APR 3 1987

MEMORANDUM FOR: Philip S. Justus, Acting Branch Chief
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

FROM: Harold E. Lefevre
Keith McConnell
Geology/Geophysics Section
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: REPORT DESCRIBING ACTIVITIES ASSOCIATED WITH THE SEPTEMBER 8 THROUGH SEPTEMBER 15, 1986, VISIT TO THE HANFORD (BWIP) SITE AND VICINITY

PLACES VISITED

Richland, Washington - Offices of (1) the Department of Energy (DOE), (2) Rockwell Hanford Operations (RHO), (3) Washington Public Power Supply System (WPPSS or the Supply System), and (4) the Council of Energy Resources Tribe (CERT) and (5) Nuclear Regulatory Commission.

Hanford Reservation Vicinity - Numerous field stops on, and in the vicinity of the Hanford Site as well as the Exploratory Hole Core Library on the Hanford Site.

Lacey, Washington - Offices of (1) Washington State Division of Natural Resources and (2) Washington State Office of Nuclear Waste Management

DATES OF TRIP:

September 8 through 15, 1986

PERSONS PRESENT:

The following organizational representatives participated on one or more occasions, in the activities/events described in this trip report:

STATE OF WASHINGTON	RHO	DOE	NRC
W. Brewer	S. Price	D. Dahlem	F. R. Cook
R. Lasmanis	N. Rasmussen	J. Kraupur	H. Lefevre
W. Lingley, Jr.	D. Schell	R. Lassila	K. McConnell
C. Manson	R. Scott	L. Olson	
J. Schuster	T. Tolan		

CERT	WPPSS
C. Canard	W. Kiel

NOTE: Because of his prior travel commitments, the staff was not able to meet with Mr. Jack Wittman of the Yakima Indian Nation.

PURPOSE OF TRIP:

APPENDIX 7 ASSIGNMENT:

Examination and review, but not retention, of DOE/RHO information from working files/permanent records in the following areas of interest:

1. The May Junction Monocline (fault).
2. Gable Butte structure.
3. Fault south of Gable Mountain revealed in DB-10 core.
4. The Yakima hydrologic barrier.
5. Luna Butte, Washington/Arlington, Oregon structure recently investigated by T. L. Tolan of the RHO staff.
6. Microearthquakes recorded on RHO's seismic network (maps of epicenters and fault plan analyses are of interest).
7. Cores from RRL-2A and RRL-17 (core logs and core photographs, as well as the cores themselves are of interest for review).
8. Seismic capability of faults and folds in structures which may affect the repository, including Rattlesnake Mountain, Yakima Ridge, Gable Mountain, May Juction Monocline, Toppenish Ridge, Umtanum Ridge, Gable Butte, Yakima hydrologic barrier and fracture zones associated with the microearthquakes in the area.

NOTE: Refer to the NRC Appendix 7 Assignment report dated November 14, 1986 for additional details (accomplishments, problems encountered, etc.) of this portion of the September 8 through September 15 trip.

SUPPLEMENTAL TRIP ACTIVITIES

The purpose for the discussions with representatives of the Supply System (WPPSS), CERT and Washington State officials and for examining field exposures were multiple. The reasons include: (1) familiarization with the nature of the geotechnical concerns of these organizations, (2) a desire to acquire first-hand knowledge of the above organizations' plans for future activities, (3) briefing of these organizations of the NRC's past, on-going and planned activities, (4) acquisition of verbal knowledge, reports, maps and similar material pertaining to the Hanford site from these organizations and (5) examination of selected geologic features, both on and in the vicinity of the Hanford site. One feature of particular interest, the Arlington-Luna Butte faults, was the subject of a recent paper (Anderson and Tolan, GSA Abstract,

1986) suggesting active faulting near the Columbia River south of Toppenish Ridge.

