storage

Spent fuel will be moved within the DCPP SFP and loaded into the HI-STORM 100 System in accordance with Diablo Canyon ISFSI TS, DCPP TS, and plant procedures. Only fuel assemblies meeting the burnup, cooling time, decay heat, and other limits of the Diablo Canyon ISFSI TS and SAR Section 10.2 will be loaded. Administrative controls will be used to ensure that no unauthorized fuel assemblies are loaded into the HI-STORM 100 System. The Diablo Canyon ISFSI TS and SAR Section 10.2 limits on fuel assemblies authorized for loading, in combination with the design features of the cask system described earlier in this section, ensure that:

- The k_{eff} for the stored fuel will remain less than 0.95.
- Adequate cooling will be provided to ensure peak fuel cladding temperature limits will not be exceeded.
- Radiation dose rates and accumulated doses to plant personnel and the public will be less than applicable limits.

The fuel selection process includes a review of reactor operating records for each fuel assembly and nonfuel hardware chosen for loading into the HI-STORM 100 System. Each fuel assembly will be classified as intact fuel, damaged fuel, or fuel debris, in accordance with the applicable definitions in the Diablo Canyon ISFSI TS and SAR Section 10.2. Fuel assemblies classified as damaged fuel or fuel debris are required to be placed in DFCs for storage in the HI-STORM 100 System.

Section 3.3.1.5 discusses contamination as it relates to the operation of the HI-STORM 100 System. The Diablo Canyon ISFSI TS and SAR Section 10.2 provide the necessary limits on MPC moisture removal, helium backfill, and helium leakage prior to declaring the MPC ready for storage. Chapter 8 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1, provides generic operating procedures for all facets of fuel loading, MPC preparation, and cask handling. The general operating sequence specific to the Diablo Canyon ISFSI is discussed in Sections 5.1 and 10.2 of this SAR. Implementation procedures will be developed based on both generic and site-specific guidelines, as applicable.

The HI-STORM 100 System is designed to allow retrievability of the fuel, as necessary. If the situation warrants fuel retrieval, the MPC is removed from the overpack and returned to the FHB/AB in the transfer cask. The MPC cavity gas is cooled, in accordance with the requirements of the Diablo Canyon ISFSI TS and SAR Section 10.2 and the HI-STORM 100 System FSAR. The MPC is reflooded, the lid removed, and the fuel assemblies are returned to the SFP. Fuel removal activities take place entirely inside the FHB/AB, ensuring that any radiological conditions are controlled and maintained ALARA.

3.3.1.7.2 Radioactive Waste Treatment

There are no radioactive wastes created by the HI-STORM 100 System while in storage at the storage pads, transport to or from the CTF, or at the CTF. During fuel loading and cask preparation activities inside the plant facility, any radioactive wastes created (for example, from decontamination activities) will be treated and handled like any other radioactive waste under the DCPP radwaste management program.

3.3.2 ISFSI CONCRETE STORAGE PAD

The Diablo Canyon ISFSI includes a number of individual storage pads, which will be constructed periodically to meet fuel storage needs of DCPP. For simplicity, this discussion refers to a single storage pad. The design criteria are identical for all pads comprising the ISFSI.

3.3.2.1 General

The ISFSI concrete storage pad must be designed to support the weight of the loaded overpacks under all design basis static and dynamic conditions of storage. The pad must also be designed to support the studs that anchor the overpack to the pad and to maintain the integrity of the fastening mechanism embedded in the pad during a postulated design-basis event. The ISFSI pad has been evaluated for the physical uplift, pad sliding, and overturning moments caused by extreme environmental events (for example, tornado missiles, earthquakes, etc.). Therefore, the pad is engineered as a thick, heavily reinforced concrete structure.

Because tipover of a cask installed in an anchored configuration is not a credible event, the pad does not need to be engineered to accommodate this non-mechanistic event. Since the lifting devices are designed, fabricated, inspected, maintained, operated, and tested in accordance with NUREG-0612 (Reference 4), a drop of the loaded overpack will not occur; therefore, a specific lifting height limit for the cask at the ISFSI is not required to be established. Based on these two criteria, there is no maximum limit on the hardness of the concrete pad and subgrade.

3.3.2.2 Natural Phenomena

The Diablo Canyon ISFSI concrete storage pad is engineered to perform its design function under all loadings induced by design basis natural phenomena. The design criteria for the natural phenomena applicable to the Diablo Canyon ISFSI site, including seismic loadings, tornado wind, and missile loadings, are discussed in Section 3.2.

3.3.2.3 Design Criteria

The ISFSI pad and its embedment steel design must comply with the ACI 349-97, NUREG-1536 (Reference 5) and with NRC draft Regulatory Guide DG-1098 as applicable. A new Proposed Appendix B to the ACI 349-97 (dated 10/01/00) was used. (It may be noted that the NRC took exception to the Appendix B [of the 97 Code] as stated in DG-1098.) Specifically, the design strength capacity of the embedded base plate, concrete bearing, and diagonal tension shear capacity are in accordance with the design provisions of ACI 349-97 and the embedded anchorage is to meet the ductile anchorage provisions of the Proposed Draft New Appendix B to ACI 349-97 (dated October 1, 2000). The materials of construction (for example, anchor stud material and additives in the pad concrete) have been chosen to be compatible with the environment at the Diablo Canyon ISFSI site. ISFSI pad design life is 40 years. The surface anchorage studs (i.e. SA-193 B7 Studs and the exposed embedment plates) will be properly coated for corrosion protection.

The use of an embedded steel structure underneath the cask and in the concrete storage pad is to be employed at the Diablo Canyon ISFSI. The purpose of the embedded structure is to permit the cask anchor studs to be preloaded, while the embedded steel structural connection to the concrete does not involve a preload. The embedded structure, while not part of the cask system, is designed in accordance with the AISC Manual of Steel Construction (Reference 6) and the ACI 349-97 requirements.

3.3.2.3.1 Load Combinations for the Concrete Storage Pad

Factored load combinations for ISFSI pad design are provided in the ACI-349-97 and supplemented by the factored load combinations from NUREG-1536 (Reference 5) Table 3.1 and NRC draft Regulatory Guide DG-1098, as applicable.

