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ADJUDICATIONS STAFF

In the Matter of

Louisiana Energy Services, L.P.
National Enrichment Facility

Docket No. 70-3103

ASLBP No. 04-826-01-ML

HEARING EXHIBITS OFFERED ON BEHALF OF NUCLEAR INFORMATION AND RESOURCE SERVICE AND PUBLIC CITIZEN

The following exhibits will be offered on behalf of Nuclear Information and Resource Service and Public Citizen ("NIRS/PC") at the hearing scheduled for February 7 through 16, 2005. In listing exhibits NIRS/PC have not included as exhibits those portions of the Application itself (i.e., Environmental Report and Safety Analysis Report) that are planned to be referred to by witnesses, since such documents are contained in the record of this proceeding. When an item is readily available from a public Internet location, the location is cited.

This revised list is provided pursuant to the Memorandum and Order of the Atomic Safety and Licensing Board dated January 18, 2005 (Regarding NIRS/PC Prefiled Testimony and Exhibits). This list is subject to further revisions upon the submittal of prefiled rebuttal testimony and revised prefiled direct testimony and, thereafter, based upon conferences with other parties to eliminate duplicate exhibits.

NIRS/PC Exhibits:

1. Areva, 2004a, *Calculation Summary Sheet, Water Balance Tables for National Enrichment Facility Basins,* September 2004, Bates numbers LES-05129 – LES-05188.

Template=SECY-028

SECY-02

2. Barrett, M.E., R.D. Zuber, E.R. Collins, J.F. Malina, Jr., R.J. Charbeneau, and G.H. Ward, 1993, *A Review and Evaluation of Literature Pertaining to the Quality and Control of Pollution from Highway Runoff and Construction,* Technical Report CRWR 239, April 1993 URL (2nd ed., 1995), URL: http://www.crwr.utexas.edu/reports/pdf/1995/rpt95-5.pdf.

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33. G. Rice Figure 2, Laboratory Hydraulic Conductivity

34. G. Rice Figure 3, Schematic—Geologic Cross Section in Vicinity of Proposed Site (showing fracture flow).

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69. Louisiana Energy Services, L.P. Response to Nuclear Information and Resource Service and Public Citizen Interrogatories, December 20, 2004, responses to interrogatories 1, 2, 3.

70. NRC Staff's Response to Interrogatories and Document Request by Petitioners Nuclear Information and Resource Service and Public Citizen to Commission Staff, November 10, 2004, responses to interrogatories 3, 10, 11, 12.

71. Deposition of George A. Harper and Roger L. Peery, September 17, 2004, at:

    a. Page 16 line 4 through page 18 line 17.
    b. Page 20 line 22 through page 21 line 17
    c. Page 48 line 3 through line 14.
    d. Page 54 line 1 through line 23.
    e. Page 55 line 7 through page 56 line 22.
    f. Page 57 line 16 through page 58 line 14.
    g. Page 61 line 2 through page 62 line 2.
    h. Page 72 line 4 through page 73 line 7.
    i. Page 100 line 18 through page 101 line 23.
    j. Page 117 line 6 through page 118 line 1.

72. Deposition of George R. Campbell, et al., September 17, 2004, at:

    a. Page 20 line 23 through page 22 line 8.
    b. Page 22 line 23 through page 24 line 1.
    c. Page 47 line 7 through page 48 line 18.

73. Deposition of Kirk Schnoebelen, et al., September 29, 2004, at:

    a. Page 54 line 5 through page 55 line 14.
    b. Page 60 line 16 through page 61 line 13.
    c. Page 83 line 17 through page 87 line 20.
    d. Page 107 line 2 through page 108 line 3.

74. Exhibit 8 to Schnoebelen deposition, e-mail from C. Chater to C. Andrews, January 10, 2003, Subject: Comments on the ERI No Need Analysis.

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January 24, 2005

CERTIFICATE OF SERVICE

Pursuant to 10 CFR § 2.305 the undersigned attorney of record certifies that on January 24, 2005, the foregoing Hearing Exhibits Offered on Behalf of Nuclear Information and Resource Service and Public Citizen was served by electronic mail and by expedited delivery upon the following:

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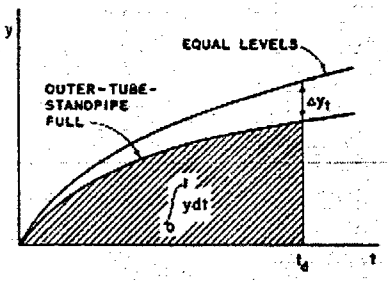

Figure 5.18 Curves of water-level drop versus time in standpipe on inner tube when water level in outer-tube standpipe was held at top of pipe (lower curve) and when allowed to fall at same rate as water level in inner-tube standpipe (upper curve).

measurements (equal levels in standpipes) will be above that for the first set (outer-tube standpipe kept full), as shown in Figure 5.18. The K value is calculated from these curves as

$$K = \frac{r_r^2}{F_f r_c} \frac{\Delta y_t}{\int_0^{t_d} y\,dt} \tag{5.48}$$

where r_r = radius of standpipe on inner tube
r_c = radius of inner tube
Δy_t = vertical difference between curves in Figure 5.18 at time t_d
F_f = dimensionless factor
$\int_0^{t_d} y\,dt$ = area under lower y-vs.-t curve between $t = 0$ and $t = t_d$

The time t_d for which Δy_t is read from the graph and for which the area under the lower curve is evaluated should be selected as small as possible while still yielding a sufficiently accurate value of Δy_t. The factor F_f is dependent on the geometry of the system, and it was evaluated with a resistance network analog as a function of r_c/d (Figure 5.19), where d is the penetration of the inner tube into the hole bottom. The curve in this figure applies to soil that is uniform to great depth,

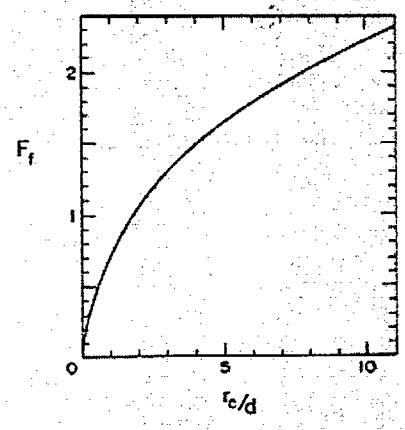

Figure 5.19 Plot of F_f in relation to r_c/d for double-tube method if soil is uniform to a depth of at least $2r_c$ below hole bottom.

which in practice means a depth of at least $2r_c$ below the hole bottom. Values of F_f were also determined for the case where impermeable or infinitely permeable material occurs at depths less than $2r_c$ below the hole bottom (Bouwer, 1961; Bouwer and Jackson, 1974). A simplified procedure for calculating K, based on replacing the y-vs.-t curves as in Figure 5.18 by straight lines to eliminate the integral, was developed by Bouwer and Rice (1964).

The K value obtained with the double-tube method is affected by K in both horizontal and vertical direction, but it is closest to K in vertical direction. The soil region sampled for K is approximately a cylinder with a radius somewhat larger than r_c and a height of about $2r_c$. Tests usually take 3 to 6 h to complete, and several hundred liters of water may be required per test.

5.5.4 Well Pump-in Technique

With the well pump-in technique, which is also called the *reverse auger-hole* method, a well or auger hole is dug and filled with water to a certain depth L_w, which should not be less than 10 times the hole radius r_w (Figure 5.20). Water is added to the hole to maintain this water depth until the outflow Q from the hole into the soil has become essentially constant. If the depth S_i of the impermeable layer below the hole bottom is greater than $2L_w$, K of the wetted zone can be calculated as

$$K = \frac{Q}{2\pi L_w^2}\left\{\ln\left[\frac{L_w}{r_w} + \sqrt{\left(\frac{L_w^2}{r_w^2} - 1\right)}\right] - 1\right\} \tag{5.49}$$

If $S_i < 2L_w$, the equation for K is

$$K = \frac{3Q \ln \frac{L_w}{r_w}}{\pi L_w (3L_w + 2S_i)} \tag{5.50}$$

These equations were developed by Zangar (Bouwer and Jackson, 1974, and references therein).

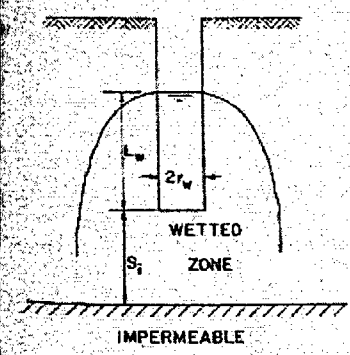

Figure 5.20 Schematic of well pump-in method.

The value of K obtained with the well pump-in technique mostly reflects K in horizontal direction. Sealing and other disturbances of the soil at the hole wall may cause underestimation of the true K value. The volume of the soil region sampled for K is approximately the same as that for the auger-hole method, i.e., about $0.4L_w^3$. Water may have to be added to the hole for several days before Q approaches a constant value. The water requirements are about 1 m^3 per test. Lining the hole with perforated casing or filling it with gravel may be necessary in unstable soils. The method can be used in gravelly or stony materials, which normally is not possible for the other techniques for measuring K in the absence of a water table.

5.6 MEASURING ANISOTROPY OF SOILS AND AQUIFERS

Anisotropy of subsurface material can be evaluated by combining techniques that measure K in different directions. In isotropic soils, these methods theoretically yield the same K value. Different K values indicate anisotropy, provided of course that the soil is otherwise homogeneous. To minimize the effect of local nonuniformities, the different techniques should measure K on essentially the same body of soil or aquifer material, so that the predominant flow direction is the only factor that is different.

Measurements of K in predominantly vertical and horizontal directions can be obtained with the piezometer method by first using a cavity of zero height and then deepening the cavity to a depth of about 4 or 5 times the cavity diameter below the piezometer tube (Maasland, 1957). Talsma (1960), however, found that the hydraulic conductivity K_z in a vertical direction showed much greater variation with depth than the hydraulic conductivity K_x in a horizontal direction. Thus, increasing the height of the piezometer cavity could yield a different K value merely by including soil with different K_z values in the flow system around the cavity. This would lead to erroneous conclusions regarding anisotropy.

Measurement of K in different directions but on essentially the same soil region can be accomplished by first measuring K with the double-tube method (yielding a value affected by both K_z and K_x) and then measuring K_z of the same soil by applying the infiltration-gradient technique to the same installation. Based on the theory of flow in anisotropic media, K_x can then be calculated (Bouwer, 1964; Bouwer and Rice, 1967).

Anisotropy in the horizontal plane can be evaluated with the two-well method, which measures mostly K_x in the direction of the line connecting the wells. If a well or auger hole is dug on each corner of a square, K_x in two mutually perpendicular directions can be evaluated by applying the two-well method in succession to each pair of diagonally opposite holes. Estimates of three-dimensional anisotropy can then be obtained by measuring K_z in the same area with, for example, the infiltration-gradient method.

The above methods give directional K values for relatively small volumes of soil or aquifer material ("point" measurements) and at relatively small depths. To obtain K in different directions for aquifers as a whole, some of the recent refinements in analyzing pumping-test data could be used (see references in Section 5.2.6). Other techniques include simulating certain flow systems in a model and varying K_z and K_x in the model until the simulated system produces the same cause-and-effect relations as observed for the actual system. This technique was employed by Bouwer (1970) to evaluate K_z and K_x of an unconfined aquifer from the response of the water levels in two piezometers to infiltration from groundwater recharge basins. Stallman (1963) developed a procedure, based on electric analog analyses, to determine anisotropy of unconfined aquifers from drawdown measurements at five points. Weeks (1969) evaluated K_z and K_x from drawdown measurements around a pumped well in a glacial-outwash aquifer.