BACKGROUND

Between September 8 and September 15, 1986, Keith McConnell and Harold Lefevre conducted numerous BWIP-related activities within Washington State. These activities are categorized into those associated with (1) an Appendix 7 Assignment and (2) other events. The Appendix 7 Assignment of September 9, 11 and 12, 1986, is described in the NRC Trip Report dated November 14, 1986, and consisted of discussions with representatives of the Department of Energy (DOE) and Rockwell Hanford Operations at Richland, Washington and a visit to the DOE's Exploratory Hole Core Library on the Hanford site. Activities independent of the Appendix 7 Assignment are described in this report, encompassing the period September 8 through 15, 1986, and include:

Discussions with representatives of:

a. The Washington Public Power Supply System (WPPSS) at Richland
b. Council of Energy Resources Tribe (CERT) at Richland
c. Washington State Division of Geology and Earth Resources at Lacey, Washington
d. Washington State Office of Nuclear Waste Management at Lacey, Washington

Geologic field trips to numerous areas within, and in the vicinity of, the Hanford Reservation

Although the NRC staff acquired valuable insight into the tectonics of the region within and adjacent to the Hanford Reservation through field trips to numerous locations, the overall visit could have been more productive had DOE/BWIP chosen to participate in the numerous NRC-CERT-WPPSS discussions and geologic field trips held between September 9 and 13, 1986. Specifically, discussions and field trips were held on the following dates in various geographic areas: September 9 - Rattlesnake Mountain and Gable Butte; September 10 - Gable Mountain, Rattlesnake Springs, Umtanum Ridge; September 11 - Toppenish Ridge, Yakima River gorge and Sentinel Gap; September 12 - Wallula Gap-Yellepit area, Touchet and Hite fault; September 13 - Luna Butte fault.

NOTE: Documentation (slides, photographs, and Washington State publications and Library Reference Computer Printout) associated with this trip is enclosed in a folder appended to this report.

SUMMARY OF DAILY ACTIVITIES - SEPTEMBER 8 THROUGH 15, 1986

September 8 - Overview of scarp-like features on Toppenish Ridge and Rattlesnake-Wallula lineament (RAW)
(Bill Kiel, Bob Cook, Harold Lefevre, Keith McConnell).

Accomplishments:

Met with William Kiel at WPPSS's Richland office to firm-up plans for field trips in the week to come and to discuss various aspects of the geology of the Pasco basin, most notably the scarp-like features on Toppenish Ridge. We viewed slides that Mr. Kiel had taken several years ago of Toppenish Ridge. The slides were taken during a fly-by under low sun-angle conditions. Numerous scarp-like features are apparent on the north-facing slope of Toppenish Ridge suggesting that recent faulting has occurred (Campbell and Bentley, 1981). One of the scarp-like features can be traced for 24 km. Also observed in the photography were several landslide scars, some very large, which complicate the identification of faulting. A visit to the Toppenish Ridge area is planned for later in the week.

Problems Encountered:

NONE.

Pending Actions:

NONE.

Recommendations:

The features present on the north face of Toppenish Ridge suggest recent faulting. Since the mechanisms and age relationships of folding and faulting are so poorly understood in the area of the Reference Repository Location (RRL) some future effort should be undertaken on our part to study the features on Toppenish Ridge in an attempt to acquire insight, through indirect means perhaps, into the tectonic regime in the RRL area.

September 9 - Curtis Canard (CERT) cross-section; Rattlesnake Mountain; RHO core library; Gable Butte (Curtis Canard, William Kiel, Bob Scott, Harold Lefevre, F. R. Cook, Keith McConnell).

Accomplishments:

In the morning we met with Curtis Canard of the Council of Energy Resources Tribe at CERT's Richland office.

Mr. Canard showed us a preliminary fence diagram correlating the geology in deep petroleum-test wells in the RRL area. Drill holes used include the Bissa wells on Naneum Ridge, the Shell Oil Company well on Saddle Mountain, and the deep hole on Rattlesnake Mountain. Mr. Canard indicated that in the Bissa wells, natural gas was produced from the Oligocene sediments beneath the basalts with most coal located in Eocene sediments. On Saddle Mountain, Shell encountered gas in Eocene sediments below the basalt. Production was stated as 1 mcf/day which Mr. Canard indicated would be economical in any other part of the country. To the southwest correlation was made with the deepened hole on

Rattlesnake Mountain (RSH-1) which lies to the west of the abandoned Rattlesnake Hills gas field (production of more than 1 billion cf). Mr. Canard has interpreted logs of the Rattlesnake Hills drill hole to suggest that there are numerous imbricate faults ramping up coal bearing measures from the Eocene section into the upper part of the basalt section. He also attributes the production of gas at the Rattlesnake Hills field to migration along a fault zone. Also noted by Mr. Canard were the erratic strikes and dips of basalt layering near the bottom of the Rattlesnake Hills hole as given by impression logs.