<u>Overturning and Sliding</u>

Since the casks at the Diablo Canyon ISFSI are anchored to the concrete pads, the load combinations from Table 3-1 of NUREG-1536 associated with gross sliding and overturning at the cask/pad interface are not applicable to the cask. The gross sliding of the loaded pad structure was evaluated using a dynamic non-linear seismic analysis to determine the extent of sliding. Pad overturning is not considered as a credible failure mechanism due to the size and geometry of the pad (that is, 68 ft wide by 105 ft long by 7.5 ft thick). The sliding analysis acceptance criteria is: The analysis is to show insignificant impact on the pad's ability to meet its functional requirements and the cask design qualifications as a result of potential pad sliding.

3.3.2.3.2 Load Combinations for the Cask Anchor Studs

The design of the cask anchor studs is governed by the ASME Code, Section III, Subsection NF and Appendix F (Reference 7). The applicable load combinations and allowable stress limits for the anchor studs attaching the cask to the intervening steel support structure are:

Normal Conditions:

Load Combination: D

Code Reference for Stress Limits: NF-3322.1 and NF-3324.6

Off-Normal Conditions:

Load Combination: D+F

Code Reference for Stress Limits: NF-3322.1 and NF-3324.6 with all stress limits increased by a factor of 1.33

Accident Conditions:

Load Combinations: D+E and D+W_t

Code Reference for Stress Limits: Appendix F, Sections F-1334 and F-1335

The axial stress in the cask anchors induced by pretensioning is kept below 75 percent of the material yield stress, such that during a seismic event the maximum stud axial stress remains below the limit prescribed for bolts in the ASME Code, Section III, Subsection NF, for Level D conditions.

3.3.2.3.3 Maximum Permissible Tornado Wind and Missile Load

During a tornado event, the HI-STORM 100 System may be subjected to a constant wind force and differential pressures. It may also be subjected to impacts by tornado-borne missiles. In contrast to a free-standing cask, the anchored cask system is capable of withstanding greater lateral pressures and impulsive loads from large missiles. The anchored HI-STORM 100SA cask design at the Diablo Canyon ISFSI has been analyzed assuming the lateral force from the site-specific design-basis, large-tornado-missile impact occurs at the worst-case height on the cask and the force created by the tornado wind action and differential pressure acts simultaneously at cask mid-height. The resulting overturning moment is bounded by the maximum seismic overturning moment applied to the cask anchorage embedment and the pad.

3.3.3 CASK TRANSPORTER

3.3.3.1 General

The cask transporter is a U-shaped tracked vehicle used for lifting, handling, and onsite transport of loaded overpacks and the transfer cask. The cask transporter does not have a suspension system (for example, springs). The transporter consists of the vehicle main frame, the lifting towers, an overhead beam system that connects the parallel lifting towers, a cask restraint system, the drive and control systems, and a series of cask lifting attachments. The casks are individually carried within the internal footprint of the transporter tracks (Sections 4.3 and 4.4 provide more detailed descriptions of cask transportation components and operating characteristics). The cask is supported by the lifting attachments that are connected to the overhead beam. The overhead beam is supported at the ends by a pair of lifting towers. The lifting towers transfer the cask weight directly to the vehicle frame and ultimately to the tracks and the transport route surface. The cask transporter has the added capability of being able to raise and lower an MPC between the transfer cask and the overpack when used in conjunction with the CTF. The transporter's CTF functions are contained in Section 2.3.3.1 of the HI-STORM 100 System FSAR, as amended by LAR 1014-1.

3.3.3.2 Design Criteria

The key design criteria for the cask transporter are summarized in Table 3.4-4. The bases for these criteria are discussed in the sections below.

3.3.3.2.1 Design Life

The cask transporter design life of 20 years has been established based on a reasonable length of time for a vehicle of its type with normal maintenance. The cask transporter may be replaced or recertified for continued use at the end of its design life.

3.3.3.2.2 Environmental Design Criteria

The cask transporter is an "all-weather" vehicle. It is designed to operate in both rain and snow over a temperature and humidity range that bounds the historical conditions at the Diablo Canyon site. Materials that would otherwise degrade in an coastal marine environment will be appropriately maintained.

A lightning strike on the cask transporter would not structurally affect the ability of the transporter to hold the load. Due to the massive amount of steel in the structure, the current would be transmitted to the ground without significantly damaging the transporter. However, the driver may be affected by a lightning strike. Therefore, the transporter design includes fail-safe features to automatically shutdown the vehicle into a safe, stopped, and braked condition if the operator is injured or incapacitated for any reason while handling a loaded cask.

Flooding is not a concern on the transport route as discussed in Section 3.2.2. Sources of fires and explosions have been identified and evaluated. Fixed sources of fire and explosion are sufficiently far from the transport route to not be of concern (Section 2.2). Mobile sources of fire and explosion, such as fuel tanker trucks, will be kept at a safe distance away from the transporter during cask movement through the use of administrative controls. The cask transporter is diesel-powered and is limited to a maximum fuel volume consistent with that used in the HI-STORM 100 System fire accident analysis. The hydraulic fluid used in the cask transporter is nonflammable.

3.3.3.2.3 Regulatory Design Criteria and Industry Standards

The transporter is designed, fabricated, inspected, maintained, operated, and tested in accordance with applicable guidelines of NUREG-0612, which allows the elimination of the need to establish a cask lift height limit.

3.3.3.2.4 Performance Design Criteria

As described in Section 4.4, the cask transporter must lift and transport either the loaded transfer cask or the loaded overpack, including the weight of all necessary ancillary lift devices such as rigs and slings. The loaded overpack, being the heavier of the two casks to be lifted, provides the limiting weight for the design of the transporter.

3.3.3.2.5 Stability Design Criteria

The cask transporter is custom designed for the Diablo Canyon site, including the transport route with its maximum grade of approximately 8.5 percent. It will remain stable and will not experience structural failure, tip over, or leave the transport route should a design-basis seismic event occur while the loaded transfer cask is being moved to the CTF, while transferring an MPC at the CTF, while moving a loaded overpack from the CTF to the storage pad, or while moving a loaded overpack on the storage pad. In addition, the cask transporter is designed to withstand design-basis tornado winds and tornado-generated missiles without an uncontrolled lowering of the load or leaving the transport route. All design criteria for natural phenomena used to design the cask transporter are specific to the Diablo Canyon site (Sections 3.2 and 3.4 provide further information).

3.3.3.2.6 Drop Protection Design Criteria

In accordance with NUREG-0612, prevention of a cask or MPC drop is provided by enhancing the reliability of the load supporting systems by design, using a combination of component redundancy and higher factors of safety than would normally be used for a commercial lift device. Load supporting components include the special lifting devices used to transfer the force of the payload to the cask transporter lift points (including attachment pins, as appropriate), the cask transporter lift points, the overhead beam, the lifting towers, and the vehicle frame. The design criteria for each of the components of the cask transporter are the following:

Slings and Special Lifting Devices

The transfer cask horizontal lift rig, HI-TRAC lift links, MPC downloader slings, overpack lifting brackets, and HI-STORM lift links are designed to applicable guidelines of NUREG-0612.