5.7 CORE SAMPLING AND PERMEAMETER TECHNIQUE

The oldest technique for measuring K of subsurface materials is to collect a sample, place it in a cylinder or "permeameter" in the laboratory (Klute, 1965; Reeve, 1957), let water flow through the cylinder, and calculate K with Darcy's equation from the observed flow rate and head loss across the sample (see Section 3.2). Needless to say, this disturbed-sample permeameter technique yielded reliable results only for uniform sands or other coarse materials consisting of relatively round particles. Better results are obtained with an "undisturbed" sample, collected by pushing, driving, or drilling (for rock) a metal cylinder into the material (Campbell and Lehr, 1974; Reeve, 1957; see also Section 6.2.2). The cylinder with the sample inside is then taken to the laboratory for determination of K with the permeameter principle. Disadvantages of the technique are disturbance of the material (truly undisturbed samples of unconsolidated materials are almost impossible to obtain, no matter how sophisticated the core sampling technique is), the small size of the sample (the diameter is usually 5 to 10 cm and the height 5 to 50 cm), and the possibility of leakage flow between the sample and the cylinder wall. Core samples are usually taken in vertical bore holes so that the technique yields K_z. Horizontal samples for measuring K_x can be obtained by pushing the sampler horizontally into walls of pits, trenches, etc.

5.8 PLANNING AND INTERPRETING HYDRAULIC-CONDUCTIVITY MEASUREMENTS

Careful planning of hydraulic-conductivity measurements and rational interpretation of the results are needed where the similar-flow-system approach is not possible and "point" measurement techniques must be resorted to. Because of the heterogeneity of soils and aquifers, the locations and depths of K measurements and the number of replications must be carefully selected. This requires detailed knowledge of the various soils, soil layers, and stratigraphy of the area so that each layer or soil type will be adequately covered by the measurements.

Also by R. J. M. DeWiest

GEOHYDROLOGY

HYDROGEOLOGY

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This Book Is Dedicated to

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of Modern Well Hydraulics

per day through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 at a temperature of 60°F.

A second coefficient, the field coefficient of hydraulic conductivity, is also used by the Water Resources Division of the U.S. Geological Survey. This unit is defined as the flow of water in gallons per day through a cross section of aquifer 1 foot thick and 1 mile wide under a hydraulic gradient of 1 foot per mile at field temperature [38].

In Equation 6.7 it is assumed that both porous material and water are chemically and mechanically stable. This may never be true. Ion exchange on clay and colloid surfaces will cause changes of mineral volume which in turn will change the pore size and shape. Extreme changes in pressure will cause dilatation or compaction of aquifers. Moderate to high groundwater velocities will move colloids and small clay particles. Also, all water movement will facilitate solution or deposition of dissolved constituents. Relatively small changes in pressure or temperature may cause gases to come out of solution and clog pore space, thus reducing the hydraulic conductivity.

Table 6.1 Average Values of K and k

Soil Class	K, cm/sec	k, darcys	K, gpd/ft^2
Gravel	1–10^2	10^2–10^5	10^4–10^6
Clean sands (good aquifers)	10^{-3}–1	1–10^3	10–10^4
Clayey sands, fine sands (poor aquifers)	10^{-6}–10^{-3}	10^{-2}–1	10^{-2}–10

Table 6.2 Representative Values for k and K

Geologic Classification		Darcys, k	Meinzers, K
Argillaceous limestone	2% porosity	1.0×10^{-4}	1.80×10^{-3}
Limestone	16% porosity	1.4×10^{-1}	2.50
Sandstone, silty	12% porosity	2.6×10^{-3}	4.74×10^{-2}
Sandstone, coarse	12% porosity	1.1	19.90
Sandstone	29% porosity	2.4	43.60
Very fine sand	well sorted	9.9	18.00×10
Medium sand	very well sorted	2.6×10^2	4.60×10^3
Coarse sand	very well sorted	3.1×10^3	5.80×10^4
Gravel	very well sorted	4.3×10^4	7.88×10^5
Montmorillonite clay[a]		10^{-5}	10^{-4}
Kaolinite clay[a]		10^{-3}	10^{-2}

[a] For the clays only the order of magnitude is indicated.

Table 6.3 Equivalence between K and k Values

1 darcy	$= 9.87 \times 10^{-9}$ cm^2 $= 1.062 \times 10^{-11}$ ft^2
10^{-10} cm^2	$= 1.012 \times 10^{-2}$ darcys
0.1 cm/day	$= 1.15 \times 10^{-6}$ cm/sec $\approx 1.18 \times 10^{-11}$ cm^2 for water at 20°C
1.0 cm/sec	$\approx 1.02 \times 10^{-5}$ cm^2 for water at 20°C
1 darcy	$\approx$ 18.2 meinzer units for water at 60°F
1 meinzer	$= 0.134$ ft/day $= 4.72 \times 10^{-5}$ cm/sec $\approx 5.5 \times 10^{-2}$ darcys for water at 60°F

Tables 6.1, 6.2, and 6.3 contain useful data about K and k. In Table 6.3, $\approx$ means "equivalent to."

K may be determined by laboratory methods as well as by field measurements. In the laboratory, the hydraulic conductivity may be determined by means of so-called permeameters [34] in which small samples taken at different points of the aquifer are submitted to flow under constant head or variable head. These samples are generally disturbed, and, moreover, even if they were undisturbed they might not be representative of the average K of the aquifer. More significant for the hydrogeologist is the determination of K through a well-pumping test in the field.

Many researchers have tried to investigate the various factors which influence the intrinsic permeability and hence the hydraulic conductivity, both in experimental and analytical work. Among others, the influence of porosity was studied by Kozeny [22], that of grain size by Hazen [16], and that of void ratio by Zunker [39]. Other important contributions were made by Slichter [31,32,14], Fair and Hatch [11], Rose [27,28], and Bakhmeteff and Feodoroff [1].

The influence of the fluid properties on the value of the hydraulic conductivity is evident from Equation 6.7. Hence, hydraulic conductivity may be measured by using different fluids. It is possible, at least in principle, to measure the hydraulic conductivity using a gas, say air, and to compute the intrinsic permeability k. Once k is known, it suffices to multiply k by g/ν to find the hydraulic conductivity for any fluid. Klinkenberg [21], however, has shown that the permeability of a porous medium to a liquid and to a gas is not the same. Owing to the slip phenomenon, whereby the velocity of a gas layer in the immediate vicinity of the surface of the grains has a finite (instead of zero) velocity, the permeability to a gas is higher than to a liquid. Klinkenberg derived the equation

$$k_a = k\left(1 + \frac{b}{\bar{p}}\right) \tag{6.11}$$

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This may well be the only book that either of us will ever write. We cannot save our dedications, as novelists do, to let them forth one by one. We recognize and appreciate the life-long influences of our parents, our wives, our families, our teachers, and our students. This book is dedicated to all of them.

This book is also dedicated to the taxpayers of Canada and the United States, few of whom will ever read it, but all of whom have contributed to its birth through scholarships in our student days and through research support and sabbatical periods in more recent years.

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

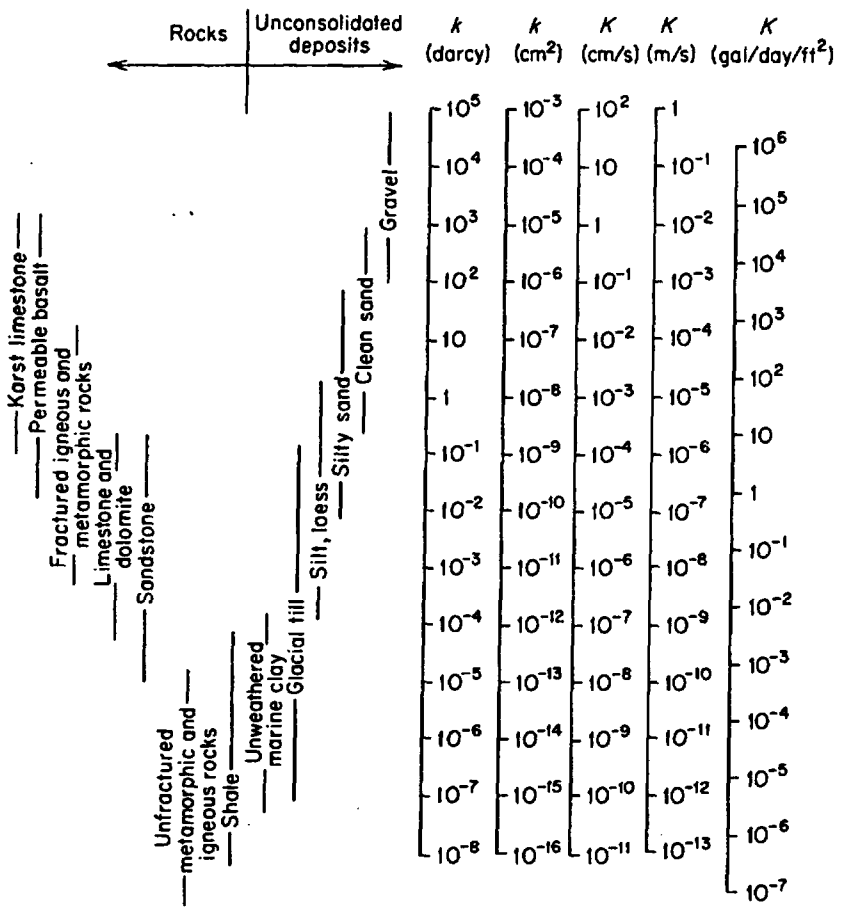

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	5.74×10^{5}
gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.74×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.

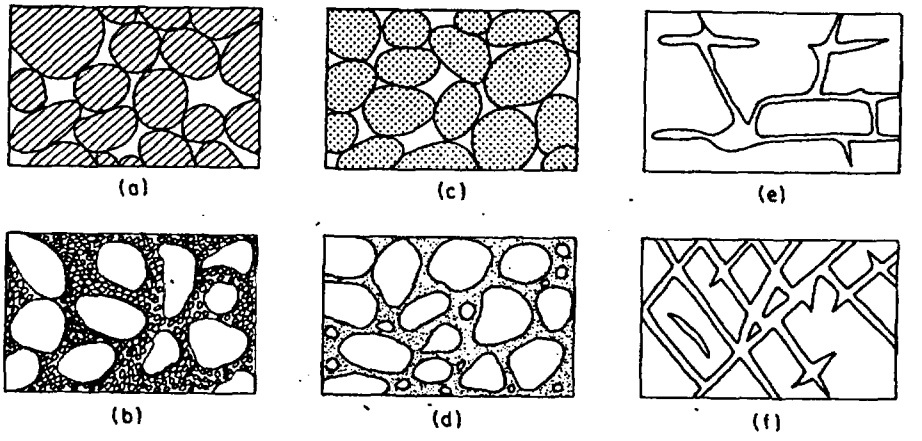

Figure 2.11 Relation between texture and porosity. (a) Well-sorted sedimentary deposit having high porosity; (b) poorly sorted sedimentary deposit having low porosity; (c) well-sorted sedimentary deposit consisting of pebbles that are themselves porous, so that the deposit as a whole has a very high porosity; (d) well-sorted sedimentary deposit whose porosity has been diminished by the deposition of mineral matter in the interstices; (e) rock rendered porous by solution; (f) rock rendered porous by fracturing (after Meinzer, 1923).

soil or rock matrix [Figure 2.11(a), (b), (c), and (d)], and *secondary porosity*, which may be due to such phenomena as secondary solution [Figure 2.11(e)] or structurally controlled regional fracturing [Figure 2.11(f)].

