Public Service

71-6346
71-9253
72-9

Public Service
Company of Colorado
550 15th Street, Suite 700
Denver, CO 80202-4256

A. Clegg Crawford
Vice President
Engineering and
Operations Support

August 19, 1996
Fort St. Vrain
P-96071

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

ATTN: Dr. William D. Travers, Director
Spent Fuel Project Office

Docket No. 71-6346
Docket No. 71-9253
Docket No. 72-009

SUBJECT: NRC Bulletin 96-04

REFERENCE: NRC Bulletin 96-04, Grimes and Travers to Addressees, dated July 5, 1996 (G-96120)

Dear Dr. Travers:

This letter submits PSCo's response to the referenced NRC Bulletin 96-04, entitled "Chemical, Galvanic, or Other Reactions in Spent Fuel Storage and Transportation Casks". This bulletin applies to Public Service Company of Colorado's (PSCo) TN-FSV spent fuel shipping casks, Certificate of Compliance No. 9253; to PSCo's FSV-1 spent fuel shipping casks, Certificate of Compliance No. 6346; and to the Fort St. Vrain (FSV) Independent Spent Fuel Storage Installation (ISFSI), Materials License No. SNM-2504.

PSCo is the owner of two FSV-1 casks, and General Atomics (GA) owns one FSV-1 cask. The FSV-1 casks are licensed to transport FSV graphite fuel elements, and were used for all previous FSV spent fuel shipments, including transfer of fuel elements from the FSV Reactor Building to the FSV ISFSI from December 1991 to June 1992. PSCo has decided that it will not use its FSV-1 casks to transport the graphite fuel elements from the FSV ISFSI when the ISFSI is defueled. Instead, the TN-FSV spent fuel shipping casks were licensed for this purpose and will be used for the ISFSI defueling, as discussed in ISFSI SAR Section 4.3.2. Since PSCo's FSV-1 casks are not licensed to transport any other fuel types, PSCo will not use these casks to transport spent nuclear fuel in the future. Therefore, these casks are not evaluated as part of the response to this bulletin.

NTO1

GA does not wish to exclude possible use of the FSV-1 cask for spent nuclear fuel shipments in the future, and considers that GA could possibly use it to transport FSV spent fuel presently stored at the Idaho National Engineering Laboratory. GA has informed PSCo that GA is submitting an independent evaluation of the FSV-1 cask to the NRC in response to this bulletin.

PSCo confirms that it has completed the actions requested by the NRC in items 1(a), 1(b), 1(c), 1(d) and 2 of NRC Bulletin 96-04 for the ISFSI fuel storage containers and the TN-FSV spent fuel shipping casks. The attachment to this letter summarizes PSCo's findings resulting from the required evaluations.

If you have any questions concerning this report, please contact Mr. M. H. Holmes at (303) 620-1701.

Very truly yours,

A. Clegg Crawford

A. Clegg Crawford
Vice President
Engineering and Operations Support

ACC/JRJ/Attachment

cc: Regional Administrator, Region IV

Mr. Robert M. Quillin, Director
Radiation Control Division
Colorado Department of Public Health and Environment

Mr. Jan Hagers
U.S. Department of Energy

REVIEW OF STORAGE, HANDLING AND TRANSPORT OF THE FSV ISFSI FUEL STORAGE CONTAINERS

Background

The fuel storage containers (FSC) used in the Fort St. Vrain (FSV) Independent Spent Fuel Storage Installation (ISFSI) and the TN-FSV spent fuel shipping casks are described in ISFSI SAR Sections 4.2.3.2, 4.3 and 4.4.4. The FSCs are high integrity containment vessels designed to ASME Section III requirements. They are proof pressure tested during manufacture and were leak tested after being loaded with spent fuel. The FSC is a cylindrical carbon steel canister approximately 16 ft. long and 18 inches in diameter, with a 0.5-inch thick shell, a 2.0-inch thick bottom plate and a 1.5-inch thick lid. The lid is bolted to the body of the container with 24 one-half inch steel bolts, sealed with double metal o-rings. All exterior surfaces of the FSCs are flame sprayed with aluminum to prevent corrosion of the exterior, which is exposed to outside air that flows through the ISFSI vaults for natural convection cooling. Six graphite fuel blocks are stored in each FSC in an air environment at approximately atmospheric pressure.