Cask Transporter Lift Points, Overhead Beam, Vehicle Body and Seismic Restraints

The cask transporter lift points, overhead beam, and load supporting members of the vehicle body (whose failure would result in an uncontrolled lowering of the load) are designed to applicable guidelines of NUREG-0612.

Lifting Towers

The lifting towers are designed with redundant drop protection features. The primary cask lifting device is the hydraulic system, which prevents uncontrolled cask lowering through the control of fluid pressure in the system. A mechanical backup load retaining device, independent of the hydraulic lifting cylinders, is provided in case of failure of the hydraulic system. This may consist of load blocks, pawl and detent, locking pins, or other suitably designed positive mechanical locking device.

3.3.3.2.7 Drive System Design Criteria

The cask transporter is capable of forward and reverse movement as well as turning and stopping. It includes an on-board engine capable of supplying enough power to perform its design functions. The cask transporter includes fail-safe service brakes (that is, brakes that automatically engage in any loss of power and/or independent emergency) and parking brakes. The brake system is capable of stopping a fully loaded cask transporter on the maximum design grade. The cask transporter is equipped with an automatic drive brake system that applies the brakes if there is a loss of hydraulic pressure or the drive controls are released. The cask transporter is not capable of coasting on a 10 percent downward grade with the brakes disengaged due to the resistance in the drive system.

3.3.3.2.8 Control System Design Criteria

The cask transporter is equipped with a control panel that is suitably positioned on the transporter frame to allow the operator easy access to the controls located on the control panel and, at the same time, allow an unobstructed view of the cask handling operations. The control panel provides for all-weather operation or will be enclosed in the cab. The control panel includes controls for all cask transporter operations including speed control, steering, braking, load raising and lowering, cask restraining, engine control and "dead-man" and external emergency stop switches.

The drive control system is capable of being operated by a single operator from an on-board console. The control panel contains all gauges and instruments necessary for the operator to monitor the condition and performance of both the power source and hydraulic systems. A cask lift-height indicator is provided to ensure the loaded casks are lifted only to those heights necessary to accomplish the operational objective in progress.

3.3.3.2.9 Cask Restraint Design Criteria

The cask transporter is equipped with a cask restraint to secure the cask during movement. The restraint is designed to prevent lateral and transverse swinging of the cask during cask transport. The restraint is designed to preclude damage to the cask exterior with padding or other shock dampening material used, as necessary.

3.3.4 CASK TRANSFER FACILITY

3.3.4.1 General

The ISFSI CTF is used in conjunction with the cask transporter to accommodate MPC transfers between the transfer cask and the overpack. The CTF is designed to position an overpack sufficiently below grade where the transfer cask can be mated to the overpack using the cask transporter. The CTF lifting platform acts as an elevator to raise and lower the overpack. In the full-up position, the overpack base is approximately 40 inches below grade. The surface of the CTF contains an approach pad that supports the loaded transporter and provides a laydown area for the transfer cask, cask transport frame, mating device, seismic restraint, and other load handling equipment.

3.3.4.2 Design Criteria

The rated load of the CTF lifting system is the bounding weight of a loaded overpack (360,000 lb). The design criteria for the specific subcomponents are discussed below. The CTF is designed to withstand a design-basis seismic event without an uncontrolled lowering of the lifted load. The design life of the CTF is 40 years. Design criteria for the CTF are summarized in Table 3.4-5.

3.3.4.2.1 Main Shell Design Criteria

A cylindrical steel shell forms the opening in the ground into which the overpack is lowered, provides the support for the lifting jacks, and provides a setdown location for the lifting platform when it is fully lowered. The main shell forms a cylindrical opening of approximately 150 inches in diameter and approximately 200 inches deep. Three extensions run the length of the cylinder and form the locations for the jacks. The shell is also equipped with a sump for collecting and disposing of incidental water from the CTF. The surrounding area is reinforced concrete. The resulting structure is a flat-surfaced pad with a steel-lined hole. The main shell is designed in accordance with applicable portions of ASME Section III, Subsection NF.

3.3.4.2.2 Lifting Jacks

Three lifting jacks provide the lifting force for the lifting platform. The jacks are located on the circumference of the main shell in the extensions. The jacks are supported at the top end and suspend the lifting platform by bearing on a traveling nut on each jack screw. All jacks operate in unison to keep the platform level through the entire travel range (approximately 160 inches). The jacks are interconnected with an electronic position monitoring and control system. The maximum lift speed of the jacks is 12 inches/minute and will not unwind on loss of the driver.

3.3.4.2.3 Drive and Control System

A drive and control system provides the power and control for the lifting jacks. Electrical power is supplied to each jack drive motor. The speed is reduced via one or more gearboxes. The relative position of each jack is monitoring by the drive and control system to stop all jacking if a mismatch is detected. Position switches limit the travel beyond established points. The control system is designed in accordance with applicable guidelines of NUREG-0612, Section 5.1.6 (2). The lifting jack design ensures the load will stop in position on a loss of electrical power to the drive and control system.

3.3.4.2.4 Lifting Platform

A lifting platform provides the support of the overpack and transmits the lifting jack force to the cask. Multiple beams or a single torsion box-type beam forms the lifting platform. The platform provides a level base on which the overpack rests. To interface with the lifting jacks, the platform has extensions that enter into each main shell extension. Uniform loading of the lifting platform is afforded by the location and controlled movement of the jacks. Radial stability of the lifting platform is provided by the main shell.

Wheeled or low-friction pad-type vertical guides or runners are provided to prevent damage to the main shell and lifting platform at the interface locations. The guides (or runners) are capable of restraining the lift platform under the maximum horizontal loading due to a design basis seismic event.

3.3.4.2.5 HI-STORM Mating device

A mating device provides structural support and shielding at the interface between the top of the open overpack and the bottom of the transfer cask during MPC transfer operations. The mating device also facilitates the removal of the pool lid from the transfer cask prior to MPC transfer operations.

3.3.4.2.6 Seismic Restraint

A removable seismic restraint provides lateral structural support in the gap between the overpack and the CTF main shell.