Table 2.4, based in part on data summarized by Davis (1969), lists representative porosity ranges for various geologic materials. In general, rocks have lower porosities than soils; gravels, sands, and silts, which are made up of angular and

Table 2.4 Range of Values of Porosity

	n(%)
Unconsolidated deposits	
Gravel	25–40
Sand	25–50
Silt	35–50
Clay	40–70
Rocks	
Fractured basalt	5–50
Karst limestone	5–50
Sandstone	5–30
Limestone, dolomite	0–20
Shale	0–10
Fractured crystalline rock	0–10
Dense crystalline rock	0–5

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Dedicated to the memory of
my father, whose silent
presence has guided my effort.

6 *Infiltration—Entry of Water into Soil*

A. General

Infiltration is the term applied to the process of water entry into the soil, generally (but not necessarily[1]) through the soil surface and vertically downward. This process is of great practical importance, since its rate often determines the amount of runoff which will form over the soil surface (and hence also determines the hazard of erosion) during rainstorms. Where the rate of infiltration is limiting, the entire water economy of the rooting zone of plants may be affected. Knowledge of the infiltration process as it relates to soil properties and mode of water supply is needed for efficient soil and water management. Comprehensive reviews of infiltration processes were published by Parr and Bertrand (1960) and by Philip (1969).

B. Description of the Process

If we sprinkle or otherwise supply water to the soil surface at a steadily increasing rate, sooner or later the moment will come when the supply rate begins to exceed the capability of the soil to absorb water, and the excess will accumulate and pond over the surface, or trickle downslope as runoff (Fig. 6.1). The *infiltration rate* is the flux passing through the surface and

[1] Water may enter the soil through the entire surface uniformly, as under ponding or rain, or it may enter the soil through furrows or crevices, or it may move up into the soil from a source below (e.g., a high water table).

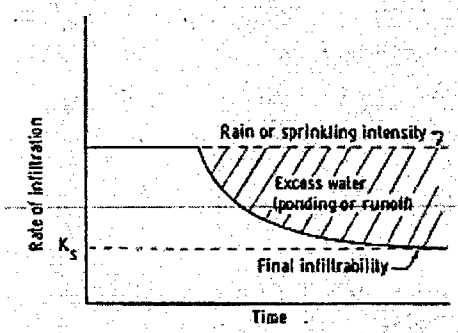

Fig. 6.1. Dependence of the infiltration rate upon time, under an irrigation of constant intensity lower than the initial value, but higher than the final value of soil infiltrability.

flowing into the profile. The *infiltration capacity*,[2] which we propose to call *soil infiltrability*, is the flux which the soil profile can absorb through its surface when it is maintained in contact with water at atmospheric pressure. As long as the rate of water supply to the surface is smaller than soil infiltrability, water infiltrates as fast as it is supplied and the supply rate determines the infiltration rate (i.e., the process is *flux-controlled*). However, once the supply rate exceeds soil infiltrability, it is the latter which determines the actual infiltration rate, and thus the process becomes *profile-controlled*.

If a shallow layer of water is instantaneously applied, and thereafter maintained, over the surface of an initially unsaturated soil, the full measure of soil infiltrability comes into play from the start. Many measurements of infiltration under shallow ponding have shown infiltrability to vary, and generally to decrease, in time. Thus, the *cumulative infiltration*, being the time integral of the infiltration rate, has a curvilinear time dependence, with a gradually decreasing slope.

Soil infiltrability and its variation with time are known to depend upon the initial wetness and suction, as well as on the texture, structure, and uniformity (or layering sequence) of the profile. In general, soil infiltrability is high in the early stages of infiltration, particularly where the soil is initially quite dry, but tends to decrease monotonically and eventually to approach asymptotically a constant rate which is often termed the *final infiltration capacity*[3] but which we prefer to call the *steady-state infiltrability*.

[2] The word "capacity" is generally used to denote an amount, or a volume. Its use in connection with the time-rate of a process can be misleading.

[3] The adjective "final" in this context does not signify the end of the process (since infiltration can persist practically indefinitely if profile conditions permit) but it does indicate that soil infiltrability has finally attained a constant value from which it appears to decrease no more.

Numerous empirical expressions have been proposed to describe the dependence of infiltrability upon time and upon cumulative infiltration. Among these are the equations of Kostiakov (1932) and of Horton (1940). However, purely empirical equations, not based on basic physical relationships, cannot be expected to apply universally.

The decrease of infiltrability from an initially high rate can in some cases result (at least in part) from gradual deterioration of soil structure and the consequent partial sealing of the profile by the formation of a dense surface crust, or from the detachment and migration of pore-blocking particles, or from swelling of clay, or from entrapment of air bubbles or the bulk compression of soil air if it is prevented from escaping as it is displaced by incoming water. Primarily, however, the decrease in infiltration rate results from the inevitable decrease in the matric suction gradient (constituting one of the forces drawing water into the soil) which occurs as infiltration proceeds.

If the surface of an initially dry soil is suddenly saturated, the matric suction gradient acting in the surface layer is at first very steep. As the wetted zone deepens, however, this gradient is reduced, and, as the wetted part of the profile becomes thicker and thicker, the suction gradient tends eventually to become vanishingly small. In a horizontal column, the infiltration rate eventually tends to zero, whereas in downward flow into a vertical column, the infiltration rate can be expected to settle down to a steady rate, gravity-induced, which, as we shall later show, is practically equal to the saturated hydraulic conductivity if the profile is homogeneous and structurally stable. If the surface is supplied with water at a rate lower than the saturated conductivity, or is otherwise maintained at a wetness lower than saturation, then the steady infiltration rate will correspond to the unsaturated conductivity at the particular wetness obtained.

C. Profile Moisture Distribution during Infiltration

If we examine a homogeneous profile at any moment during infiltration under ponding, we shall find that the surface of the soil is saturated, perhaps to a depth of several millimeters or centimeters, and that beneath this zone of complete saturation is a lengthening zone of apparently uniform, nearly saturated, wetness, known as the *transmission zone*. Beyond this zone there is a *wetting zone*, in which soil wetness decreases with depth at a steepening gradient down to a *wetting front*, where the moisture gradient is so steep[4]

[4] The reason for the steepening gradient is that, as the water content decreases, the hydraulic conductivity generally decreases exponentially. Since the flux is the product of the gradient by the conductivity, it follows that, to get a certain flux moving in the soil, the gradient must increase as the conductivity decreases.

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of the soil zone encompassing the sample sites. Since the elements actually measure soil-moisture tension they have about the same resistance at field capacity in any type of soil. The same is true at the wilting point.

6-5. Movement of soil moisture. *Infiltration* is the movement of water through the soil surface into the soil and is distinguished from *percolation* which is movement of water through the soil. When water is first applied to the soil surface, gravity water begins to move down through the larger soil openings while the smaller surface pores take in water by capillarity. The downward-moving gravity water is also taken in by capillary pores. As the capillary pores at the surface are filled and the intake capacity is reduced, the infiltration rate decreases. In homogeneous soil, as pores at lower levels are filled, infiltration decreases gradually until the zone of aeration is saturated. Normally, the soil is stratified and frequently the subsoil layers are less permeable than the surface soil. In this case, the infiltration rate is eventually limited to the rate of percolation through the least pervious subsoil stratum.

Two cases of infiltration must be recognized. Infiltration from rainfall is distinguished by very shallow depths of water on the soil surface but is extensive over large areas. Quantities of water infiltrated are usually very small (a few inches per day maximum) and rarely sufficient to saturate a great depth of soil. At the termination of rain, gravity water remaining in the soil continues to move downward and, at the same time, is taken up in capillary pore spaces. Usually the infiltrated water is distributed within the upper few feet of soil, with little or no contribution to groundwater unless the soil is highly permeable or the zone of aeration very thin. Infiltration from rainfall is discussed in greater detail in Sec. 8-2.

For irrigation and artificial recharge of the groundwater (Sec. 6-16), water is ponded to a considerable depth over limited areas for long periods of time. The aim of recharge operations is to saturate the soil down to the water table. Under these conditions the time variation of infiltration is complex, with temporary increases in rate superimposed on a gradually declining trend. Escape of soil air around the infiltration basin, bacterial action, changes in water temperature, changes in soil structure, and many other factors appear to influence these variations.

Movement of moisture within the soil is governed by the moisture potential following the equation

$$q = -K_w \frac{\partial \Lambda}{\partial x} \tag{6-2}$$

where q is the flow per unit time through unit area normal to the direction of flow, x is distance along the line of flow, K_w is conductivity, and Λ is potential. After gravity water has left the soil, the principal

component of total potential is the capillary potential. Equation (6-2) states that flow is from a region of high potential to a region of lower potential. Quantitative determination of the conductivity is difficult although it has been shown to increase with moisture content and decrease with pore size. Thus capillary movement decreases as soil dries and is least in fine-grained soils. Fortunately, a qualitative understanding of these phenomena is normally sufficient for engineering hydrology.

Transport of water vapor in the soil is controlled by temperature differences. Vapor movement is from high temperature (high vapor pressure) to low temperature. Vapor transport is an important factor in moisture movement when the moisture content is lowered to the point where capillary moisture is discontinuous. Under this condition, however, moisture-content and temperature gradients are usually so small that the quantity of moisture moved is negligible. When the surface soil is frozen, the vapor-pressure gradient is upward and is accentuated by the lower vapor pressure of ice relative to water at the same temperature. Thus when frozen soil thaws, its moisture content may be greater than at the time of freezing. Conversely, during summer, vapor-pressure gradients would be downward were it not for evaporation and transpiration.

MOISTURE IN THE ZONE OF SATURATION

Within the zone of saturation all pore spaces are filled with water, and the different states of moisture, moisture tension, etc., are of little concern. Interest is centered on the amount of water present, the amount which can be removed, and the movement of this water.

6-6. Aquifers. A geologic formation which contains water and transmits it from one point to another in quantities sufficient to permit economic development is called an *aquifer*. In contrast, an *aquiclude* is a formation which contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring. An *aquifuge* has no interconnected openings and cannot hold or transmit water. The ratio of the pore volume to the total volume of the formation is called *porosity*. The *original porosity* of a material is that which existed at the time the material was formed. *Secondary porosity* results from fractures and solution channels.

Secondary porosity cannot be measured without an impossibly large sample. Original porosity is usually measured by oven-drying an undisturbed sample and weighing it. It is then saturated with some liquid and weighed again. Finally, the saturated sample is immersed in the same liquid and the weight of displaced liquid is noted. The weight of liquid required to saturate the sample divided by the weight of liquid displaced is the porosity as a decimal. If the material is fine-grained,

the liquid may have to be forced into the sample under pressure to assure complete saturation.