PSCo is the owner of two TN-FSV spent fuel shipping casks, licensed for shipment of FSV spent fuel elements. These casks will be used for ISFSI defueling, as discussed in ISFSI SAR Section 4.3.2. As described in References 1 and 2, the TN-FSV casks are stainless steel-jacketed, lead shielded shipping casks. The lid is also stainless steel, fully recessed into the cask top flange, and fastened to the cask body by twelve 1-inch diameter high strength steel closure bolts. The lid is sealed with double silicone O-rings. The cask body is covered with a stainless steel thermal shield comprised of 0.25-inch thick stainless steel plate over a wire wrap. The impact limiters consist of balsa and redwood encased in stainless steel shells. The cask body and lid assembly are designed to provide the containment.

The inner container of the licensed TN-FSV cask shipping configuration is the FSC, discussed above. The TN-FSV cask body is designed to function as the containment vessel.

NRC REQUEST FOR INFORMATION

1.(a) Review the cask materials, including coatings, lubricants, and cleaning agents, to determine whether chemical, galvanic, or other reactions among the materials, contents, and environment can occur during any phase of loading, unloading, handling, storage, and transportation. Consideration should be given to all environments that may be encountered under normal, off-normal, or accident conditions.

PSCo RESPONSE

The above review has been completed for the ISFSI fuel storage containers (FSC) and the TN-FSV spent fuel shipping casks, which are licensed to transport a loaded FSC as the inner container.

ISFSI Fuel Storage Containers

Corrosion of the FSC externals is not a concern due to the aluminum coating. Even if there are nicks in the coating and the carbon steel is exposed in places, the aluminum will act as a sacrificial anode, and protect the carbon steel from oxidation. The interior of each FSC was painted with a thin coating of etch primer. The lid is bolted onto the body of the FSC with 24 low alloy steel bolts, with a seal established by double metal (silver-plated inconel) o-ring seals. A thin film of grease was applied to the seating surface prior to bolting the lids in place to reduce the potential for corrosion and improve the seal. A lubricant was applied to the lid bolt threads to prevent galling. These materials and compounds were considered in the evaluation to determine the potential for chemical, galvanic or other reactions.

Section 4.2.3.2 of the ISFSI SAR states the following in regards to the FSCs:

> "Engineering Evaluation EE-DEC-0031, Rev. A (Ref. 19), determined that corrosion on the internal wall of the container due to potential water contained in the graphite fuel elements was not detrimental to the safe function of the fuel storage containers during their 40-year design lifetime."

This evaluation, which was submitted to the NRC in Reference 3, assumed substantial wetting of the graphite fuel blocks prior to emplacement in the FSCs to conservatively assess potential corrosion rates. The evaluation was performed when the spent fuel was stored in the reactor vessel and fuel storage wells, and it was not known what moisture levels could be present in the graphite fuel blocks when they would be loaded into the FSCs in the future. It was considered that certain accidents (which were extremely unlikely) could possibly result in water spraying onto the fuel blocks being stored in the reactor vessel with subsequent storage of wet blocks in FSCs at the ISFSI. The evaluation conservatively assumed the occurrence of an incident that would result in substantial wetting of the fuel blocks prior to placing the blocks in FSCs and transfer to the ISFSI.

In order to project conservative moisture levels that could be present in the graphite fuel blocks, PSCo commissioned the Great Lakes Carbon Corporation (GLCC) to perform tests for the purpose of determining worst case water absorption by graphite blocks. These tests, discussed in EE-DEC-0031, Rev. A, concluded that 0.01% by weight water absorption in graphite represented a conservative estimate for graphite blocks exposed to moist conditions. Graphite that had been stored outdoors at the GLCC facility in Morganton, North Carolina, and subjected to several months of heavy rains, exhibited less than 0.01% by weight water absorption. A moisture level of 0.01% would result in 77.6 cc of water in a FSC with 6 fuel blocks (each block weighs about 285 lbs.).