Rattlesnake Mountain:

Viewed the Cold Creek syncline area from Rattlesnake Mountain. Also observed Gable Butte, Gable Mountain, Saddle Mountains and Yakima Ridge to the north and the "rattles" of the RAW to the southeast. A discussion of the nature of faulting along the RAW resulted. A previous site visit (data review field trip of October 22-26, 1984) notes that S. Reidel (RHO) indicated that there are two thrusts dipping southwest under Rattlesnake Mountain from the northeast face.

Core Library:

Viewed photos and core from drill holes DC-18, RRL-2A, DB-10 and RRL-17. Looked for intervals where tectonic breccias have been reported and core disking is present. Tectonic breccia were compared to flow tops*.

* See NRC Appendix 7 Assignment Trip Report dated November 14, 1986 for additional details.

Gable Butte:

We drove to Gable Butte to observe what appears to be the closest major structural feature to the RRL. The area is structurally complex with the suggestion of several different fold generations. The Gable Butte structure has the appearance of a dome and basin type of interference pattern. Fecht (1978) performed what appears to be a reconnaissance investigation of Gable Butte describing the structure as a series of parasitic folds on the eastern extension of the Umtanum Ridge structure. Fecht (1978) notes oversteepened dips on the north limbs of folds in the area of Gable Butte.

William Kiel brought along a report by Bond and others (1978) that indicated that most deformation in the Pasco basin occurred after 8 m.y. ago and attributed the folds and faults to basement weaknesses. Mapping related to Bond and others (1978) probably formed the basis for the report by Barresh and others (1983) who also suggested that most deformation occurred after deposition of the majority of the Columbia basalt.

Problems Encountered:

See "significant problem encountered", page 3.

Pending Actions:

NONE.

Recommendations:

1) The geophysical and other borehole logs of the Rattlesnake Hills well should be studied in detail to ascertain whether the thrust imbrication and repeated sections proposed by Mr. Canard actually are a viable interpretation.

2) Fecht's (1978) study of the Gable Butte area appears reconnaissance in nature. Since Gable Butte is the nearest exposed structure to the RRL and is structurally complex, a detailed study of Gable Butte and the implications with respect to the RRL is warranted.

September 10 _ Gable Mountain; Rattlesnake Springs; Yakima Ridge; Umtanum Ridge (Curtis Canard, William Kiel, F. R. Cook, Harold Lefevre, Keith McConnell).

Accomplishments:

Gable Mountain:

We visited trenches across the Central fault on Gable Mountain to observe the evidence for recent movement along this fault. The northernmost trench shows a thin (1cm) clastic dike at a flow top. The clastic dike is overprinted with slickensides suggesting recent movement. The clastic dike bifurcates and commonly is associated with a thin gouge zone. At trench G-3 the fault is exposed at the base of an interbed (Rattlesnake) and cuts across the contact into glaciofluvial sediments.

Rattlesnake Springs:

We walked a portion of the Rattlesnake Springs gully in an unsuccessful attempt to find offset in recent sediments. We then walked west to Yakima Ridge to examine the north-south trending fault. A near vertical, relatively thick breccia zone approximately 30 feet thick was present. A question arose as to whether this fault was along trend with the Yakima barricade present in the subsurface to the north. If the trends do coincide, then what is the significance of this feature to waste isolation?

Priest Rapids Dam-Umtanum Ridge:

We drove to Priest Rapids Dam to observe the Umtanum Ridge structure. The northernmost limb appears upright to overturned. Exposures of the Umtanum fault on the north side of the ridge are apparently rare and are covered by talus.

Problems Encountered:

See "significant problem encountered", page 3.

Pending Actions:

NONE.

Recommendations:

1) An investigation into the relationship, if any, between the north trending fault at Yakima Ridge and the Yakima barricade could possibly link structures exposed on anticlinal features to synclinal deformation. Since the Final Environmental Assessment (FEA) deemphasizes any deformation in the Cold Creek syncline this is a potential contradiction as is the May Junction Monocline.

September 11 - Toppenish Ridge; Yakima River gorge; Sentinel Gap
(Bob Cook, Harold Lefevre, Keith McConnell).

