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This is a short description of the DOE SNF inventory. The verbiage describing the naval SNF has been reviewed and Oked by them

Chemical Composition of DOE Spent Nuclear Fuel

The DOE spent nuclear fuel has been placed into 16 categories to simplify repository performance analysis. These are the same fuel categories that are used in the viability assessment for the Yucca Mountain repository. The fuel is presently located at several DOE locations, but will be consolidated at three major DOE sites for management and preparation for repository disposal. Each of the 16 categories have different chemical compositions. The chemical composition will be discussed by category. Table 1 indicates the chemical composition and the materials of construction for each of the categories. The table does not contain the activation products or the fission products.

Category 1 - uranium metal
All of the fuel in this group is constructed of uranium metal. N-reactor fuel was chosen to represent the group because its mass was so large that the performance of the rest of the groups fuels, even if they might be worse than N-reactor fuel, would not change the overall group performance. The fuel is composed of uranium metal less than 2% enriched in uranium 235, clad with a zirconium alloy. These fuels typically have low burnup. Much (50% - 80%) of the N-reactor fuel cladding is disrupted. Other contributors to this category include the Single Pass Reactor fuel at Hanford and declad EBR-II blanket material at Savannah River.

Category 2 - uranium-zirconium alloy
All of the fuel in this category is constructed of a uranium - 91% zirconium alloy. Heavy Water Components Test Reactor (HWCTR) was chosen as the representative fuel because it was the largest part of the inventory. This fuel is approximately 85% enriched in uranium 235, which is clad with a zirconium alloy. A few of the elements are leaking fission products, but no major damage has been identified.

Category 3 - uranium Molybdenum alloy
The fuel in this category is constructed of uranium - 10% molybdenum alloy, 25% enriched in uranium 235, and is clad with a zirconium alloy. Fermi driver core 1 and 2 are the only fuel in the group. The fuel is in an existing aluminum can. The proposed disposition will place the aluminum cans into a standard stainless steel canister that will be placed in the repository disposal container.

Category 4 - intact uranium oxide assemblies
All of the fuel in this category is constructed of uranium oxide that has been formed into pellets or plates and clad with a corrosion resistant material. Commercial fuel was chosen as the representative fuel for this group because it was a significant part of the inventory. The fuel is made of uranium oxide, some of which is highly enriched in uranium 235 and some of the fuel is low enriched in uranium 235. The fuel rods are clad with a zirconium alloy. There are many fuels in the group that are constructed with uranium that is highly enriched in uranium-235.

Category 5 - uranium oxide with failed cladding
The fuels in this category are chemically similar with the fuels in category 4, except that they have been disrupted by an accident or by destructive examination. The failed fuel from the Three Mile Island Reactor 2 was chosen to represent this group because it comprised 94% of the total group. The TMI-2 fuel is composed of uranium oxide that has been melted. The cladding was significantly disrupted during the accident. Other fuels in this group are declad or have significant cladding damage. A few of the fuels are clad with aluminum.

Category 6 - Uranium-aluminide and uranium oxide compounds
This category consists of fuels with the uranium-aluminum compound or an uranium oxide compound, dispersed in a continuous aluminum metal phase. The fuels are clad with an aluminum alloy. The uranium 235 enrichments vary from 10% to 93%.

Category 7 Uranium silicide compound
This category consists of fuels with a uranium silicide compound dispersed in a continuous aluminum metal phase. The fuels are clad with an aluminum alloy. The uranium 235 enrichments vary from 8% to 93%, but the majority are less than 20%.

Category 8 - Uranium/thorium carbide in a high integrity particle
This category consists of fuels with uranium carbide and thorium carbide that was made into particles that were coated with a high integrity coating. Fort St. Vrain Reactor is selected to represent the category as it makes up 95% of the mass of the group. The fuel is made of uranium carbide and thorium carbide that has been formed into particles and coated with layers of pyrolytic carbon and silicon carbide. The particles are bonded together by a carbonaceous matrix material and placed into a graphite block. The fuel was made with uranium enriched to 93% in uranium 235. The thorium was used to generate fissile uranium 233 during irradiation. There is some fuel that does not utilize a silicon carbide coating, but its effect on the group is negligible. Less than 1% of the fuel particles are breached.

Category 9 - Uranium/thorium carbide in a low integrity particle
This category consists of fuels with uranium carbide and thorium carbide that was made into particles that were coated with a coating of an earlier design described in category 8. Peachbottom core 1 is the only fuel in the group. This category is chemically similar to category 8 except 60% of the particle coating is breached. Peachbottom core 2 is included in group 8 because it's fuel particles are basically intact and are more rugged than the Peachbottom core 1 particles.

Category 10 - Uranium/plutonium carbide, non-graphite
This category consists of fuels that contain uranium carbide with many also containing plutonium carbide. FFTF carbide assemblies were chosen to represent the group because it makes up 70% of the group and it contains both uranium and plutonium. The FFTF carbide fuel was constructed from uncoated uranium and plutonium carbide spheres that were loaded directly into the fuel pins, or were pressed into pellets that were loaded into the pins. The pins are clad with stainless steel.

Category 11 - Mixed uranium-plutonium oxide (MOX)
This category consists of fuels that are constructed of both uranium oxide and plutonium oxide. FFTF MOX test assembly was chosen as the representative fuel because it comprises more than 80% of the group. The fuels are a combination of uranium oxide and plutonium oxide that are pressed into a pellet and clad with stainless steel or a zirconium alloy. The uranium 235 enrichment is low but the fissile contribution of the plutonium raises the effective enrichment to 15%.