The spent fuel blocks loaded into the FSCs were dry. The fuel and the reactor primary coolant system were dry when the FSV reactor was permanently shut down on August 19, 1989. Reactor operations personnel do not recall incidents resulting in water ingress events between the final reactor shutdown and the completion of fuel loading at the ISFSI in June, 1992. The fuel blocks were maintained in a dry helium environment throughout their storage period in the Reactor Building, stored in either the reactor vessel or the fuel storage wells. The fuel blocks did not come into contact with air until they were loaded into the FSCs for transfer to the ISFSI. PSCo considers that the graphite fuel blocks could not have absorbed 0.01% by weight moisture levels when loaded into the FSCs, and it is most probable that moisture levels are substantially below this value. However, this value is used as a conservative upper bound for evaluation purposes.

Engineering Evaluation EE-DEC-0031, Rev. A, considered the following types of corrosion: general corrosion, galvanic corrosion, oxygen pitting, stress corrosion cracking, hydrogen embrittlement, chloride sensitization and chemical attack. It was concluded that general corrosion was the only corrosion mechanism of concern for the conditions that would exist inside the FSC. The evaluation considers that galvanic corrosion would need a pool of water to allow ionization to take place, and that a pool of water would not exist because small amounts of moisture in the graphite would tend to remain trapped in the graphite, and would not be driven out of the graphite at the relatively low temperatures that would be expected for fuel blocks stored in the ISFSI due to decay heat generation (less than 200 degrees F). The evaluation assessed a corrosion rate of 1.0 mil per year of the inside surfaces of the FSC due to general corrosion resulting from the assumed relatively high moisture levels. It was concluded that the 0.46 inch remaining wall thickness of the FSCs after 40 years was adequate to meet structural and containment requirements and in conformance with the requirements of ASME Code Section III, Division 1, Subsection ND-3120.

The NRC staff independently assessed the potential for corrosion of the FSCs, with the results of this evaluation documented in the NRC's Safety Evaluation Report (SER) for the FSV ISFSI (Reference 4). Section 2.2.5.2.2 of this SER, "Corrosion of the FSC", concurred with PSCo's conclusion that 1.0 mil per year represented a conservative projection for general corrosion, and that the unaffected thickness of 0.46 inches is adequate to maintain container integrity and the required mechanical strength. The NRC additionally considered the total amount of corrosion that could occur if all the water assumed to be in a FSC reacted with carbon steel on the inner surface of the FSC. This evaluation states:

> "The outer surfaces of the FSC will be coated with an aluminum-based coating which will reduce the corrosion rate to well below 0.001 in/yr. However, internal corrosion is still possible if sufficient water is present. The SAR states that the water content of the fuel blocks is about 0.01%. With a safety factor of 10, this yields about 2 pounds of water per container. If this water were to fully react with the steel to produce iron oxide, the maximum penetration would be about 0.003 inches."

The NRC considered the possibility of localized corrosion in Section 2.2.5.2.2 of the above referenced SER, stating the following:

> "Localized corrosive attack, e.g., pitting and stress corrosion cracking, on the FSC requires the presence of water on its surfaces. This is precluded from the vertical surfaces of the FSC by the physical arrangement of the flow and drainage paths. The use of the similar materials for the FSC and the steel structural components of the MVDS precludes their potential for galvanic corrosion."

> "The staff was concerned regarding the possibility of general and localized corrosion, particularly crevice corrosion, along the internal flat bottom surface of the FSC. This could be an area for accumulation of water through capillary suction. If the corrosion rate were 10 times the general rate at 0.01 in/yr, the penetration over the 40-year storage time would be a maximum of 0.4 inches. This assumes that all the water present in the container will vaporize from the fuel blocks and then condense, without escaping, on the bottom surface of the FSC."

Based on this assessment, the NRC concluded that the remaining thickness of the FSC bottom plate, unaffected by the localized corrosion, would be adequate for mechanical strength and found the FSC design acceptable for both general and localized corrosion mechanisms.