3.3.4.2.7 Reinforced Concrete Support Structure

The reinforced concrete surrounding the shell is capable of supporting a loaded transporter and handling any seismic loads applied through the shell. The reinforced concrete base pad supports the CTF shell and a steel pedestal base that supports the lifting platform when it is in the full-down position. The approach pad is designed for the weight of the transporter with a loaded overpack. Independent tie-down blocks at the surface of the CTF will be provided to hold the transporter in place during the MPC transfer operation. The reinforced concrete structure is qualified to ACI-349-97 (Reference 8), NUREG-1536, and DG-1098, as applicable.

3.3.4.2.7.1 Design Load Combinations

Factored load combinations for the CTF concrete structure design are provided in the ACI 349-97 and supplemented by the factored load combinations from NUREG-1536 (Reference 8), Table 3.1, and NRC draft Regulatory Guide DG-1098 (Reference 6), as applicable.

3.3.5 REFERENCES

1. 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.

2. Final Safety Analysis Report for the HI-STORM 100 System, Holtec International Report No. HI-2002444, Revision 0, July 2000.

3. License Amendment Request 1014-1, Holtec International, Revision 2, July 2001, including Supplements 1 through 4 dated August 17, 2001; October 2, 2001; October 12, 2001; and October 19, 2001; respectively.

4. Control of Heavy Loads at Nuclear Power Plants, USNRC, NUREG-0612, July 1980.

5. Standard Review Plan for Dry Cask Storage Systems, USNRC, NUREG-1536, January 1997.

6. Manual of Steel Construction, American Institute of Steel Construction, 9th Edition.

7. Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NF, American Society of Mechanical Engineers, 1995 Edition including 1996 and 1997 Addenda.

8. ACI-349-97, Code Requirements for Nuclear Safety Related Concrete Structures, American Concrete Institute, (with Draft Appendix B [10/01/00]).

9. Draft Regulatory Guide DG-1098, Safety Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessel and Containment), USNRC, August 2000.

3.4 SUMMARY OF DESIGN CRITERIA

The major ISFSI structures, systems, and components (SSCs) classified as important to safety are the HI-STORM 100 System, the storage pad, the transporter, and the CTF. The principal design criteria for these SSCs are summarized in Tables 3.4-1 through 3.4-5.

- Table 3.4-1 provides the site-specific design criteria for environmental conditions and natural phenomena.

- Table 3.4-2 provides design criteria applicable to the HI-STORM 100 System. Detailed design criteria for the MPC, the overpack, and the transfer cask are listed in the HI-STORM 100 System FSAR, Tables 2.0.1, 2.0.2, and 2.0.3, respectively, as amended by LAR 1014-1 (References 1 and 2). Detailed anchorage design requirements are discussed in Section 4.2.

- Table 3.4-3 provides the design criteria for the storage pad.

- Table 3.4-4 provides the design criteria for the cask transporter.

- Table 3.4-5 provides the design criteria for the CTF.

3.4.1 REFERENCES

1. Final Safety Analysis Report for the HI-STORM 100 System, Holtec International Report No. HI-2002444, Revision 0, July 2000.

2. License Amendment Request 1014-1, Holtec International, Revision 2, July 2001, including Supplements 1 through 4 dated August 17, 2001; October 5, 2001; October 12, 2001; and October 19, 2001; respectively.

TABLE 3.1-1

SUMMARY OF FUEL PHYSICAL CHARACTERISTICS

Fuel Parameter	Diablo Canyon[a]	MPC Limiting Values[b]
Fuel Assemblies		
Rod array	17 x 17	17 x 17
UO_2 rods per assembly	264	264
Rod pitch, in.	0.496	≤0.496
Overall dimensions, in.	8.426 x 8.426	≤8.54 x 8.54
Uranium weight per assembly, kg	461.2/423.0[c]	≤467
Assembly weight with nonfuel hardware, lb	≤1,621	≤1,680
Number of guide thimbles per assembly	24	≤25
Fuel Rods		
Active fuel length, in.	144	≤150
Cladding outside diameter, in.	0.374/0.360	≥0.372/≥0.360
Cladding inside diameter, in.	0.329/0.315	≤0.331/≤0.315
Cladding material	Zircaloy-4 or ZIRLO	Zr or Zr alloy
Fuel Pellets		
Material	UO_2 sintered	UO_2
Diameter, in.	0.3225/0.3088	≤0.3232/≤0.3088

[a] These are the DCPP fuel characteristics. See Table 4.1-1 of the DCPP FSAR Update.
[b] In many instances, allowable fuel parameters are a function of several factors such as canister type and fuel condition. In all cases, the fuel stored will be within the limits controlled by the Diablo Canyon ISFSI Technical Specifications and specified in SAR Section 10.2, which are consistent with the applicable limiting values from the HI-STORM 100 System CoC, as amended by LAR 1014-1.
[c] LOPAR/VANTAGE 5

TABLE 3.1-2

SUMMARY OF FUEL THERMAL AND RADIOLOGICAL CHARACTERISTICS

Parameter	Diablo Canyon[(a)]	MPC Limiting Values
Maximum decay heat per assembly	1,500 Watts	See footnote (b)
Maximum assembly average burnup	~ 58,000 MWD/MTU	See footnotes (b) and (c)
Maximum initial enrichment	5 percent	See footnote (b)
Minimum cooling time	5 years	See footnote (b)

(a) These are the DCPP fuel characteristics. The DCPP license limits the peak fuel rod burnup to 62,000 MWD/MWT, which corresponds to a fuel assembly average burnup of approximately 58,000 MWD/MWT.

(b) In many instances, allowable fuel parameters are a function of several factors such as MPC type, fuel condition, and the use of a uniform or regionalized loading strategy. Some are also dependent upon one another (that is, burnup and cooling time or decay heat and cooling time). The limiting assembly decay heat, burnup, initial enrichment, and cooling times are specified in SAR Section 10.2, which is consistent with the applicable limiting values in the HI-STORM 100 System CoC, as amended by LAR 1014-1. In all cases, the fuel stored will be within the limits controlled by the Diablo Canyon ISFSI Technical Specifications and specified in SAR Section 10.2.

(c) Zirlo clad fuel is limited to a burnup of 45,000 MWD/MTU.