High porosity does not necessarily indicate a productive aquifer, since much of the water may be retained in small pore spaces under capillary tension as the material is dewatered. The *specific yield* of an aquifer is the ratio of the water which will drain freely from the material to the total volume of the formation and must always be less than the porosity. The relation between specific yield and porosity is dependent on the size of the particles in the formation. Specific yield of a fine-grained aquifer will be small whereas coarse-grained material will yield a greater amount of its contained water. Table 6-2 lists approximate average

TABLE 6-2. Approximate Average Porosity, Specific Yield, and Permeability of Various Materials

Material	Porosity, %	Specific yield, %	Permeability (K_p, Eq. (6-4)), gpd/sq ft
Clay	45	3	1
Sand	35	25	800
Gravel	25	22	5000
Gravel and sand	20	16	2000
Sandstone	15	8	700
Dense limestone and shale	5	2	1
Quartzite, granite	1	0.5	0.1

values of porosity and specific yield for some typical materials. Large variations from these average values must be expected. Note that clay, although having a high porosity, has a very low specific yield. Sand and gravel which make up most of the more productive aquifers in the United States will yield about 80 per cent of their total water content.

6-7. Movement of groundwater. In 1856 Darcy confirmed the applicability of principles of fluid flow in capillary tubes, developed several years earlier by Hagen and Poisseule, to the flow of water in permeable media. *Darcy's law* is

$$v = ks \tag{6-3}$$

where v is the velocity of flow, s is the slope of the hydraulic gradient, and k is a coefficient having the units of v (usually ft/day). The discharge q is the product of area A and velocity. The effective area is the gross area times the porosity p of the media. Hence

$$q = 7.48kpAs = K_pAs \tag{6-4}$$

where 7.48 converts to gallons when the other terms are in feet. The

coefficient of permeability K_p is usually expressed in *Meinzer units*, the discharge in gallons per day through an area of one square foot under a gradient of one foot per foot at 60°F (Table 6-2). Values at other temperatures can be found by multiplying by the ratio of the kinematic viscosities, i.e.,

$$K_{pT} = K_p \frac{\nu_{60}}{\nu_T} \tag{6-5}$$

It is convenient to use the *transmissibility* T to represent the flow in gallons per day through a section 1 ft wide and the thickness of the aquifer under a unit head (slope of 1 ft/ft).

$$T = K_pY \tag{6-6}$$

where Y is the saturated thickness of the aquifer. With this coefficient Eq. (6-4) becomes

$$q = TBs \tag{6-7}$$

where B is the width of the aquifer.

Note that the equations of groundwater flow are analogous to the electrical equation

$$i = \frac{1}{R}E \tag{6-8}$$

where the current i is equivalent to q, the voltage E is comparable to s, and the reciprocal of resistance R is equivalent to permeability. This similarity is sometimes used to advantage in electrical models of groundwater-flow problems.

6-8. Determination of permeability. Laboratory measurements of permeability are made with instruments called *permeameters* (Fig. 6-6). A sample of the material is subjected to water under a known head, and the flow through the sample in a known time is measured. Such tests have limited practical value because of the difficulty of placing samples of unconsolidated materials into the permeameter in their natural state and the uncertainty as to whether a sample is truly representative of the aquifer. Flow in solution cavities or rock fractures and the effect of large boulders in gravel aquifers cannot be duplicated in a permeameter.

The earliest field techniques for determining permeability involved introducing salt into the aquifer at one well and timing its movement to a downstream well.[1] Fluorescein dye,[2] detectable at a concentration of 0.03 ppm by the unaided eye and in concentrations as low as 0.0001 ppm

[1] C. S. Slichter, Field Measurements of Rate of Movement of Underground Water, *U.S. Geol. Survey Water-supply Paper* 140, 1905.

[2] R. B. Dole, Use of Fluorescein in Study of Underground Waters, *U.S. Geol. Survey Water-supply Paper* 160, pp. 73–85, 1906.

under ultraviolet light, has also been used as a tracer. More recently, radioactive materials have been tested. Tracer techniques have encountered numerous difficulties.[1] Chemical reactions between the tracer elements and the formation sometimes occur. Because of diffusion, tests must be conducted over short distances in order to have detectable concentrations at the downstream well, and even then it is difficult to

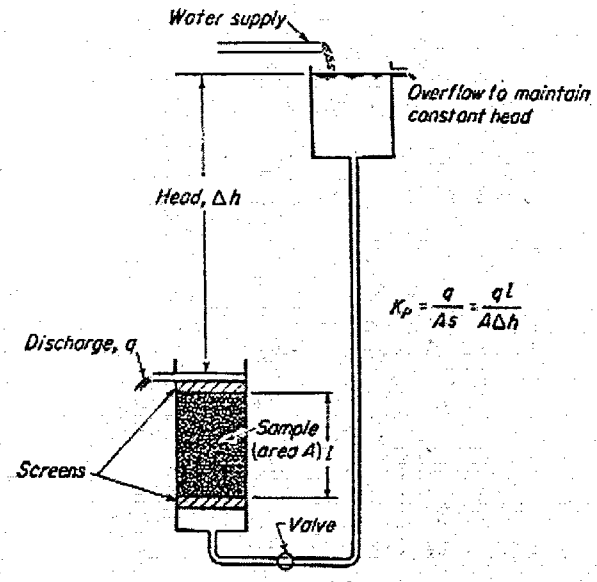

FIG. 6-6. A simple upward-flow permeameter.

determine a representative time of arrival. Tracers are most useful for determining path of flow as, for example, when it is necessary to locate a source of pollution.

Today permeability is most commonly determined by pumping tests. By using the principles of well hydraulics (Sec. 6-12) it is possible to estimate average permeability of an aquifer for a large distance around the test well.

6-9. Sources of groundwater. Almost all groundwater is *meteoric water* derived from precipitation. *Connate water*, present in the rock at its formation and frequently highly saline, is found in some areas. *Juvenile water*, formed chemically within the earth and brought to the surface in intrusive rocks, occurs in small quantities. Connate and juvenile waters are sometimes important sources of undesirable minerals

[1] W. J. Kaufman and G. T. Orlob, An Evaluation of Ground-water Tracers, *Trans. Am. Geophys. Union*, Vol. 37, pp. 297–306, June, 1956.

in the groundwater. Groundwater in the San Joaquin Valley, California, contains considerable boron brought to the surface from great depths.

Water from precipitation reaches the groundwater by the process of infiltration and by percolation from streams and lakes. Direct percolation cannot yield large quantities of groundwater except where the soil is highly permeable or the water table is close to the surface. Large quantities of direct percolation occur through the permeable basaltic lavas of northern California, eastern Oregon, southern Idaho, and Hawaii, and in the southern Appalachian region where thin soil overlies cavernous limestone.

In the southern part of the Central Valley of California groundwater is hundreds of feet below the surface, and little or no recharge from rain can occur. In such cases most of the recharge is from stream channels. Streams contributing to the groundwater are called *influent streams*. Such streams frequently go dry during prolonged dry spells when percolation absorbs all the available flow. Streams are rarely influent throughout their entire length. Often the channel crosses strata of varying permeability, with most of the percolation loss in short reaches of high permeability. Considerable percolation often occurs from stream channels crossing coarse gravels in an alluvial fan. In areas of artesian groundwater, the overlying aquiclude prevents appreciable direct recharge; the recharge area may be far removed from the artesian area.

6-10. Discharge of groundwater. Without interference by man, a groundwater basin fills with water and discharges its excess by several routes. Streams intersecting the water table and receiving flow from the groundwater are known as *effluent streams*. Perennial streams are generally effluent through at least a portion of their length and may flow in impermeable formations elsewhere so that there is little or no loss by seepage.

Where an aquifer intersects the earth's surface, a spring may form. There may be a concentrated flow constituting the headwater source of a small stream or merely effluent seepage which evaporates from the ground surface. Figure 6-7 illustrates several types of springs. The flow of most springs is small and usually of little hydrologic significance, although even a small spring may provide water for a single farmstead. Meinzer[1] classified springs from first to eighth magnitude with respect to flow. First-magnitude springs discharge 100 cfs or more while eighth-magnitude springs have a flow less than 1 pt/min. According to Meinzer[2]

[1] O. E. Meinzer, Outline of Ground-water Hydrology, *U.S. Geol. Survey Water-supply Paper* 494, 1923.

[2] O. E. Meinzer, Large Springs in the United States, *U.S. Geol. Survey Water-supply Paper* 557, 1927.