PSCo considers that general corrosion of carbon steel inside the FSC would not result in the production of significant quantities of hydrogen (as is the case for attack of metals by acid solutions), since the pH of water evaporating from the graphite blocks would be essentially neutral. PSCo considers that general corrosion of carbon steel is the most likely reaction that would occur with any water evaporating from the graphite blocks. Reference 5 identifies the general corrosion reactions anticipated for near neutral water exposed to air, as follows:

Anode reaction:	$Fe \rightarrow Fe^{++} + 2e^-$
Cathode reaction:	$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$
Overall reaction:	$2Fe + 2H_2O + O_2 \rightarrow 2Fe^{++} + 4OH^- \rightarrow 2Fe(OH)_2$
	$2Fe(OH)_2 + H_2O + \frac{1}{2}O_2 \rightarrow 2Fe(OH)_3$

The final product, $2Fe(OH)_3$, is common rust. There is no hydrogen gas produced in these general corrosion reactions.

In evaluating the request for information in NRC Bulletin 96-04, PSCo's Material Engineering Department reviewed information related to the FSCs stored at the FSV ISFSI and identified a possible galvanic corrosion mechanism, which is dependent on water collecting in the bottom of a FSC. PSCo considers that moisture levels in the graphite are well below the 0.01% by weight value discussed above, used for conservative evaluations, and that under normal storage conditions fuel block temperatures are too low to drive significant quantities of moisture out of the graphite. Therefore, pooling of water in the bottoms of FSCs is not expected to occur.

Considering off-normal and accident conditions, it may be possible for fuel blocks to reach temperatures at which some of the moisture would be driven out of the graphite. If substantial blockage of the ISFSI inlet or outlet ducts were postulated to occur, as evaluated in ISFSI SAR Sections 8.1.2 and 8.2.8, it is considered possible that relatively high fuel block temperatures (in excess of 200 degrees F) could possibly drive some of the moisture out of the graphite. The water vapor could then condense on the inside vessel walls of FSCs, and possibly collect in the bottom of the FSC, where it would be in simultaneous contact with carbon steel at the bottom of the FSC and the bottom graphite fuel block. Under these conditions, a galvanic cell could possibly exist if the water contained ionic impurities so that it served as a suitable electrolyte. Under these circumstances, a galvanic cell could develop in which the carbon steel functions as the anode and the graphite as the cathode. Iron on the inside of the FSC could oxidize with positive iron ions entering the electrolyte solution, transferring electrons to the graphite electrode, where a reduction reaction is postulated to occur. The reduction reaction in this case could involve the production of hydrogen gas at the graphite cathode, as the result of electrons transferred to H^+ ions in the water. This reaction is theoretically possible, since carbon (graphite) has a lower oxidation potential than iron, assuming the presence of a suitable electrolyte.

Review of the thermal analyses performed for the FSV ISFSI, and submitted to the NRC in Reference 6, indicates that maximum temperatures of the fuel blocks having peak decay heat generation rates would not have exceeded 200 degrees F during the storage interval at the ISFSI. This included assessment of the short-duration partial inlet duct blockage event that occurred in March, 1992, described in ISFSI SAR Section 8.1.2. Consideration was given to the longer actual fuel decay times than those considered in the Reference 6 thermal analyses. As discussed in ISFSI SAR Section 3.1.1.2, "Thermal Characteristics", thermal analyses were based on calculated decay heat generation rates of 85 watts for an average fuel block and 150 watts for a peak fuel block, assuming 600 days decay, whereas ISFSI fuel loading actually began on December 26, 1991, 859 days after reactor shutdown with 55 watt average and 101 watt peak decay heat generation rates calculated for a single fuel block. Presently, all the spent fuel stored at the ISFSI has undergone approximately 7 years decay. In addition, it is unlikely fuel block temperatures exceeded 200 degrees F for the relatively short residence time of the FSCs in the FSV-1 spent fuel shipping cask during transfer from the Reactor Building to the ISFSI. Based on this, PSCo does not believe significant quantities of moisture could have been driven out of the graphite, condensed on the FSC walls and pooled in the FSCs, and therefore conditions to date have not been conducive to the galvanic cell reaction.

PSCo contacted personnel associated with the graphite fuel storage facility at the Idaho National Engineering Laboratory (INEL), where FSV spent fuel is stored. This fuel was removed from the FSV reactor in the three refuelings that took place over the life of the reactor plant, with the first fuel segment removed from the FSV core in February, 1979. FSV fuel has been stored in carbon steel canisters in an air environment at INEL for as long as 17 years. One difference with the INEL spent fuel storage canisters and those at FSV is that the FSV canisters are sealed with double metal o-rings, whereas the lids of the INEL canisters do not have seals. Personnel at INEL have not observed any corrosion problems with the carbon steel canisters that contain FSV graphite fuel blocks.