Toppenish Ridge:

After meeting with DOE/RHO in the morning* we travelled to the Toppenish Ridge area to observe the scarp-like features on the north side of the ridge that William Kiel (WPPSS) had shown us in his slides on September 8. We were unable to climb the ridge, but observed from a distance linear features which are prominent without low sun angle photography. The scarp-like features are very suggestive of recent faulting. It may be significant to note that Campbell and Bentley (1981) report the occurrence of a magnitude 3 earthquake along the ridge front.

*See NRC Appendix 7 Assignment Trip Report dated November 14, 1986, for additional details.

Yakima River Gorge:

On the return trip to Hanford, we traversed the Yakima River gorge to observe some of the major structures and type localities. This is the best area to observe some geologic features and warrants a return trip when more time is available.

Sentinel Gap:

We stopped at Sentinel Gap to observe the Cohassett flow where it is exposed in the Saddle Mountains. Fracturing in the flow top was observed.

Problems Encountered:

See "significant problem encountered", page 3.

Pending Actions:

A return visit to Yakima River gorge to study the structures exposed in the gorge in detail.

Recommendations:

NONE.

September 12 - Finley Quarry; Wallula Gap-Yellepit area; Touchet; Hite fault (William Kiel, Harold Lefevre, Keith McConnell)

Accomplishments:

In the morning we met with Terry Tolan and Sue Price of RHO in an attempt to determine areas to observe recent movement along the Luna Butte fault (see Anderson and Tolan, 1986). Tolan indicated that these north-northwest trending faults were forming as basalt was being deposited. He also indicated that brachyanticlines formed as a result of lateral movement along these faults. However, the anticlines formed parallel to the trend of the fault.

* See the following two NRC documents for additional wrap-up interview details:

(1) F. Robert Cook to Robert E. Browning memorandum of October 1, 1986

(2) Appendix 7 Assignment Trip Report dated November 14, 1986

Finley Quarry:

Three faults were exposed in trenches at Finley Quarry, all indicating recent movement (≈70,000 yrs ago). The largest fault shows calcite-cemented breccia. Another feature to be observed here is an exposure showing lava filling a preexisting valley.

Wallula Gap-Yellepit Trench:

We traveled to the Wallula Gap area to observe the RAW and trenches showing a possible Pleistocene age fault. Greg Davis (University of Arizona) interpreted the movement on this fault as a wrench fault but others have interpreted the fault as a normal fault down to the north. The fault is nearly vertical. No late Quaternary sediments exist in this trench to ascertain the most recent movement. The Warm Springs trench on the east side of the river shows that the Touchet beds are not offset. We also observed the chilled zone at the top of the Selah interbed.

A previous data review in this area (see October 22-26, 1984 data review memo) indicates that RHO staff had not investigated fractures present in either the Finley Quarry or Yellepit trench exposures.

Touchet Beds Near Touchet:

We travelled to this area to observe clastic dikes in the Touchet sediments that show indications of either tectonic or soft-sediment disruption. Many of the sub-vertical features suggest soft-sediment deformation, however, sub-horizontal displacement of the clastic dikes is harder to explain by non-tectonic means. We also viewed the faceted spurs along this portion of the RAW between Wallula Gap and Warm Springs Canyon.

Hite Fault:

We next travelled to Indian Ridge to observe the northeast trending Hite fault zone. The zone forms a prominent alignment of notches in ridges of the Blue Mountains. The main fault zone is approximately 30 feet wide and is denoted by intensely brecciated rock. At least three other near vertical breccia zones were observed on the northwest slope of Indian Ridge suggesting distributive movement along the Hite fault.

Problems Encountered:

See "significant problem encountered", page 3.

Pending Actions:

NONE.

Recommendations:

NONE.

September 13 - Luna Butte fault:
(Keith McConnell, Harold Lefevre)

Accomplishments:

Travelled to exposures of the Luna Butte fault along the Columbia River near Arlington, Oregon. On the way we stopped at an exposure of a thrust fault in Rock Creek. The thrust fault was expressed as intensely brecciated basalt. It was difficult to discern movement history from the breccia.