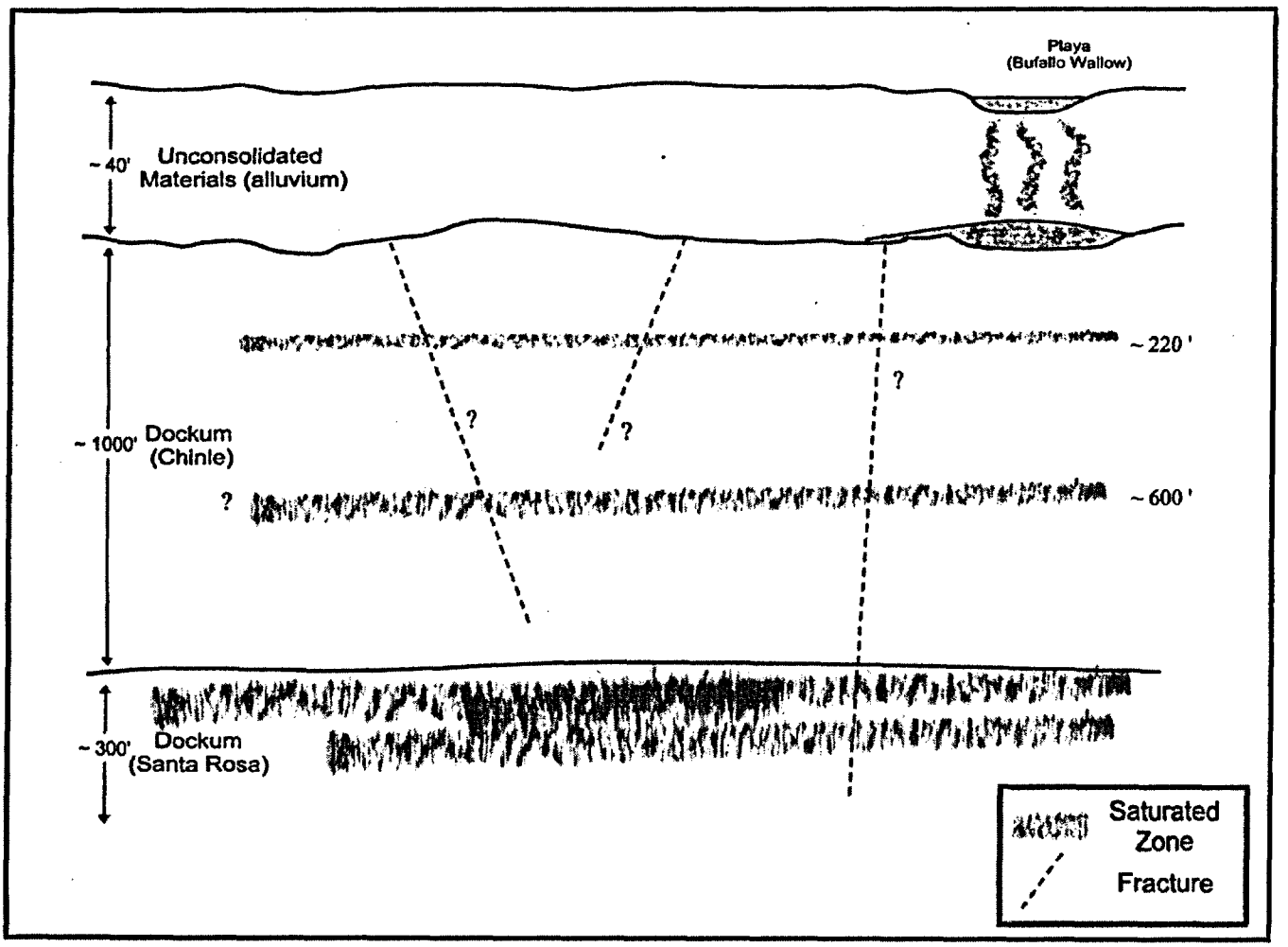

Figure 1
Schematic - Geologic Cross Section in Vicinity of Proposed Site

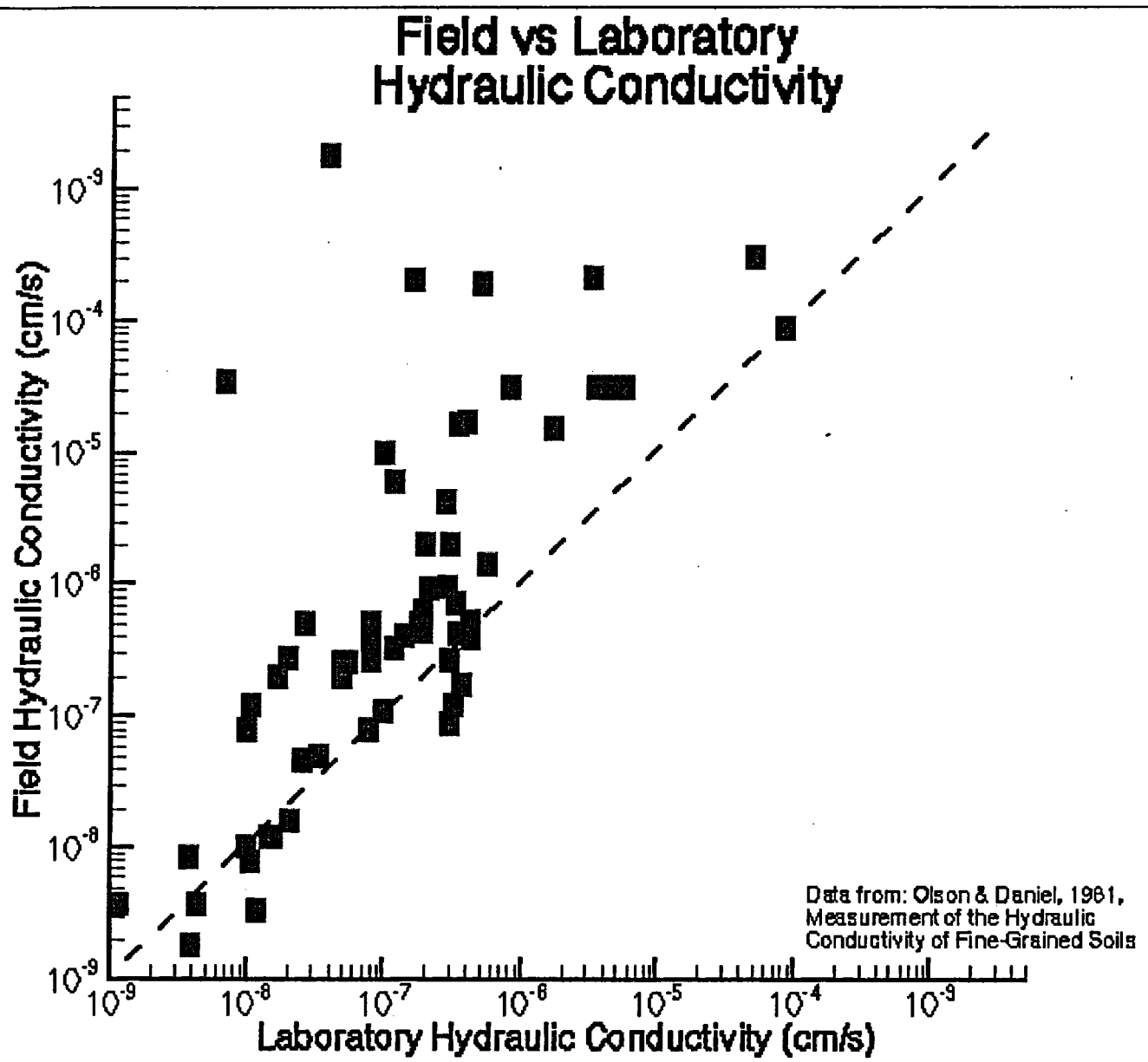
Field vs Laboratory
Hydraulic Conductivity
Field Hydraulic Conductivity (cm/s)
Laboratory Hydraulic Conductivity (cm/s)
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
Data from: Olson & Daniel, 1981,
Measurement of the Hydraulic
Conductivity of Fine-Grained Soils

Figure 2

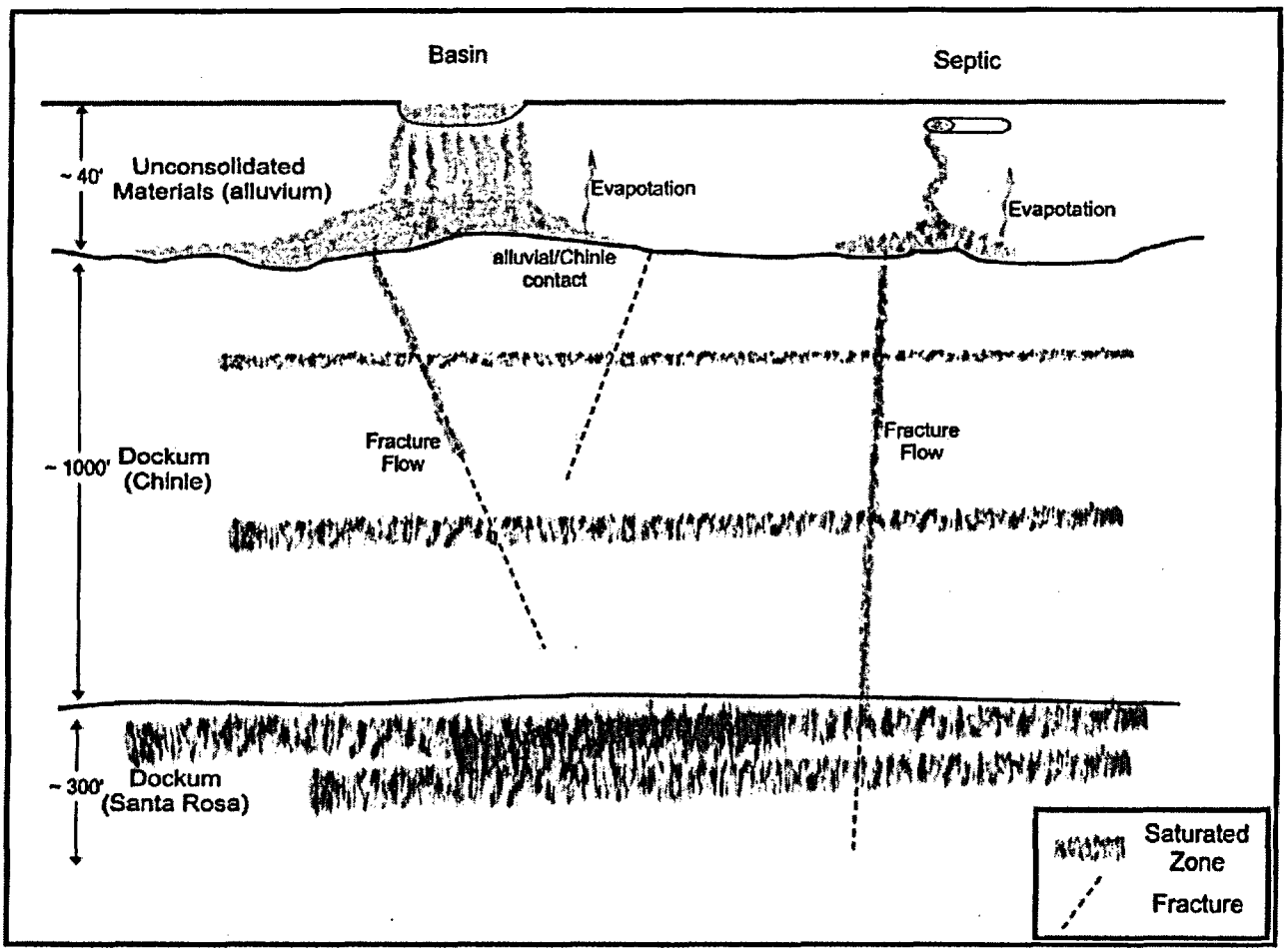

Figure 3
Schematic - Geologic Cross Section in Vicinity of Proposed Site

[Federal Register: July 27, 2004 (Volume 69, Number 143)]
[Notices]
[Page 44654-44658]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr27jy04-50]

DEPARTMENT OF ENERGY

Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, KY, Site

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) prepared a Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site (FEIS) (DOE/EIS-0359). The FEIS Notice of Availability was published by the U.S. Environmental Protection Agency (EPA) in the Federal Register (69 FR 34161) on June 18, 2004. In the FEIS, DOE considered the potential environmental impacts from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed depleted uranium hexafluoride (DUF6) conversion facility at three alternative locations within the Paducah site, including transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the aqueous hydrogen fluoride (HF) produced as a conversion co-product; and neutralization of aqueous HF to calcium fluoride (CAF2) and its sale or disposal in the event that the aqueous HF product is not sold. An option of shipping the East Tennessee Technology Park (ETTP) cylinders to the Paducah site has also been considered, as has an option of expanding operations by increasing efficiency or extending the period of operation. A similar EIS was issued concurrently for construction and operation of a DUF6 conversion facility at DOE's Portsmouth, Ohio, site (DOE/EIS-0360).

DOE has decided to construct and operate the conversion facility in the south-central portion of the Paducah site, the preferred alternative identified in the FEIS as Location A. Groundbreaking for construction of the facility will commence on or before July 31, 2004, as anticipated by Public Law (Pub. L.) 107-206. The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits, as appropriate.

ADDRESSES: The FEIS and this Record of Decision (ROD) are available on the DOE National Environmental Policy Act (NEPA) Web site at http://www.eh.doe.gov/nepa and on the Depleted UF6 Management

Information Network Web site at http://web.ead.anl.gov/uranium. Copies

of the FEIS and this ROD may be requested by e-mail at Pad_DUF6@anl.gov, by toll-free telephone at 1-866-530-0944, by toll-free

fax at 1-866-530-0943, or by contacting Gary S. Hartman, Oak Ridge Operations Office, U.S. Department of Energy, SE-30-1, P.O. Box 2001,

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Oak Ridge, Tennessee 37831.

FOR FURTHER INFORMATION CONTACT: For information on the conversion facility construction and operation, contact Gary Hartman at the address listed above. For general information on the DOE NEPA process, contact Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH-42), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, 202-586-4600, or leave a message at 1-800-472-2756.

SUPPLEMENTARY INFORMATION:

I. Background

The United States has produced DUF6 since the early 1950s as part of the process of enriching natural uranium for both civilian and military applications. Production took place at three gaseous diffusion plants (GDPs), first at the K-25 site (now called ETTP) at Oak Ridge, Tennessee, and subsequently at Paducah, Kentucky, and Portsmouth, Ohio. The K-25 plant ceased enrichment operations in 1985, and the Portsmouth plant ceased enrichment operations in 2001. The Paducah GDP continues to operate.

Approximately 440,000 t (484,000 tons) of DUF6 is presently stored at Paducah in about 36,200 cylinders. The majority of the cylinders weigh approximately 12 t (14 tons) each, are 48 inches (1.2 m) in diameter, and are stored on outside pads. DOE has been looking at alternatives for managing this inventory. Also in storage at Paducah are approximately 1,940 cylinders of various sizes that contain enriched UF6 or normal UF6 (collectively called ``non-DUF6'' cylinders) or are empty. [The non-DUF6 cylinders would not be processed in the conversion facility.]