Category 12 - Uranium/thorium oxide
This category consists of fuels that are constructed of uranium oxide and thorium oxide. Shippingport LWBR was chosen as the representative fuel because it represented more than 75% of the inventory. The fuels are made of a mixture of uranium oxide and thorium oxide. The shippingport LWBR fuel is made of uranium 233, and the irradiation of the thorium produces more uranium 233. The mixture is pressed into pellets and clad with a zirconium alloy.

Category 13 - Uranium -Zr-H
This category consists of fuels that are made on uranium - zirconium - hydride. TRIGA comprises more than 90% of this group. The fuel is made of uranium-zirconium-hydride that is formed into rods that are clad primarily with stainless steel or aluminum. The uranium is enriched up to 20% in uranium 235.

Category 14 - Containing metallic sodium
Due to the chemical reactivity of the metallic sodium, this fuel will be treated to react or remove the metallic sodium. The new form of the fuel will be conditioned to meet repository requirements prior to placement into the repository. Although the final chemical form of the fuel has not been determined, it is likely that it will be as good as or better performing in a repository setting than uranium metal in group 1.

Category 15 - Naval
Naval nuclear fuel is highly robust and designed to operate in a high-temperature, high-pressure environment for many years. Newly fabricated naval nuclear fuel is highly enriched (93% to 97%) in the isotope U-235. In addition, to ensure the design will be capable of withstanding battle shock loads, the naval fuel material is surrounded by large amounts of structural material made of an alloy of the highly corrosion-resistant metal zirconium called Zircaloy.

Approximately 300 containers of naval spent nuclear fuel are planned to be emplaced in the geologic repository. There are several different designs for naval nuclear fuel, but all designs are constructed using similar materials and mechanical arrangements. The total weight of the fuel assemblies in a container of a typical submarine spent reactor fuel, which is representative of the chemical composition of naval spent nuclear fuel, will be approximately 11,000 to 13,000 kg. Of this total, less than 500 kg is uranium, depending on the amount of time the fuel was operated in a reactor (i.e., the longer the reactor operates, the less uranium will be present in the fuel since the uranium is consumed in the fission process). Approximately 1000 to 2000 kg of the total weight of the fuel assemblies is associated with the hafnium in the poison devices, primarily control rods, permanently affixed to the fuel assemblies.

There will be approximately 9,000 to 12,000 kg of Zircaloy in the fuel structure in the typical container. The typical chemical composition of Zircaloy is approximately 98% zirconium, 1.5% tin, 0.2% iron, and 0.1% chromium.

The small remainder of the naval spent nuclear fuel mass in a canister of typical naval spent nuclear fuel from a submarine, less than 500 kg, will be comprised of small amounts of metals and nonmetals, for example, fission products and oxides.

Category 16 - Miscellaneous

This category constitutes the fuels that do not fit into the previous 15 categories. The largest fuel, as measured in MTHM is a miscellaneous fuel at ANL-W that is most likely uranium metal or alloy. The other two largest contributors are identified as uranium alloy and uranium- thorium alloy. These make up more than 80% of the MTHM in the group. It is conservative to treat the total group as uranium metal. Other total chemical compounds included in this category include: uranium oxide, uranium nitride, uranium alloys, plutonium oxide, plutonium nitride, plutonium alloys, and thorium oxide.

Table 1 Chemical composition of DOE SNF by Category

material / category	1	2	3	4	5	6	7	8
fuel meat	U metal in kg.	U-91% Zr in kg	U-10% Mo in kg	UO_2 in kg	UO_2 in kg	U-Al, U oxide in kg	U-Si in kg	$UC_2.ThC_2$ in kg
uranium	2,117,887	40	3,763	98,027	86,858	10,194	8,657	1260
aluminum	1692					18,345	4,216	
molybdenum			378					
zirconium	136	444		7,500				
thorium								27,267
plutonium								
Silicon	260						884	
silicon carbide								52,944
carbon	1164			30				224,430
fuel cladding and structure								
aluminum	101		642		17,619	64,000[1]	52,000[1]	
stainless steel				11,000	2,995			
zirconium	159,875	70	275	63,800	58,030			
inconel				1,000	1,685			
container								
stainless steel	600,000	5,600	50,400	165,000	432,040	985,000	215,000	503,300
aluminum			656		10,320			
other								
concrete					29,584			
boron						2000	500	
silver					1,101			
cadmium					34			
indium					275			
magnesium								
nickel	210							
rhodium								
ruthenium								
samarium								
gadolinium								
hafnium								

1. Assumes direct disposal of the aluminum-based fuels

Table 1 Chemical composition of DOE SNF by Category (continued)

material / category	9	10	11	12	13	14	15	16
fuel meat	$UC_2.ThC_2$ in kg	$UC_2.PuC_2$ in kg	UO_2 - PuO_2 in kg	UO_2 - ThO_2 in kg	U-Zr-H in kg	metallic sodium containing in kg	U based - Zr clad in kg	Misc. In kg
uranium	207	137	9921	812	2030	59767	65,000	8508
aluminum								
molybdenum					9			
zirconium					23,337			
thorium	1459			47,785				2,160
plutonium		16	2,400					8
silicon								
silicon carbide								
carbon	52,996				1,700			
fuel cladding and structure								
aluminum					11,274			500
stainless steel	8,000	320	2418	31,000	16,900			20,000
zirconium			500	11,515	100		3,000,000	100
inconel								
container								
stainless steel	42,000	3,500	263,200	49,700	70,000		9,900,000	30,800
aluminum								
other								
concrete								
boron	29							
silver								
cadmium								
indium								
magnesium	432							
nickel								
rhodium	30							
ruthenium	30							
samarium					67			
gadolinium								
hafnium							600,000	

blanks indicate that the quantity is less than reportable quantities