The orientation of the flow direction of the Columbia River as it encounters the area of the Luna Butte fault suggests that the river is structurally controlled. Just to the east of the mapped trace of the Luna Butte fault are good exposures that suggest the presence of a low angle fault zone with gouge along the fault surface. At the Luna Butte fault excellent exposures of massive breccia are present. J. L. Anderson (Pomona College, California) indicates that these breccias are the trace of the Luna Butte fault in this area (telecon of 9/26/86). The breccia zone is very wide here (≈100 m). J. L. Anderson (telecon of 9/26/86) indicates that the breccia zones widens where the Luna Butte fault crosses other major structural features.

Problems Encountered:

While RHO did provide us with a map of the Luna Butte fault area, it was a map that has been available for several years and of which we already had a copy. Because DOE and RHO were not able to provide additional information concerning potential Holocene movement in the Luna Butte area, we were unable to locate the evidence for Holocene movement along the Luna Butte fault.

Pending Actions:

We are awaiting the completion of J. L. Anderson's dissertation before examining the evidence for Holocene movement along the Luna Butte fault and other faults that parallel the NNE trace.

Recommendations:

1) Obtain a copy of J. L. Anderson's dissertation when available.

2) Have our contractors investigate the evidence for Holocene faulting in the Luna Butte area and, if present, the implications to the RRL.

September 14 - RAW:
(Keith McConnell, Harold Lefevre)

Accomplishments:

On this day we travelled along Interstate 82 to view exposures of the Badger Mountain fault(?) just west of Hanford near Goose Gap. Exposures at these relatively new roadcuts display some interesting soil color juxtaposition, but the exposures have been grassed-over and we were unable to determine if there is a fault exposed in these cuts.

Problems Encountered:

Interstate 82 is not displayed on the maps that we have. Therefore, it is difficult to determine exactly where the road crosses these ridges.

NONE.

Pending-Actions:

Query RHO/DOE to determine if these exposures have been mapped.

Recommendations:

Historical seismicity is associated with Rattlesnake Mountain faults to the northwest and Quaternary faulting has been proposed for the Wallula Gap area to the southeast (Farooqui, 1980). The Badger Mountain fault may represent an extension of the Rattlesnake Mountain faults and be related to the Quaternary faulting at Wallula Gap, therefore, these exposures near Goose Gap may represent some of the most accessible outcrops for viewing faults in the Hanford area. At this time, we are uncertain whether members of RHO have mapped these exposures or, in an extreme case, if they are even aware that they exist. DOE/RHO should be questioned as to whether they have mapped these exposures and what, if any. information they have with respect to faulting at this location.

September 15 - State of Washington Offices at Lacey, Washington
(NRC - Keith McConnell, Harold Lefevre; State of Washington - W. Brewer, R. Lasmanis, W. Lingley, Jr., C. Manson, J. Schuster)

Accomplishments

Discussions with representatives of the Washington State Division of Geology and Earth Resources (Raymond Lasmanis - State Geologist; Eric Schuster - Assistant State Geologist; William Lingley, Jr. - Deputy Oil and Gas Supervisor and Connie Manson - Reference Librarian) and with the Washington State Department of Ecology (William Brewer - Technical Director, Office of High-Level Nuclear Waste Management) resulted in the following State comments/observations:

- Columbia Plateau Hydrocarbon-Potential Related Matters:

  (1) Chevron has leased 81,000 acres in the Horse Heaven Hills

  (2) Chevron is planning 250 miles of seismic reflection lines

  (3) The source of the gas found in the test exploratory wells can be determined for approximately $5,000.

(4) Shell encountered circulation (loss of) problems in their test wells.

(5) Good seismic reflection records taken in the syncline would be preferable to a deep hole through the basalt.

(6) Individuals in Shell Oil and Chevron knowledgeable in seismic reflection investigative techniques were identified by William Lingley, Jr.

(7) Shell Oil believes that the surface formations do not represent the geologic structure of the underlying sediments.

(8) Chevron is obtaining good seismic reflection data.

- Coal - May not be common in the Rattlesnake Hills well with seeps being possibly mistaken for the presence of coal beds interbedded within the basalt flows.

- Basalt Permeability - The lateral and vertical permeability within the basalts is thought to be extensive.

- Tectonics:

  (1) The interrelation between tectonics and hydrology is a major concern to the State.

  (2) There are several instances of apparent coincidence of earthquake swarms and geologic structure.

  (3) Faulting may control the trend of the Columbia River in the vicinity of Wooded Island.