As a first step, DOE evaluated potential broad management options for its DUF6 inventory in a Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (DUF6 PEIS) (DOE/EIS-0269) issued in April 1999. In the PEIS Record of Decision (64 FR 43358, August 10, 1999), DOE decided to promptly convert the DUF6 inventory to a more stable uranium oxide form and stated that it would use the depleted uranium oxide as much as possible and store the remaining depleted uranium oxide for potential future uses or disposal, as necessary. In addition, DOE would convert DUF6 to depleted uranium metal, but only if uses for metal were available. DOE did not select specific sites for the conversion facilities but reserved that decision for subsequent NEPA review. Today's Record of Decision announces the outcome of that site-specific NEPA review. DOE is also issuing today a separate but related ROD announcing the siting of a DUF6 conversion facility at Portsmouth, Ohio.

Congress enacted two laws that directly addressed DOE's management of its DUF6 inventory. The first law, Public Law 105-204, signed by the President in July 1998, required the Secretary of Energy to prepare a plan to commence construction of, no later than January 31, 2004, and to operate an on-site facility at each of the GDPs at

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Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle DUF6, consistent with NEPA. The second law, Public Law 107-206, signed by the President on August 2, 2002, required that no later

than 30 days after enactment, DOE must award a contract for the scope of work described in its Request for Proposals (RFP) issued in October 2000 for the design, construction, and operation of a DUF6 conversion facility at each of the Department's Paducah, Kentucky, and Portsmouth, Ohio, gaseous diffusion sites. It also stipulated that the contract require groundbreaking for construction to occur no later than July 31, 2004, at both sites.

In response to these laws, DOE issued the Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105-204 in July 1999, and awarded a contract to Uranium Disposition Services (UDS) for construction and operation of two conversion facilities on August 29, 2002, consistent with NEPA.

On September 18, 2001, DOE published a Notice of Intent (NOI) in the Federal Register (66 FR 48123) announcing its intention to prepare an EIS for the proposed action to construct, operate, maintain, and decontaminate and decommission two DUF6 conversion facilities: One at Portsmouth and one at Paducah. Following the enactment of Public Law 107-206, DOE reevaluated the appropriate scope of its site-specific NEPA review and decided to prepare two separate EISs, one for the plant proposed for the Paducah site and a second for the Portsmouth site. This change in approach was announced in the Federal Register on April 28, 2003 (68 FR 22368).

The two draft conversion facility EISs were mailed to stakeholders in late November 2003, and a Notice of Availability was published by the EPA in the Federal Register on November 28, 2003 (68 FR 66824). Comments on the draft EISs were accepted during a 67-day review period that ended on February 2, 2004. DOE considered these comments and prepared two FEISs. The Notice of Availability for the two FEISs was published by the EPA in the Federal Register (69 FR 34161) on June 18, 2004.

II. Purpose and Need for Agency Action

DOE needs to convert its inventory of DUF6 to more stable chemical form(s) for use or disposal. This need follows directly from (1) the decision presented in the August 1999 ROD for the PEIS, namely, to begin conversion of the DUF6 inventory as soon as possible, and (2) Public Law 107-206, which directs DOE to award a contract for construction and operation of conversion facilities at both the Paducah site and the Portsmouth site.

III. Alternatives

No Action Alternative. Under the no action alternative, conversion would not occur. Current cylinder management activities (handling, inspection, monitoring, and maintenance) would continue; thus the status quo would be maintained at Paducah indefinitely.

Action Alternatives. The proposed action evaluated in the FEIS is to construct and operate a conversion facility at the Paducah site for conversion of the Paducah DUF6 inventory into depleted uranium oxide (primarily triuranium octaoxide [U3O8]) and other conversion products. The FEIS review is based on the conceptual conversion facility design proposed by the selected contractor, UDS. The UDS dry conversion process is a continuous process in which DUF6 is vaporized and converted to a mixture of uranium oxides (primarily U3O8) by reaction with steam and hydrogen in a fluidized-bed conversion unit. The hydrogen is generated from anhydrous ammonia (NH3). The depleted U3O8 powder is collected and packaged for disposition in bulk bags (large-capacity, strong, flexible bags) or

the emptied cylinders to the extent practicable. Equipment would also be installed to collect the aqueous HF (also called HF acid) co-product and process it into HF at concentrations suitable for commercial resale. A backup HF acid neutralization system would convert up to 100% of the HF acid to CaF2 for sale or disposal in the future, if necessary. The conversion products would be transported to a disposal facility or to users by truck or rail. The conversion facility will be designed with four parallel processing lines to convert 18,000 t (20,000 tons) of DUF6 per year, requiring 25 years to convert the Paducah inventory.

Three alternative locations within the site were evaluated, Locations A (preferred), B, and C. In addition, an option of transporting the ETTP cylinders to Paducah rather than to Portsmouth was considered, as was an option of expanding conversion facility operations.

Alternative Location A (Preferred Alternative). Location A is the preferred location for the conversion facility. It is located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road. This location is an L-shaped tract consisting mostly of grassy field. However, the southeastern section is a wooded area. A drainage ditch crosses the northern part of the site, giving the cylinder yard storm water access to Kentucky Pollution Discharge Elimination System (KPDES) Outfall 017. This location is about 35 acres (14 ha) in size and was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

Alternative Location B. Location B is directly south of the Paducah maintenance building and west of the main plant access road. The northern part of this location is mowed grass and has a slightly rolling topography. The southern part has a dense covering of trees and brush, and some high-voltage power lines cross it, limiting its use. This location has an area of about 59 acres (23 ha).

Alternative Location C. Location C is east of the Paducah pump house and cooling towers. It has an area of about 53 acres (21 ha). Dykes Road runs through the center of this location from north to south. Use of the eastern half of this location could be somewhat limited because several high-voltage power lines run through this area.

Under the action alternatives, DOE evaluated the impacts from packaging, handling, and transporting depleted uranium oxide conversion product (primarily U3O8) from the conversion facility to a low-level waste (LLW) disposal facility that would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized to receive the conversion products by DOE (in conformance with DOE orders), or licensed by the U.S. Nuclear Regulatory Commission (NRC) (in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at an LLW disposal facility has been deferred to the disposal site's site-specific NEPA or licensing documents. While the FEIS presents the impacts from transporting the DUF6 conversion products to both the Envirocare of Utah, Inc., facility and the Nevada Test Site (NTS), DOE plans to decide the specific disposal location(s) for the depleted U3O8 conversion product after additional NEPA review, as necessary. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making its specific disposal decision and will provide any

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additional NEPA analysis for public review and comment.

The following alternatives were considered but not analyzed in detail in the FEIS: Use of Commercial Conversion Capacity, Sites Other Than Paducah, Alternative Conversion Processes, Long-Term Storage and Disposal Alternatives, Transportation Modes Other Than Truck and Rail, and One Conversion Plant Alternative.

IV. Summary of Environmental Impacts

The FEIS evaluated potential impacts from the range of alternatives described above. The impact areas included human health and safety, air quality, noise, water and soil, socioeconomics, ecological resources, waste management, resource requirements, land use, cultural resources, environmental justice, and cumulative impacts. In general, the impacts are low for both the no action and the proposed action alternatives. Among the three alternative locations considered at the Paducah site for the conversion facility, there are no major differences in impacts that would make one location clearly environmentally preferable. The discussion below summarizes the results of the FEIS impact analyses, highlighting the differences among the alternatives.

Human Health and Safety--Normal Operations and Transportation. Under all alternatives, it is estimated that potential exposures of workers and members of the general public to radiation and chemicals would be well within applicable public health standards and regulations. UDS would confirm, prior to conversion or at the initiation of the conversion operations, that polychlorinated biphenyl (PCB) releases to the workplace from the paint coating of some cylinders manufactured prior to 1978 would be within applicable Occupational Safety and Health Administration (OSHA) limits. Transportation by rail would tend to cause fewer impacts than by truck primarily because of exhaust emissions from the trucks and the higher number of shipments for trucks than for rail. The option of converting the aqueous HF to CaF_2 and transporting the CaF_2 to a disposal facility would result in increased shipments. The impacts associated with transportation of uranium oxide product to a disposal facility in the western United States by truck would be about the same if bulk bags are used or two filled cylinders are loaded onto a truck. If only one cylinder is loaded onto a truck, the impacts would be higher because of the increased number of shipments.

Human Health and Safety--Accidents. DOE has extensive experience in safely storing, handling, and transporting cylinders containing UF_6 (depleted, normal, or enriched). In addition, the chemicals used or generated at the conversion facility are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for their storage and transportation.

Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting both the workers and members of the general public. It is also possible that, similar to other industrial facilities, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. Similarly, during transportation of materials, both crew members and members of the public may be injured or killed as a result of traffic accidents.

Three kinds of accidents have the largest possible consequences: (1) Those involving the DUF_6 cylinders during storage and handling under all alternatives, (2) those involving chemicals used or generated by the conversion process at the conversion site (in

particular NH3 and aqueous HF) under the action alternatives, and (3) those occurring during transportation of chemicals and cylinders under the action alternatives. The severity of the consequences from such accidents would depend on weather conditions at the time of the accident, and, in the case of the transportation accidents, the location of the accident, and could be significant. However, those accidents would have a low estimated probability of occurring, making the risk low. (Risk is determined by multiplying the consequences by the probability of occurrence).

In comparing truck versus rail transportation, even though the consequences of rail accidents are generally higher (because of the larger cargo load per railcar than per truck), the accident probabilities tend to be lower for railcars than for trucks. As a result, the risks of accidents would be about the same under either option.

Under the no action alternative, the risks associated with cylinder storage and handling would continue to exist as long as the cylinders are there. However, under the action alternatives, the risks associated with both the cylinder accidents and the chemical accidents would decline over time and disappear at the completion of the project.

Air Quality and Noise. Under the action alternatives, the total (modeled plus background value) concentrations due to emissions of most criteria pollutants--such as sulfur dioxide, nitrogen oxides, and carbon monoxide--would be well within applicable air quality standards. For construction, the primary concern would be particulate matter (PM) released from near-ground-level sources. Total concentrations of PM10 and PM2.5 (PM with an aerodynamic diameter of 10 [mu]m or less and 2.5 [mu]m or less, respectively) at the construction site boundaries would be close to or above the standards because of the high background concentrations. Accordingly, construction activities would be conducted so as to minimize further impacts on ambient air quality.

Water and Soil. During construction of the conversion facility, concentrations of any potential contaminants in soil, surface water, or groundwater would be kept well within applicable standards or guidelines by implementing storm water management, sediment and erosion controls, and good construction practices. During operations, no impacts would be expected because no contaminated liquid effluents are anticipated.

Socioeconomics. Under the action alternatives, construction and operation of the conversion facility would create more jobs and personal income in the vicinity of the Paducah site than would be possible under the no action alternative. The number of jobs would be approximately 190 direct and 290 total during construction, and 160 direct and 330 total during operations.