PSCo's Materials Engineering Department also identified the possibility for the grease applied to the sealing surfaces at the tops of the FSCs to break down over time due to exposure to the high radiation field known to exist in the FSCs. Decomposition of the grease could result in the generation of a small quantity of hydrogen gas. Six of the FSC double metal 0-ring lid seals were leak-tested in March, 1996, as required by ISFSI Technical Specification Surveillance 3.3.2. All seals tested were determined to be intact.

It should be noted that there are no ignition sources in a FSC, as discussed below, and the potential for generation of some hydrogen gas does not pose a threat to safe storage of the FSCs.

TN-FSV Spent Fuel Shipping Casks

The TN-FSV spent fuel shipping casks containing a FSC were also evaluated for the possibility of chemical, galvanic or other reactions among the materials, environment or contents. No potential reactions of significance involving the TN-FSV casks were identified. The internal surface of the TN-FSV cask is stainless steel, and the external surface of a FSC is coated with aluminum. Both materials develop a passive oxide layer which is highly resistant to general corrosion. It should be noted that loading and unloading of the FSCs with the TN-FSV casks are performed dry, and at no time are these items submerged in a pool of water. Neither the TN-FSV cask internal cavity nor the external surface of the FSC will have significant moisture when the FSC is loaded into the TN-FSV cask. Even if water were somehow introduced into the TN-FSV cavity, any galvanic corrosion would oxidize some of the aluminum coating of the FSC, although it is considered that this would be insignificant over the relatively short duration of a cask shipment. This would not impact the FSC carbon steel vessel that contains the fuel, and would have no effect on FSC integrity. A strong corrosive, such as hydrochloric acid, would have to be introduced into the TN-FSV internal cavity that could attack the passive oxide layer of the FSC or the stainless steel TN-FSV cask to raise a corrosion concern. This is not considered credible even under off-normal and accident conditions. Expendables used in the fabrication of the TN-FSV casks were reviewed and it was determined that the materials used as cleaning agents and for other purposes would not be detrimental to the cask materials.

A depleted uranium plug (DUP) is designed to fit on top of the FSC in the TN-FSV cask. The DUP is nickel plated, for the purpose of preventing oxidation of the depleted uranium. Nickel is frequently used as an oxidation barrier since it has very good oxidation resistance. As with the above materials, a very corrosive material, such as a strong acid solution, would have to be present to attack nickel in its passive state. Such circumstances are not considered credible, even under off-normal and accident conditions.

NRC REQUEST FOR INFORMATION

1.(b) "Evaluate the effects of any identified reactions to determine if any adverse conditions could result during cask operations, including loading and unloading. Consideration should be given, but not limited, to:

(i) generation of flammable or explosive quantities of hydrogen or other combustible gases; and

(ii) increased neutron multiplication in the fuel in a cask because of boron precipitation from a chemical reaction among the borated water and cask materials."

PSCo RESPONSE

Assuming that the oxidation/reduction reaction in the theoretical galvanic cell discussed in 1.(a) above could actually proceed at a significant rate, then an adverse condition could possibly exist due to oxidation of the carbon steel anode and generation of hydrogen at the graphite cathode. This is dependent on water pooling in the bottom of a FSC, which PSCo considers to be very unlikely since the graphite fuel blocks were essentially dry when loaded into the FSCs and graphite temperatures under normal conditions of storage and transport are to low to drive significant quantities of moisture out of the graphite, as discussed above. In the highly improbable occurrence of a graphite heatup event, it is considered that most of the moisture driven out of the graphite blocks and into the air would likely be readsorbed into the graphite as it cools rather than condense on the sides of the FSC.

Worst case oxidation effects on the carbon steel due to a galvanic cell reaction are evaluated in the response to item 2 below, which determined that the FSC would retain its integrity even if all 77.6 cc of water that hypothetically could be present in six graphite fuel blocks somehow collected in a localized area in the bottom of a FSC and completely reacted to oxidize the steel.