  (4) Changes in hydraulic head may result from structural discontinuities (probably faults).

- Remote Sensing - The U.S. Geological Survey will be initiating a SLAR (Side-Looking Airborne Radar) survey (hopefully in stereo) in the Hanford area in the near future.

- Issue-Tracking System - The State expects to have an issue-tracking system containing thousands of items operational within a few weeks.

- Active-Faulting - Unpublished materials including mylars and other working maps of the Arlington-Luna Butte area originated by Jim Anderson were examined. These documents indicate the Luna Butte fault and an unnamed fault at the John Day Dam showing Quaternary faulting of alluvial fan materials. Since this material is

unpublished (but is expected to be released during caleandar year 1987) it was suggested by the State that NRC obtain the author's permission before the State, as custodian, could release the above preliminary information.

- Literary Search - The resources of the Department of Natural Resources library were made available to the NRC staff with Connie Manson, Reference Librarian, providing a computer printout of Hanford-related geologic and hydrologic references. The staff took advantage of the opportunity to peruse the shelf documents (open-file reports, theses, dissertations and BWIP-oriented publications and reports). A number of BWIP-related geologic documents were purchased from the State. These documents are:

  1. Bentley, R. D.; Campbell, N. P.; 1983, Geologic map of the Ellensburg Quadrangle, Washington Division of Geology and Earth Resources, Geologic Map GM-28.

  2. Bentley, R. D.; Campbell, N. P.; 1983, Geologic map of the Yakima Quadrangle, Washington Division of Geology and Earth Resources, Geologic Map GM-29.

  3. Campbell, Newell P., 1975, A geologic road log over Chinook, White Pass and Ellensburg: Washington Division of Geology and Earth Resources, Information Circular 54.

  4. Listing of Open File Reports; 1985, Washington Division of Earth Resources.

  NOTE: The hydrology-geology reference printout, photographs and slides, as well as the above four documents have been placed in the NRC's Division of Waste Management, Document Control Center, as an attachment to this trip report.

Problems Encountered

NONE.

Pending Actions:

1. Maintain contact, through the State, of hydrocarbon-related activity in the Pasco Basin, especially that of seismic reflection lines in the vicinity of the RRL.

2. Through the State, remain cognizant of the status and availability of the USGS's SLAR program.

3. Upon completion of J. L. Anderson's dissertation obtain geologic maps depicting active faulting.

Recommendations:

Continue contacting the State relative to significant items identified above under "Accomplishments" as well as other items relevant to the Hanford site.

SIGNATURES	DATE
ORIGINAL SIGNED BY Harold E. Lefevre	APR 3 1987
ORIGINAL SIGNED BY Keith McConnell	APR 3 1987

Enclosures:
- 35mm Slides
- Color Prints
- Publications
- Reference List

References Cited:

Anderson, J.L., and Tolan, T.L., 1986, Ages of wrench faulting in interridge basins, southwest Columbia Plateau, Washington and Oregon: Geological Society of America Abstracts with Programs, v. 18, no. 2, p. 137.

Barresh, W., Bond, J., and Venkatakrishnan, R., 1983, Structural evolution of the Columbia Plateau in Washington and Oregon: American Journal of Science, v. 283, p. 897-935.

Bond, J.G., Kauffman, J.D., Miller, E.A., and Barrash, W., 1978, Geology of the southwestern Pasco Basin: RHO-BWI-C-25.

Campbell, N.P., and Bentley, R.D., 1981, Late Quaternary deformation of the Toppenish Ridge uplift in south-central Washington: Geology, v. 9, p. 519-524.

Farooqui, S.M., 1980, Kinematic analysis of the Wallula fault, Columbia Plateau-Southeastern Washington: Geological Society of America Abstracts with Programs, v. 12, no. 3, p. 106.

Fecht, K.R., 1978, Geology of Gable Mountain-Gable Butte area: RHO-BWI-LD-5.

U.S. Nuclear Regulatory Commission, 1986a, Appendix 7 Assignment Trip Report (September 9, 11 and 12, 1986) of Harold E. Lefevre to Paul R. Hildenbrand, dated November 14, 1986.

U.S. Nuclear Regulatory Commission, 1986b, F. Robert Cook to Robert E. Browning memorandum of October 1, 1986.