Ecology. For the action alternatives, the total area disturbed during conversion facility construction would be up to 45 acres (18 ha). Although vegetation communities in the disturbed area would be impacted by a loss of habitat, impacts could be minimized (e.g., by appropriate placement of the facility within each location), and negligible long-term impacts to vegetation and wildlife are expected at all locations. Impacts to wetlands could be minimized, depending on where exactly the facility was placed within each location and by maintaining a buffer near adjacent wetlands during construction. Construction of the conversion facility in the eastern portion of Location C could impact potential habitat for cream wild indigo (state-listed as a species of special concern) and compass plant (state-listed as threatened). For construction at all three locations, potential impacts to forested areas could be avoided if temporary construction areas were placed in previously disturbed

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locations. During construction, trees with exfoliating bark (such as shagbark hickory or dead trees with loose bark) that can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer would be saved if possible.

Waste Management. Under the action alternatives, waste generated during construction and operations would have negligible impacts on the Paducah site waste management operations, with the exception of possible impacts from disposal of CaF2. If the aqueous HF were not sold but instead neutralized to CaF2, it is currently unknown whether (1) the CaF2 could be sold, (2) the low uranium content would allow the CaF2 to be disposed of as nonhazardous solid waste, or (3) disposal as LLW would be required. The low level of uranium contamination expected (i.e., less than 1 ppm) suggests that sale or disposal as nonhazardous solid waste would be most likely. Waste management for disposal as nonhazardous waste could be handled through appropriate planning and design of the facilities. If the CaF2 had to be disposed of as LLW, it could represent a potentially large impact on waste management operations.

The U3O8 produced during conversion would amount to about 80% of Paducah's annual projected LLW volume.

Option of Shipping ETTP Cylinders to Paducah. The cylinders at ETTP would require preparation for shipment by either truck or rail. Three cylinder preparation options were considered for the shipment of noncompliant cylinders: cylinder overpacks, shipping ``as-is'' under a U.S. Department of Transportation (DOT) exemption, and use of a cylinder transfer facility (there are no current plans to build such a facility at ETTP). The operational impacts (e.g., storage, handling, and maintenance of cylinders) from any of the options would be small and limited primarily to external radiation exposure of involved workers. The annual impacts from conversion operations at Paducah would remain the same, however the conversion period would be approximately 3 years longer. If a decision was made to construct and operate a transfer facility at ETTP in the future, additional NEPA review would be conducted.

Conversion Product Sale and Use. The conversion of the DUF6 inventory produces products having some potential for reuse. These products include aqueous HF and CaF2, which are commonly used as commercial materials. DOE is currently pursuing the establishment of authorization limits (allowable concentration limits of uranium) in these products to be able to free-release them to commercial users. In addition, there is a small potential for reuse of the depleted uranium oxide product.

D&D Activities. D&D impacts would be primarily from external radiation to involved workers and would be a small fraction of allowable doses. Wastes generated during D&D operations would be disposed of in an appropriate disposal facility and would result in low impacts in comparison with projected site annual generation volumes.

Cumulative Impacts. The FEIS analyses indicated that no significant cumulative impacts at the Paducah site and its vicinity would be anticipated due to the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions.

Option of Expanding Conversion Facility Operations. The throughput of the Paducah facility could be increased by making process efficiency improvements. Such an increase would not be expected to significantly change the overall environmental impacts when compared with those of

the current plant design.

The conversion facility operations could be extended to process any additional DUF6 for which DOE might assume responsibility by operating the facility longer than the currently anticipated 25 years. With routine facility and equipment maintenance and periodic equipment replacements or upgrades, it is believed that the conversion facility could be operated safely beyond this time period. If operations were extended beyond 25 years and if the operational characteristics (e.g., estimated releases of contaminants to air and water) of the facility remained unchanged, it is expected that the annual impacts would be essentially unchanged.

V. Environmentally Preferred Alternative

In general, the FEIS shows greater impacts for the no action alternative than for the proposed action of constructing and operating the conversion facility mainly because of the relatively higher radiation exposures of the workers from the cylinder management operations and cylinder yards and because the cylinders and associated risk would remain if no action occurred. However, considering the uncertainties in the impact estimates and the magnitude of the impacts, the differences are not considered to be significant. The no action alternative has the potential for groundwater contamination with uranium over the long-term; this adverse impact is not anticipated under the proposed action alternatives. Beneficial socioeconomic impacts would be higher for the action alternatives than for the no action alternative.

The impacts associated with transportation of materials among sites would be comparable whether the transportation is by truck or rail.

With all alternatives, there is the potential for some high-consequence accidents to occur. The risks associated with such accidents can only be completely eliminated when the conversion of the DUF6 inventory has been completed.

Although there are some differences in impacts among the three alternative locations for the conversion facility, these differences are small and well within the uncertainties associated with the methods used to estimate impacts. In general, because of the relatively small risks that would result under all alternatives and the absence of any clear basis for discerning an environmental preference, DOE concludes that no single alternative analyzed in depth in the FEIS is clearly environmentally preferable compared to the other alternatives.

VI. Comments on Final EIS

The Final EIS was mailed to stakeholders in early June 2004, and the EPA issued a Notice of Availability in the Federal Register on June 18, 2004. The entire document was also made available on the World Wide Web. Two comment letters were received on the DUF6 Conversion Facility Final EISs. The State of Nevada indicated that it had no comments on the Final EISs and that the proposal was not in conflict with state plans, goals, or objectives. The U.S. Environmental Protection Agency, Region 5 in Chicago, stated that the Portsmouth Final EIS adequately address its concerns, and that it concurs with the Preferred Alternative and has no further concerns.

Decision

I. Bases for the Decision

DOE considered potential environmental impacts as identified in the

FEIS (including the information contained in the classified appendix); cost; applicable regulatory requirements; Congressional direction as included in Public Law 105-204 and 107-206; agreements among DOE and the States of Ohio, Tennessee, and Kentucky concerning the management of DUF6 currently stored at the Portsmouth, ETTP, and Paducah sites,

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respectively; and public comments in arriving at its decision. In deciding among the three alternative locations at the Paducah site for the conversion facility, DOE considered environmental factors, site preparation requirements affecting construction, availability of utilities, proximity to cylinder storage areas, and potential impacts to current or planned site operations. DOE has determined that Location A is the best alternative. DOE believes that the decision identified below best meets its programmatic goals and is consistent with all the regulatory requirements and public laws.

II. Decision

DOE has decided to implement the actions described in the preferred alternative from the FEIS at Location A. This decision includes the following actions:

DOE will construct and operate the conversion facility at Location A within the Paducah site. Construction will commence on or before July 31, 2004, as intended by Congress in Public Law 107-206.

All shipments to and from the conversion site, including any potential shipments of non-DUF6 cylinders currently stored at ETTP to Paducah, will be conducted by either truck or rail, as appropriate. Cylinders will be shipped in a manner that is consistent with DOT regulations for the transportation of UF6 cylinders.

Current cylinder management activities (handling, inspection, monitoring, and maintenance) will continue, consistent with the Cylinder Project Management Plan for Depleted Uranium Hexafluoride, effective October 2003, which cover actions needed to meet safety and environmental requirements, until conversion could be accomplished.

The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits as appropriate. If necessary, CaF2 will be produced and reused, pending approval of authorized release limits, or disposed of as appropriate.

The depleted U3O8 conversion product will be reused to the extent possible or packaged for disposal in emptied cylinders at an appropriate disposal facility. DOE plans to decide the specific disposal location(s) for the depleted U3O8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

III. Mitigation

On the basis of the analyses conducted for the FEIS, the DOE will adopt all practicable measures, which are described below, to avoid or minimize adverse environmental impacts that may result from constructing and operating a conversion facility at Location A. These measures are either explicitly part of the alternative or are already

performed as part of routine operations.

The conversion facility will be designed, constructed, and operated in accordance with the comprehensive set of DOE requirements and applicable regulatory requirements that have been established to protect public health and the environment. These requirements encompass a wide variety of areas, including radiation protection, facility design criteria, fire protection, emergency preparedness and response, and operational safety requirements.

Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility will be controlled by the best available practices, as necessary, to comply with the established standards for PM10 and PM2.5.

During construction, impacts to water quality and soil will be minimized through implementing storm water management, sediment and erosion controls, and good construction practices consistent with the Soil, Erosion, and Sediment Control Plan and Construction Management Plan.

If live trees with exfoliating bark are encountered on construction areas, they will be saved if possible to avoid destroying potential habitat for the Indiana bat.

Issued in Washington, DC this 20th day of July 2004.

Paul M. Golan,

Principal Deputy Assistant Secretary for Environmental Management.

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DEPARTMENT OF ENERGY

Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, OH, Site

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) prepared a Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site (FEIS) (DOE/EIS-0360). The FEIS Notice of Availability was published by the U.S. Environmental Protection Agency (EPA) in the Federal Register (69 FR 34161) on June 18, 2004. In the FEIS, DOE considered the potential environmental impacts from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed depleted uranium hexafluoride (DUF6) conversion facility at three alternative locations within the Portsmouth site, including transportation of cylinders (DUF6, normal and enriched UF6, and empty) currently stored at the East Tennessee Technology Park (ETTP) near Oak Ridge, Tennessee, to Portsmouth; construction of a new cylinder storage yard at Portsmouth (if required) for the ETTP cylinders; transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the aqueous hydrogen fluoride (HF) produced as a conversion co-product; and neutralization of aqueous HF to calcium fluoride (CaF2) and its sale or disposal in the event that the aqueous HF product is not sold. An option of shipping the ETTP cylinders to the Paducah, Kentucky, site has also been considered, as has an option of expanding operations by increasing throughput (through efficiency improvements or by adding a fourth conversion line) or by extending the period of operation. A similar EIS was issued concurrently for construction and operation of a DUF6 conversion facility at DOE's Paducah site (DOE/EIS-0359).

DOE has decided to construct and operate the conversion facility in the west-central portion of the Portsmouth site, the preferred alternative identified in the FEIS as Location A. Groundbreaking for construction of the facility will commence on or before July 31, 2004, as anticipated by Public Law (Pub. L.) 107-206. Cylinders currently stored at the ETTP site will be shipped to Portsmouth; a new cylinder yard will be constructed, if necessary, based on the availability of storage yard space when the cylinders are received. The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits, as appropriate.

ADDRESSES: The FEIS and this Record of Decision (ROD) are available on the DOE National Environmental Policy Act (NEPA) Web site at http://www.eh.doe.gov/nepa and on the Depleted UF6 Management

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Information Network Web site at http://web.ead.anl.gov/uranium. Copies

of the FEIS and this ROD may be requested by e-mail at Ports_DUF6@anl.gov, by toll-free telephone at 1-866-530-0944, by toll-free

fax at 1-866-530-0943, or by contacting Gary S. Hartman, Oak Ridge Operations Office, U.S. Department of Energy, SE-30-1, P.O. Box 2001, Oak Ridge, Tennessee 37831.

FOR FURTHER INFORMATION CONTACT: For information on the conversion facility construction and operation, contact Gary Hartman at the address listed above. For general information on the DOE NEPA process, contact Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH-42), U.S. Department of Energy, 1000 Independence Avenue, SW.,

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Washington, DC 20585, 202-586-4600, or leave a message at 1-800-472-2756.

SUPPLEMENTARY INFORMATION:

I. Background

The United States has produced DUF6 since the early 1950s as part of the process of enriching natural uranium for both civilian and military applications. Production took place at three gaseous diffusion plants (GDPs), first at the K-25 site (now called ETTP) at Oak Ridge, Tennessee, and subsequently at Paducah, Kentucky, and Portsmouth, Ohio. The K-25 plant ceased enrichment operations in 1985, and the Portsmouth plant ceased enrichment operations in 2001. The Paducah GDP continues to operate.