TABLE 3.2-1

HI-STORM 100 SYSTEM AND DIABLO CANYON ISFSI SITE
TORNADO DESIGN PARAMETERS

Parameter	**Value**	
	HI-STORM 100 System[a]	**Diablo Canyon ISFSI Site**[b]
Rotational wind speed (mph)	290	157
Translational wind speed (mph)	70	43
Maximum wind speed (mph)	360	200
Pressure drop (psi)	3.0	0.86
Rate of pressure drop (psi/sec)	Instantaneous	0.36

[a] Table 2.2.4 of HI-STORM 100 System FSAR, except for rate of pressure drop, which is provided in FSAR Section 3.4.8
[b] Section 3.3.2.1.1 of DCPP FSAR Update

TABLE 3.2-2

HI-STORM 100 SYSTEM AND DIABLO CANYON SITE
TORNADO MISSILE DESIGN PARAMETERS

HI-STORM 100 System [(a)]		
Missile Description	**Mass (kg)**	**Velocity (mph)**
Automobile	1,800	126
Rigid Solid Steel Cylinder (8 in. diameter)	125	126
Solid Sphere (1 in. diameter)	0.22	126

Diablo Canyon Power Plant Site [(b)]		
Missile Description	**Mass (kg)**	**Velocity [(c)] (mph)**
Automobile	1,814	33.3
10 ft long x 3 in. diameter Schedule 40 pipe	34.5	66.7
4 in. x 12 in. x 10 ft board	49.0	200

Additional Missiles Evaluated for Diablo Canyon ISFSI Site			
Missile Description	**Mass (kg)**	**Velocity (mph)**	
		Diablo Licensing Basis	**Holtec Evaluation[(d)]**
6 in. diameter Sch 40 pipe[(e)]	130	7	93.9
Utility Pole[(e)]	510	35	107.4
12 in. diameter Sch 40 pipe[(e)]	340	5	62.6
(2 in. x 2 in. x 1/8 in. x 5 ft) Long Steel Angle[(f)]	3.9	157[(g)]	157
500-kV Insulator String[(f)]	344.7	157[(g)]	157
500-kV Insulator Segments and Miscellaneous Conductor Hardware[(f)]	6.8	157[(g)]	157
1 in. diameter Steel Rod[(e)]	4	5	89.5

[(a)] Table 2.2.5 of HI-STORM 100 System FSAR
[(b)] Section 3.3.2.1.2 of the DCPP FSAR Update
[(c)] Tornado wind velocity is 200 mph per Section 3.3.2.1.1 of the DCPP FSAR Update. Missile velocities are presented in Section 3.3.2.1.2 of the DCPP FSAR Update as fractions of tornado wind speed.
[(d)] Velocities used by Holtec in a bounding analysis of missile effects based on Region II 300 mph wind velocity.
[(e)] Additional missile based on NUREG-0800, Section 3.5.1.4, Spectrum II missile table.
[(f)] Unique missile for Diablo Canyon ISFSI.
[(g)] Conservatively assumed as equal to tornado rotational wind speed.

TABLE 3.4-1

DESIGN CRITERIA FOR ENVIRONMENTAL CONDITIONS AND NATURAL PHENOMENA APPLICABLE TO THE MAJOR ISFSI STRUCTURES, SYSTEMS, AND COMPONENTS

Design Criterion	Design Value	Reference Documents
Wind	80 mph with a gust factor of 1.1 Condition is bounded by tornado wind	Diablo Canyon ISFSI SAR Section 3.2.1
Tornado	200 mph maximum speed 157 mph rotational speed 43 mph translational speed 0.86 psi pressure drop 0.36 psi/sec pressure drop rate	Diablo Canyon ISFSI SAR Section 3.2.1, Table 3.2-1
Tornado Missiles	See Diablo Canyon ISFSI SAR Table 3.2-2	Diablo Canyon ISFSI SAR Section 3.2.1
Flood	Design-basis flooding event is not considered credible	Diablo Canyon ISFSI SAR Section Section 3.2.2
Seismic	See Diablo Canyon ISFSI SAR Section 3.2.3	Diablo Canyon ISFSI SAR Section 3.2.3
Snow & Ice	Design-basis snow and ice loadings are not considered credible	Diablo Canyon ISFSI SAR Section 3.2.4
Explosion	A fuel tank for the transporter, load handling equipment, or other vehicle A 7-gallon propane bottle being transported via Reservoir Road A standard acetylene bottle transported to the vehicle maintenance shop via Reservoir Road A 250-gallon propane tank, a 2,000-gallon #2 diesel fuel oil tank, and a 3,000-gallon gasoline tank located in close proximity to each other and beside the main plant road and approximately 1,200 ft from the transport route to the ISFSI storage pad	Diablo Canyon ISFSI SAR Sections 2.2.2.3, 3.3.1.6, and 8.2.6

TABLE 3.4-1

Design Criterion	Design Value	Reference Documents
Explosion (continued)	The Unit 2 main bank transformers, which contain approximately 13,000 gallons each of mineral oil and are located 160 ft from the transport path A standard compressed gas bottle (air, nitrogen, argon, CO_2) located inside the RCA and near the El. 115' south gate Hydrogen gas facility adjacent to the transport route Acetylene bottles stored on the east side of the cold machine shop	
Fire	A fuel tank for the transporter, load handling equipment, or other vehicle Local stationary fuel tanks Local combustible materials Nearby grass/brush fire	Diablo Canyon ISFSI SAR Sections 2.2.2.2, 3.3.1.6, and 8.2.5
Ambient Temperatures	Annual Average = 55°F Minimum recorded was below freezing for a few hours. Maximum Recorded = 97°F Extreme Temperature Range = 24°F to 104°F	Diablo Canyon ISFSI SAR Sections 2.3.2, 3.2.7, 8.2.6, and 8.2.10
Insolation	766 g-cal /cm^2 maximum for a 24-hr period	Diablo Canyon ISFSI SAR Section 3.2.7