If hydrogen gas were generated inside the FSCs due to a galvanic cell reaction, it should be noted that there are no ignition sources present and the potential for ignition of the hydrogen-air mixture does not exist under normal conditions of FSC storage, handling and transport in the TN-FSV cask. The FSC lids are bolted in place, and there are no welding operations on loaded FSCs. Transient analyses, documented in Attachment 3 of Reference 6, indicate that peak fuel temperatures would not exceed 350 degrees F even if the ISFSI air inlets are totally blocked for ten days, an event that is not considered credible. These analyses were based on decay heat generation rates after 600 days decay. Actual decay time is now approximately 7 years. The minimum autoignition temperature of a flammable mixture of hydrogen gas in air at atmospheric pressure is stated as 400 degrees C (752 degrees F) in the Society of Fire Protections Engineers' Handbook of Fire Protection Engineering, First Edition.

Item 1.(b)(ii) above, consideration for increased neutron multiplication in the fuel in a cask because of boron precipitation from a chemical reaction among the borated water and cask materials, is not applicable to PSCo's mode of storage since neither boron nor any other neutron absorbing material is used in the FSC design.

NRC REQUEST FOR INFORMATION

1.(c) "Review current cask operating procedures to determine if adequate controls and procedures are in place to minimize hazardous conditions that may be created by any identified reactions."

PSCo RESPONSE

All the FSV fuel on-site was transferred from the Reactor Building to the ISFSI during the fuel loading operation which took place from December 1991 through June 1992. There are no plans to transfer fuel from the ISFSI in the near future, or for any other operations which could involve handling a loaded FSC.

Procedures do not currently include a provision for checking the atmosphere inside a FSC prior to handling the FSC or removing the lid bolts. PSCo considers that it would not be prudent to handle or transport a FSC containing a potentially flammable mixture of hydrogen gas in air, even though it is unlikely for ignition to occur during handling or transport operations. In the event of a FSC drop accident, evaluated in Section 8 of the ISFSI SAR, or collision of the TN-FSV spent fuel shipping cask, a spark could possibly occur inside the FSC which could ignite any flammable gases. While PSCo considers it extremely unlikely that the conditions conducive to a galvanic reaction resulting in production of hydrogen gas could exist in a FSC, as discussed above, PSCo will revise its procedures, or institute controls to assure measures are included in future procedures, to preclude handling of a loaded FSC, or removal of the lid bolts, until such time as the gas space inside a FSC has been analyzed and determined not to have a combustible gas mixture, or evacuated and purged with air to assure hydrogen concentrations are below flammable levels. This will assure that only FSCs that do not contain a flammable concentration of hydrogen are transported in the TN-FSV casks. If no significant hydrogen concentration is detected in the first six FSCs whose internal atmospheres are tested, then it will be assumed that the theoretical galvanic reaction is not occurring at a significant rate in the FSCs, and additional FSCs will not be tested.

NRC REQUEST FOR INFORMATION

1.(d) "Evaluate the effects of any identified reactions to determine if their reaction products could reduce the overall integrity of the cask or its contents during storage or transportation. Determine if the reaction products could adversely affect the cask ability to maintain the structural integrity and retrievability of the spent fuel throughout the term of the license or to transport fuel safely. Consideration should be given, but not limited, to:

(i) changes in cask and fuel cladding thermal properties, such as emissivity;

(ii) binding of mechanical surfaces, especially fuel-to-basket clearances

(iii) degradation of any safety components, either caused directly by the effects of the reactions, or by the effects of the reactions combined with the effects of long-term exposure of the materials to neutron and gamma radiation, high temperatures, or other possible conditions."

PSCo RESPONSE

The products of the potential galvanic cell reaction discussed in the above response to item 1.(a) are iron in its oxidized state and hydrogen gas. The product of concern from possible radiolytic decomposition of the grease that was applied to the FSC lid seating surface is also hydrogen gas. The response to item 2 concludes that the quantity of iron that could hypothetically be involved in a galvanic cell reaction which exhausts the maximum potential moisture inventory is relatively small, and the FSC would continue to maintain its structural integrity and perform its safety functions assuming oxidation of this iron from portions of the bottom of the FSC. The production of hydrogen gas could possibly have adverse effects on the structural integrity of a FSC if the hydrogen generated could hypothetically achieve a flammable concentration in air and an ignition source were present. As stated in the responses to 1.(b) and 1.(c) above, an ignition source is not present during normal conditions of FSC storage, handling and transport. However, during off-normal and accident conditions of FSC handling and transport, such as drop of a FSC, the potential exists for a spark which could serve as an ignition source. Procedural controls will be implemented to eliminate the potential for a hydrogen combustion reaction, as discussed in the response to 1.(c) above.