TABLE 3.4-2

PRINCIPAL DESIGN CRITERIA APPLICABLE TO THE HI-STORM 100 SYSTEM

Design Criterion	Design Value	Reference Documents
GENERAL		
HI-STORM 100 System Design Life	40 years	Holtec FSAR, Section 2.0.1 and Diablo Canyon ISFSI SAR Section 3.3.1.3.1
ISFSI Storage Capacity	140 casks (138 required + 2 spare locations)	Diablo Canyon ISFSI SAR Section 3.1
Number of Fuel Assemblies	4,400 (approx.)	Diablo Canyon ISFSI SAR Section 3.1
Nonfuel Hardware	Borosilicate absorber rods Wet annular burnable absorber rods Thimble plug devices Rod cluster control assemblies	Diablo Canyon ISFSI SAR Section 3.1.1.3 and Table 3.1-1 and Table 10.2-10
SPENT FUEL SPECIFICATIONS		
Type of Fuel	Non-consolidated PWR - Westinghouse 17 x 17 LOPAR and VANTAGE 5	Diablo Canyon ISFSI SAR Section 3.1.1, 10.2.1.1, and Tables 10.2-1 through 10.2-5
Fuel Characteristics	See Diablo Canyon ISFSI SAR Tables 3.1-1 and 3.1-2 for physical, thermal, and radiological characteristics	See Diablo Canyon ISFSI SAR Section 3.1.1, 10.2.1.1 and Tables 10.2-1 through 10.2-5
Fuel Classification	Intact, Damaged, Debris	Diablo Canyon ISFSI SAR Section 3.1.1, 10.2.1.1, Tables 10.2-1 through 10.2-10, and Diablo Canyon ISFSI TS
STRUCTURAL DESIGN		
Design Codes	ASME III-95, with 1996 and 1997 Addenda, Subsection NB and Code Case N-595-1; ASCE 7-88; ANSI N14.6 (93); ACI-318 (95); and ACI-349 (85)	Holtec FSAR, as amended by LAR 1014-1, Tables 2.2.6, 2.2.7, 2.2.14, and 2.2.15
Environmental Conditions and Natural Phenomena	See Diablo Canyon ISFSI SAR Table 3.4-1	Diablo Canyon ISFSI SAR Sections 3.2 & 3.3

TABLE 3.4-2

Design Criterion	Design Value	Reference Documents
STRUCTURAL DESIGN (continued)		
Weights	Maximum loaded transfer cask handling weight = 250,000 lb Maximum loaded overpack weight = 360,000 lb Transporter weight = 170,000 lb	Reference 4 Section 9.1.4.2.1.3 (fuel handling building crane capacity); Holtec FSAR, Section 3.2, as amended by LAR 1014-1; Diablo Canyon ISFSI SAR Section 4.3.2.1.1.
MPC Internal Pressure	Normal/off-normal = 100 psig Accident = 200 psig	Holtec FSAR, Table 2.0.1, as amended by LAR 1014-1
Cask Loads and Load Combinations	See HI-STORM 100 System FSAR	Holtec FSAR, Sections 2.2.1 through 2.2.3 and Tables 2.2.13 and 2.2.14, as amended by LAR 1014-1
THERMAL DESIGN		
Maximum Cask Heat Duty	Varies by MPC model, fuel loading strategy (uniform loading vs. regionalized loading), fuel assembly burnup, and cooling time Maximum PWR basket heat duty = 28.74 kW	Holtec FSAR, Section 4.4.2, as amended by LAR 1014-1, Section 4.4.2 and Table 4.4.28
Peak Fuel Cladding Temperature Limits	Long term (normal) limits vary based on fuel cooling time Short term (accident) = 1058°F	Holtec FSAR, Section 4.3, as amended by LAR 1014-1
Other SSC Temperature Limits	Varies by material	Holtec FSAR, Tables 2.0.1 through 2.0.3, as amended by Holtec LAR
MPC Backfill Gas	99.995% pure helium	Holtec CoC, Appendix A, Table 3-1, as amended by Holtec LAR 1014-1 and Diablo Canyon ISFSI SAR Section 10.2.2.4
Maximum Air Inlet to Outlet Temperature Rise	126°F	Holtec CoC, Appendix A, LCO 3.1.2, as amended by Holtec LAR 1014-1
RADIATION PROTECTION AND SHIELDING DESIGN		
Storage Cask Dose Rate Objectives	60 mrem/hr on the sides, top, and adjacent to air ducts	Holtec FSAR, Section 2.3.5.2, as amended by LAR 1014-1; and Diablo Canyon ISFSI SAR 3.3.1.5.2
Occupational Exposure Dose Limits	5 rem/yr or equivalent	10 CFR 20.1201

TABLE 3.4-2

Design Criterion	Design Value	Reference Documents
RADIATION PROTECTION AND SHIELDING DESIGN (continued)		
Restricted Area Boundary Dose Rate Limit	2 mrem/hr	10 CFR 20.1301
Normal Operation Dose Limits to Public	25 mrem/yr whole body 75 mrem/yr thyroid 25 mrem/yr and other critical organ	10 CFR 72.104
Accident Dose Limits to Public	5 rem TEDE 50 rem DDE plus CDE 15 rem lens dose equivalent 50 rem shallow dose equivalent to skin or extremity	10 CFR 72.106
Overpack Unreinforced Concrete	Various	Holtec FSAR, Appendix 1.D, as amended by LAR 1014-1
CRITICALITY DESIGN		
Maximum initial fuel enrichment	$\leq$ 5%	Holtec CoC, Tables 2.1-1 and 2.1-2, as amended by LAR 1014-1; and Diablo Canyon ISFSI SAR Sections 3.3.1.4.1 and 3.1.1.1, Tables 10.2-1 through 10.2-5, and the Diablo Canyon ISFSI TS
Control Method (Design Features)	MPC-32 fuel storage cell pitch $\geq$ 9.158 In and B-10 loading 0.0372 g/cm^2 MPC 24: flux trap size 1.09 inch and B-10 loading 0.0267 g/cm^2 MPC-24E AND 24EF: flux trap size 0.776 inch for cells 3,6, 19 and 22; 1.076 inch for all other fuel cells; and B-10 loading 0.0372 g/cm^2	Diablo Canyon ISFSI TS

TABLE 3.4-2

Design Criterion	Design Value	Reference Documents
CRITICALITY DESIGN (continued)		
Control Method (Operational)	For all MPC with maximum initial enrichment of $\leq$ 4.1 wt % $\geq$ 2000 ppm soluble boron in the MPC water during loading and unloading For MPC-24/24E/24EF with maximum initial enrichment of >4.1 and $\leq$ 5.0 wt% $\geq$ 2000 ppm soluble boron in the MPC water during loading and unloading For MPC-32 with maximum initial enrichment of >4.1 and $\leq$ 5.0 wt% $\geq$ 2600 ppm soluble boron in the MPC water during loading and unloading	Diablo Canyon ISFSI TS
Maximum k_{eff}	<0.95	Holtec FSAR, Table 2.0.1, as amended by LAR 1014-1; and Diablo Canyon ISFSI SAR Section 3.3.1.4
CONFINEMENT DESIGN		
Confinement Method	MPC with redundant welds	Holtec FSAR, Section 2.3.2.1 and Chapter 7, as amended by LAR 1014-1
Confinement Barrier Design	Multi-purpose canister: ASME III, NB and Code Case N-595-1	Holtec FSAR, Tables 2.2.6 and 2.2.15, as amended by LAR 1014-1 and Diablo Canyon ISFSI TS
Maximum Confinement Boundary Leak Rate	5.0 x 10^{-6} atm-cm^3/sec	Diablo Canyon ISFSI SAR Section 10.2.2.5