The potential galvanic cell reaction, and other corrosion reactions previously evaluated and described in the response to 1.(a), would not adversely affect the ability to maintain the structural integrity and retrievability of the spent fuel throughout the term of the license, or to transport the spent fuel safely. These reactions do not have the potential for changing graphite fuel thermal properties, such as emissivity, nor for causing binding of the graphite fuel blocks with each other or with the FSC. PSCo has not identified reactions capable of significantly degrading any of the safety components of the FSC, which comprises secondary containment of the fission products inside the coated fuel particles. These components would not be significantly degraded by the possible galvanic and corrosion reactions, even considering the reactions combined with the effects of long-term exposure of the materials to neutron and gamma radiation.

NRC REQUEST FOR INFORMATION

2. "For storage casks currently loaded with spent fuel, determine the extent, if any, of the chemical, galvanic, or other reactions that have occurred, and the effect of these reactions on the cask ability to maintain the structural integrity and retrievability of the spent fuel throughout the term of the license.

PSCo Response

The only potential reaction of concern that was not previously evaluated is the galvanic reaction discussed in item 1.(a) above. As discussed in item 1.(b) above, PSCo considers it highly probable that there is insufficient moisture in the graphite fuel blocks and insufficient temperature of the blocks to drive moisture out to cause pooling of condensate in the bottom of a FSC. However, PSCo has conservatively estimated the quantity of iron that could be oxidized, assuming that all of the water that could potentially be present in the graphite blocks is evaporated from the blocks and condenses on the side walls of the FSC and collects in the bottom of the FSC. In order to maximize the depth of steel affected, it was assumed that the water is trapped in the bottom of the FSC, between the 6 faces of the bottom hexagonal graphite block and the sides and bottom of the FSC. Water evaporating from a hexagonal face of a graphite block would be expected to condense on the wall of the FSC adjacent to that face. In actuality, some water postulated to collect in the bottom of a FSC would run underneath the blocks and react with steel below the blocks, decreasing the depth of steel affected by the galvanic reaction. The calculation did not consider that water in the bottom of a FSC in contact with graphite would be re-adsorbed by the graphite.

77.6 cc of water trapped in the spaces between the bottom graphite fuel block and the FSC would have a depth of 0.11 inch, and contact an area of 49.1 square inches of the bottom and sides of the FSC internal cavity. Conservatively assuming all the water somehow is expended in a galvanic cell reaction, 1.9 cubic inches of iron could be oxidized. Limiting the reaction to only the FSC surfaces noted above results in calculation of a maximum depth of steel affected by oxidation of 0.038 inch. This is less than the 0.04 inch depth previously considered in PSCo Engineering Evaluation EE-DEC-0031, Rev. A. As stated in the response to 1.(d) above, it was concluded that the remaining bottom plate and side wall thickness of a FSC would be adequate to meet structural and containment requirements and in conformance with the requirements of ASME Code Section III, Division 1, Subsection ND-3120.

As stated above, there are no potential ignition sources during FSC storage operations. Measures will be implemented to assure a flammable concentration of hydrogen gas in air does not exist prior to handling a FSC or removing its lid bolts, as discussed in item 1.(c) above. In the unlikely event that testing determines a FSC contains a flammable concentration of hydrogen in air, then the FSC will be evacuated and purged with air prior to handling. This control will preclude handling of FSCs until assurance is provided that a flammable mixture of gases is not present in the FSCs. This eliminates the potential for off-normal handling operations and transport, which could possibly produce a spark that would constitute an ignition source, from affecting the structural integrity of the FSC or adversely affecting the spent fuel.

Under FSC shipping and transport conditions, credit is not taken for the FSC integrity to provide containment. The TN-FSV spent fuel shipping cask affords the containment boundary in the licensed shipping congiguration.