TABLE 3.4-3

DESIGN CRITERIA FOR STORAGE PAD

Design Criterion	Design Value	Reference Documents
Storage Pad Design Codes	NUREG-1536; ACI-349 (97), and Draft Appendix B (10/01/01)	Diablo Canyon ISFSI SAR Sections 3.3.2.3 and 4.2.1.1.2
Design Life	40 years	DCPP ISFSI SAR 3.3.2.3
Maximum Single Loaded Cask Weight	360,000 lb	Holtec FSAR, Table 2.0.1
Transporter with Loaded HI STORM	530,000 lb	Holtec FSAR, Table 2.0.1 and assumed value
Maximum Number of Casks on a Single Pad	20	Diablo Canyon ISFSI SAR Sections 1.3 and 4.1
Maximum Number of Pads at the ISFSI	7	Diablo Canyon ISFSI SAR Sections 1.3 and 4.1`
Operating Temperature Range	0-100°F	DCPP FSAR Update, Section 2
Concrete Pad Strength	5,000 psi at 90 days	D-1098 (8/00); ACI-349(97) and Draft Appendix B (10/01/00)
Pad Loads and Load Combinations	Various	NUREG-1536, Table 3-1
Cask Anchor Stud Loads and Load Combinations	Various	ASME, Section III, Subsection NF and Appendix F; and Diablo Canyon ISFSI SAR Section 3.3.2.3.2
Environmental Conditions and Natural Phenomena	See Diablo Canyon ISFSI SAR Table 3.4-1	Diablo Canyon ISFSI SAR Sections 3.2 & 3.3