Based on the above, it is concluded that the potential galvanic cell reaction between the graphite and iron in the steel could not oxidize sufficient iron to prevent the FSC from carrying out its containment safety function, and from meeting its minimum strength requirements. Any FSC affected by galvanic reaction, as well as by the general corrosion and crevice corrosion mechanisms previously considered, would continue to maintain its structural integrity. The potential for hydrogen explosions is eliminated by procedural controls. Integrity and retrievability of the graphite fuel blocks would not be affected by any of the reactions identified.

References

1. TN-FSV Spent Fuel Shipping Cask Certificate of Compliance Number 9253.

2. Safety Analysis Report for the Transnuclear - Fort St. Vrain Packaging, Docket No. 71-9253

3. PSCo letter, Crawford to Roberts, dated July 23, 1990 (P-90236)

4. NRC letter, Haughney to Crawford, dated November 4, 1991 (G-91230)

5. Fontana, M., and Greene, N., "Corrosion Engineering" (textbook), published by McGraw Hill in 1967

6. PSCo letter, Warembourg to Sturz, dated December 15, 1992 (P-92310)

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of the	
ISFSI Materials License No. SNM-2504,	) Docket No. 72-009
FSV-1 Certificate of Compliance No. 6346	) Docket No. 71-6346
TN-FSV Certificate of Compliance No. 9253	) Docket No. 71-9253
	)
of	)
	)
PUBLIC SERVICE COMPANY OF COLORADO	)

Response to NRC Bulletin 96-04

OF THE

PUBLIC SERVICE COMPANY OF COLORADO

FOR THE

FORT ST. VRAIN INDEPENDENT SPENT FUEL STORAGE INSTALLATION,
FSV-1 SPENT FUEL SHIPPING CASKS,
AND THE TN-FSV SPENT FUEL SHIPPING CASKS

This response to NRC Bulletin 96-04 is submitted for NRC review and approval.

Respectfully submitted,

PUBLIC SERVICE COMPANY OF COLORADO

By A. Clegg Crawford
Vice President
Engineering & Operations
Support

Patricia T. Smith
Senior Vice President and
General Counsel

Attorney for Applicant

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of the	
ISFSI Materials License No. SNM-2504,	) Docket No. 72-009
FSV-1 Certificate of Compliance No. 6346	) Docket No. 71-6346
TN-FSV Certificate of Compliance No. 9253	) Docket No. 71-9253
	)
of	)
	)
PUBLIC SERVICE COMPANY OF COLORADO	)

Response to NRC Bulletin 96-04

OF THE

PUBLIC SERVICE COMPANY OF COLORADO

FOR THE

FORT ST. VRAIN INDEPENDENT SPENT FUEL STORAGE INSTALLATION,
FSV-1 SPENT FUEL SHIPPING CASKS,
AND THE TN-FSV SPENT FUEL SHIPPING CASKS

This response to NRC Bulletin 96-04 is
submitted for NRC review and approval.

Respectfully submitted,

PUBLIC SERVICE COMPANY OF COLORADO

By A. Clegg Crawford
Vice President
Engineering & Operations
Support

Patricia T. Smith
Senior Vice President and
General Counsel

Attorney for Applicant

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of the	
ISFSI Materials License No. SNM-2504,	) Docket No. 72-009
FSV-1 Certificate of Compliance No. 6346	) Docket No. 71-6346
TN-FSV Certificate of Compliance No. 9253	) Docket No. 71-9253
	)
of	)
	)
PUBLIC SERVICE COMPANY OF COLORADO	)

Response to NRC Bulletin 96-04

AFFIDAVIT

A. Clegg Crawford, being first duly sworn, deposes and says: That he is Vice President, Engineering and Operations Support, of Public Service Company of Colorado, the Licensee herein, that he has read the response to NRC Bulletin 96-04, and knows the contents thereof, and that the statements and matters set forth therein are true and correct to the best of his knowledge, information and belief.

A. Clegg Crawford
A. Clegg Crawford
Vice President
Engineering and Operations Support

STATE OF Denver)

COUNTY OF Denver)

Subscribed and sworn to before me, a Notary Public on this 19th day of August, 1996

Audrey L. Ketzman
Notary Public

My commission expires 11-29, 1999