TABLE 3.4-4

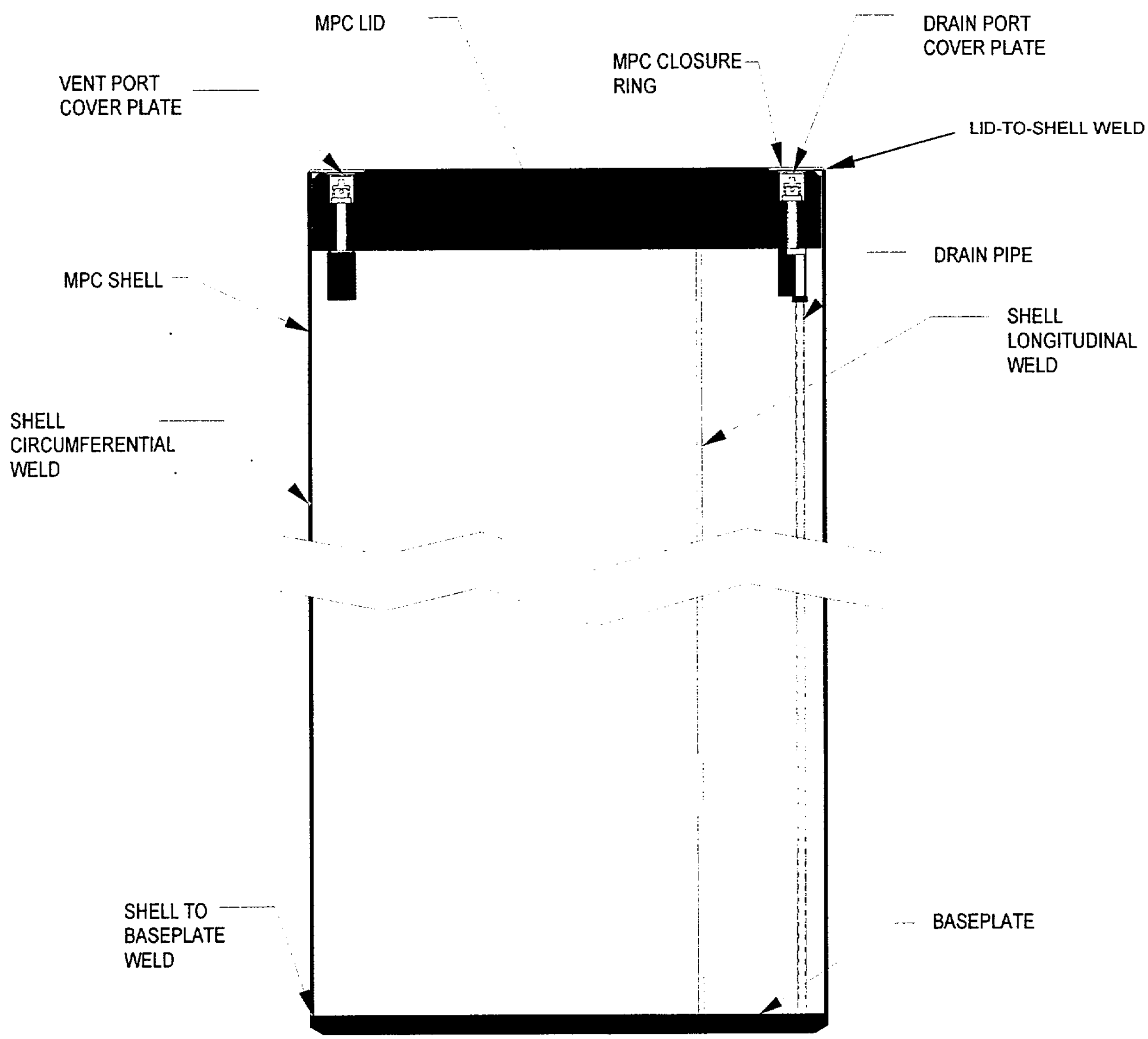
DESIGN CRITERIA FOR TRANSPORTER

Design Criterion	Design Value	Reference Documents
Transporter Design Codes	Purchase commercial grade and qualify by testing prior to use in accordance with NUREG-0612	Diablo Canyon ISFSI SAR Sections 3.3.3 and 4.3.2.1, and Diablo Canyon ISFSI TS
Design Life	20 years	DCPP ISFSI SAR Section 3.3.3.2.1
Maximum Payload	360,000 lb	Holtec FSAR, Table 2.0.1
Transporter Weight	170,000 lb	Assumed value
Maximum Loaded Travel Speed	0.4 MPH	Assumed value
Minimum Uphill Grade Capability	5% (Carrying a loaded overpack) 10% (Carrying a loaded transfer cask)	Assumed value
Maximum On-Board Fuel Quantity	50 gallons	Diablo Canyon ISFSI TS and SAR Section 2.2.2.3
Maximum Hydraulic Fluid Volume	Unlimited (must be non-flammable)	Diablo Canyon ISFSI TS and SAR Section 3.3.3.2.2
Operating Temperature Range	0-100°F	DCPP FSAR Update, Section 2
Redundancy and Safety Factors for Load Path Structures and Special Lifting Devices	Per the applicable guidelines of NUREG-0612	Holtec FSAR, Section 2.3.3.1
Hoist Load Factor	15%	CMAA 70 (94)
Position Control Maintained with Loss of Motive Power	Stops in position	Applicable Guidelines of NUREG-0612
Environmental Conditions and Natural Phenomena	See Diablo Canyon ISFSI SAR Table 3.4-1	Diablo Canyon ISFSI SAR Sections 3.2 & 3.3

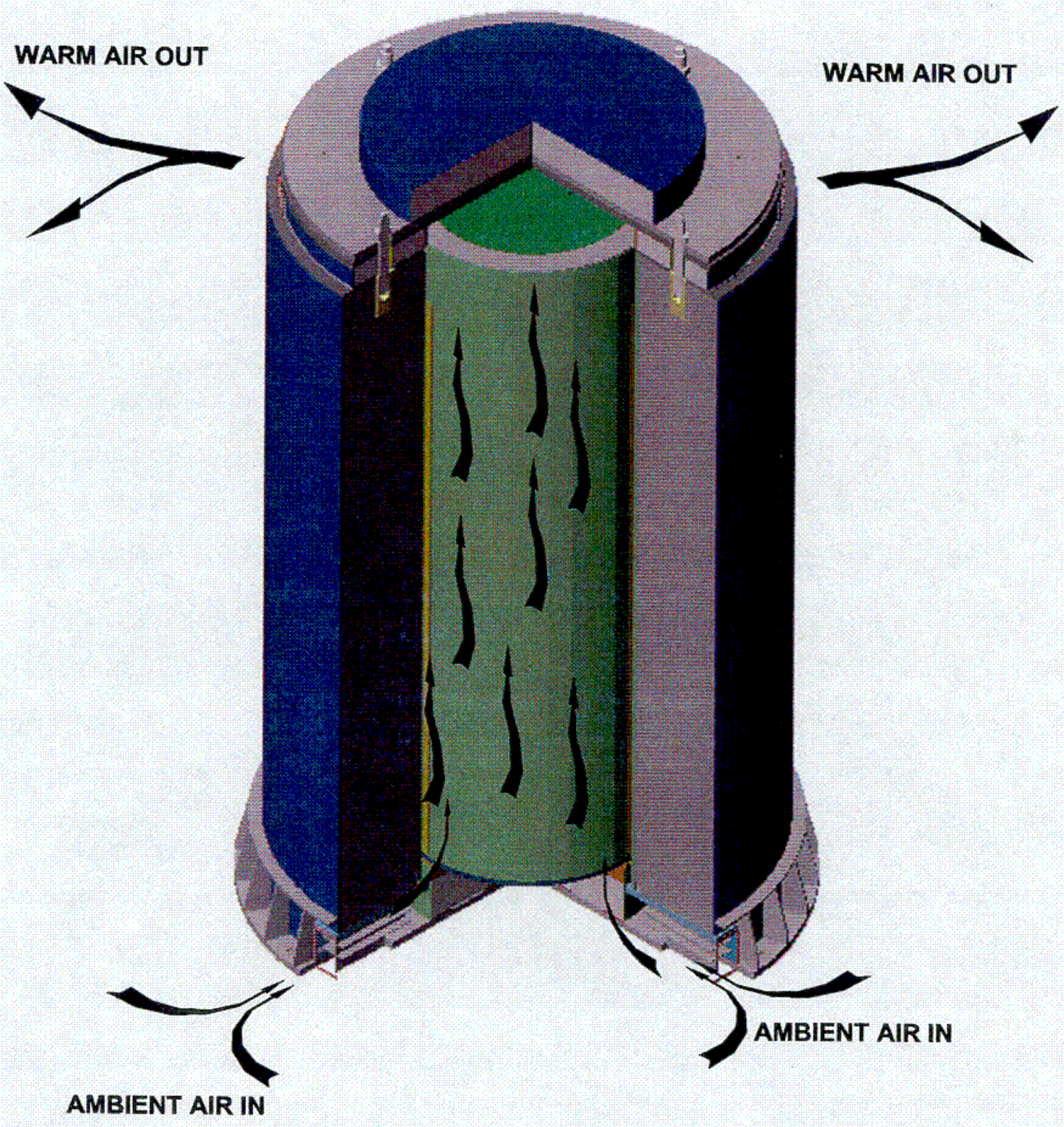
TABLE 3.4-5

DESIGN CRITERIA FOR CASK TRANSFER FACILITY

Design Criterion	Design Value	Reference Documents
CTF Design Codes	ASME III NF (95 Edition with 96 and 97 Addenda); NUREG-0612(80); NUREG-1536; ACI-349(97) and Draft Appendix B (10/01/00)	Diablo Canyon ISFSI SAR Sections 3.3.4 and 4.4.5.2
Design Life	40 years	Holtec FSAR, Section 2.3
Design Payload for Lift System	360,000 lb	Holtec FSAR, Table 2.0.1
Loads and Load combinations	Various	Diablo Canyon ISFSI SAR Section 3.3.4.2.7; ASME, Section III, Subsection NF and Appendix F
Hoist Load Factor	15%	CMAA 70 (94)
Operating Temperature Range	0-100°F	DCPP FSAR Update, Section 2
Redundancy and Safety Factors for Load Path Members Special Lifting Devices	Per the applicable guidelines of NUREG-0612	Holtec FSAR, Section 2.3.3.1
Load Travel on Loss of Power or Jack Malfunction	Stops in position	Applicable guidelines of NUREG-0612
Environmental Conditions and Natural Phenomena	See Diablo Canyon ISFSI SAR Table 3.4-1	Diablo Canyon ISFSI SAR Sections 3.2 & 3.3



SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 3.3-1 HI-STORM MPC CONFINEMENT BOUNDARY



SAFETY ANALYSIS REPORT
DIABLO CANYON ISFSI
FIGURE 3.3-2 HI-STORM 100 SYSTEM COOLING

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