Approximately 250,000 t (275,000 tons) of DUF6 is presently stored in about 16,000 cylinders at Portsmouth and about 4,800 cylinders at ETTP. The majority of the cylinders weigh approximately 12 t (14 tons) each, are 48 inches (1.2 m) in diameter, and are stored on outside pads. DOE has been looking at alternatives for managing this inventory. Also in storage are 3,200 cylinders at Portsmouth and 1,100 cylinders at ETTP that contain enriched UF6 or normal UF6 (collectively called ``non-DUF6'' cylinders) or are empty. [The non-DUF6 cylinders would not be processed in the conversion facility.] The Portsmouth FEIS considers the shipment of all ETTP cylinders to Portsmouth, as well as the management of both the Portsmouth and ETTP non-DUF6 cylinders at Portsmouth.

As a first step, DOE evaluated potential broad management options for its DUF6 inventory in a Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (DUF6 PEIS) (DOE/EIS-0269) issued in April 1999. In the PEIS Record of Decision (64 FR 43358, August 10, 1999), DOE decided to promptly convert the DUF6 inventory to a more stable uranium oxide form and stated that it would use the depleted uranium oxide as much as possible and store the remaining depleted uranium oxide for potential future uses or disposal, as necessary. In addition, DOE would convert DUF6 to depleted uranium metal, but only if uses for metal were available. DOE did not select specific sites for the conversion facilities but reserved that decision for subsequent NEPA review. Today's Record of Decision announces the outcome of that site-specific

NEPA review. DOE is also issuing today a separate but related ROD announcing the siting of a DUF6 conversion facility at Paducah, Kentucky.

Congress enacted two laws that directly addressed DOE's management of its DUF6 inventory. The first law, Pub. L. 105-204, signed by the President in July 1998, required the Secretary of Energy to prepare a plan to commence construction of, no later than January 31, 2004, and to operate an on-site facility at each of the GDPs at Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle DUF6, consistent with NEPA. The second law, Pub. L. 107-206, signed by the President on August 2, 2002, required that no later than 30 days after enactment, DOE must award a contract for the scope of work described in its Request for Proposals (RFP) issued in October 2000 for the design, construction, and operation of a DUF6 conversion facility at each of the Department's Paducah, Kentucky, and Portsmouth, Ohio, gaseous diffusion sites. It also stipulated that the contract require groundbreaking for construction to occur no later than July 31, 2004, at both sites.

In response to these laws, DOE issued the Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105-204 in July 1999, and awarded a contract to Uranium Disposition Services (UDS) for construction and operation of two conversion facilities on August 29, 2002, consistent with NEPA.

On September 18, 2001, DOE published a Notice of Intent (NOI) in the Federal Register (66 FR 48123) announcing its intention to prepare an EIS for the proposed action to construct, operate, maintain, and decontaminate and decommission two DUF6 conversion facilities: One at Portsmouth and one at Paducah. Following the enactment of Pub. L. 107-206, DOE reevaluated the appropriate scope of its site-specific NEPA review and decided to prepare two separate EISs, one for the plant proposed for the Paducah site and a second for the Portsmouth site. This change in approach was announced in the Federal Register on April 28, 2003 (68 FR 22368).

The two draft conversion facility EISs were mailed to stakeholders in late November 2003, and a Notice of Availability was published by the EPA in the Federal Register on November 28, 2003 (68 FR 66824). Comments on the draft EISs were accepted during a 67-day review period that ended on February 2, 2004. DOE considered these comments and prepared two FEISs. The Notice of Availability for the two FEISs was published by the EPA in the Federal Register (69 FR 34161) on June 18, 2004.

II. Purpose and Need for Agency Action

DOE needs to convert its inventory of DUF6 to more stable chemical form(s) for use or disposal. This need follows directly from (1) the decision presented in the August 1999 ROD for the PEIS, namely, to begin conversion of the DUF6 inventory as soon as possible, and (2) Pub. L. 107-206, which directs DOE to award a contract for construction and operation of conversion facilities at both the Paducah site and the Portsmouth site.

III. Alternatives

No Action Alternative. Under the no action alternative, conversion would not occur. Current cylinder management activities (handling, inspection, monitoring, and maintenance) would continue: Thus the status quo would be maintained at Portsmouth and ETTP indefinitely.

Action Alternatives. The proposed action evaluated in the FEIS is to construct and operate a conversion facility at the Portsmouth site

for conversion of the Portsmouth and ETTP DUF6 inventories into depleted uranium oxide (primarily triuranium octaoxide [U3O8]) and other conversion products. The FEIS review is based on the conceptual conversion facility design proposed by the selected contractor, UDS. The UDS dry conversion process is a continuous process in which DUF6 is vaporized and converted to a mixture of uranium oxides (primarily U3O8) by reaction with steam and hydrogen in a fluidized-bed conversion unit. The hydrogen is generated from anhydrous ammonia (NH3). The depleted U3O8 powder is collected and packaged for disposition in bulk bags (large-capacity, strong, flexible bags) or the emptied cylinders to the extent practicable. Equipment would also be installed to collect the aqueous HF (also called HF acid) co-product and process it into HF at concentrations suitable for commercial resale. A backup HF acid neutralization system would convert up to 100% of the HF acid to CaF2 for sale or disposal in the future, if necessary. The conversion products would be transported to a disposal facility or to users by truck or rail. The conversion facility will be designed with three parallel processing lines to convert 13,500 t (15,000 tons) of DUF6 per year, requiring 18 years to convert the Portsmouth and ETTP inventories.

Three alternative locations within the site were evaluated, Locations A (preferred), B, and C. The proposed action includes the transportation of the cylinders currently stored at the ETTP site to Portsmouth. In addition, an

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option of transporting the ETTP cylinders to Paducah was considered, as was an option of expanding conversion facility operations.

Alternative Location A (Preferred Alternative). Location A is the preferred location identified in the FEIS for the conversion facility and is located in the west-central portion of the site, encompassing 26 acres (10 ha). This location has three existing structures that were formerly used to store containerized lithium hydroxide monohydrate. The site was rough graded, and storm water ditch systems were installed. This location was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

Alternative Location B. Location B is in the southwestern portion of the site and encompasses approximately 50 acres (20 ha). The site has two existing structures built as part of the gas centrifuge enrichment project that was begun in the early 1980s and was terminated in 1985. USEC is currently in the process of developing and demonstrating an advanced enrichment technology based on gas centrifuges. A license for a lead test facility to be operated at the Portsmouth site was issued by the U.S. Nuclear Regulatory Commission (NRC) in February 2004. The lead facility would be located in the existing gas centrifuge buildings within Location B. In addition, USEC announced in January 2004 that it planned to site its American Centrifuge Facility at Portsmouth, although it did not identify an exact location. Therefore, Location B might not be available for construction of the conversion facility.

Alternative Location C. Location C is in the southeastern portion of the site and has an area of about 78 acres (31 ha). This location consists of a level to very gently rolling grass field. It was graded during the construction of the Portsmouth site and has been maintained as grass fields since then.

Under the action alternatives, DOE evaluated the impacts from packaging, handling, and transporting depleted uranium oxide conversion product (primarily U3O8) from the conversion

facility to a low-level waste (LLW) disposal facility that would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized to receive the conversion products by DOE (in conformance with DOE orders), or licensed by the NRC (in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at an LLW disposal facility has been deferred to the disposal site's site-specific NEPA or licensing documents. While the FEIS presents the impacts from transporting the DUF6 conversion products to both the Envirocare of Utah, Inc., facility and the Nevada Test Site (NTS), DOE plans to decide the specific disposal location(s) for the depleted U3O8 conversion product after additional NEPA review, as necessary. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making its specific disposal decision and will provide any additional NEPA analysis for public review and comment.

The following alternatives were considered but not analyzed in detail in the FEIS: Use of Commercial Conversion Capacity, Sites Other Than Portsmouth, Alternative Conversion Processes, Long-Term Storage and Disposal Alternatives, Transportation Modes Other Than Truck and Rail, and One Conversion Plant Alternative.

IV. Summary of Environmental Impacts

The FEIS evaluated potential impacts from the range of alternatives described above. The impact areas included human health and safety, air quality, noise, water and soil, socioeconomics, ecological resources, waste management, resource requirements, land use, cultural resources, environmental justice, and cumulative impacts. In general, the impacts are low for both the no action and the proposed action alternatives. Among the three alternative locations considered at the Portsmouth site for the conversion facility, there are no major differences in impacts that would make one location clearly environmentally preferable. The discussion below summarizes the results of the FEIS impact analyses, highlighting the differences among the alternatives.

Human Health and Safety--Normal Operations and Transportation. Under all alternatives, it is estimated that potential exposures of workers and members of the general public to radiation and chemicals would be well within applicable public health standards and regulations. UDS would confirm, prior to conversion or at the initiation of the conversion operations, that polychlorinated biphenyl (PCB) releases to the workplace from the paint coating of some cylinders manufactured prior to 1978 would be within applicable Occupational Safety and Health Administration (OSHA) limits. Transportation by rail would tend to cause fewer impacts than by truck primarily because of exhaust emissions from the trucks and the higher number of shipments for trucks than for rail. The option of converting the aqueous HF to CaF2 and transporting the CaF2 to a disposal facility would result in increased shipments. The impacts associated with transportation of uranium oxide product to a disposal facility in the western United States by truck would be about the same if bulk bags are used or two filled cylinders are loaded onto a truck. If only one cylinder is loaded onto a truck, the impacts would be higher because of the increased number of shipments.

Human Health and Safety--Accidents. DOE has extensive experience in safely storing, handling, and transporting cylinders containing UF6 (depleted, normal, or enriched). In addition, the

chemicals used or generated at the conversion facility are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for their storage and transportation.

Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting both the workers and members of the general public. It is also possible that, similar to other industrial facilities, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. Similarly, during transportation of materials, both crew members and members of the public may be injured or killed as a result of traffic accidents.

Three kinds of accidents have the largest possible consequences: (1) Those involving the DUF6 cylinders during storage and handling under all alternatives, (2) those involving chemicals used or generated by the conversion process at the conversion site (in particular NH3 and aqueous HF) under the action alternatives, and (3) those occurring during transportation of chemicals and cylinders under the action alternatives, The severity of the consequences from such accidents would depend on weather conditions at the time of the accident, and, in the case of the transportation accidents, the location of the accident, and could be significant. However, those accidents would have a low estimated probability of occurring, making the risk low. (Risk is determined by multiplying the consequences by the probability of occurrence).

Under the no action alternative, the risks associated with cylinder storage

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and handling would continue to exist as long as the cylinders are there. However, under the action alternatives, the risks associated with both the cylinder accidents and the chemical accidents would decline over time and disappear at the completion of the conversion project.

In comparing truck versus rail transportation, even though the consequences of rail accidents are generally higher (because of the larger cargo load per railcar than per truck), the accident probabilities tend to be lower for railcars than for trucks. As a result, the risks of accidents would be about the same under either option.

Air Quality and Noise. Under the action alternatives, the total (modeled plus background value) concentrations due to emissions of most criteria pollutants--such as sulfur dioxide, nitrogen oxides, and carbon monoxide--would be well within applicable air quality standards. For construction, the primary concern would be particulate matter (PM) released from near-ground-level sources. Total concentrations of PM10 and PM2.5 (PM with an aerodynamic diameter of 10 [mu]m or less and 2.5 [mu]m or less, respectively) at the construction site boundaries would be close to or above the standards because of the high background concentrations. On the basis of maximum background values from 5 years of monitoring at the nearest monitoring station, exceedance of the annual PM2.5 standard would be unavoidable because the background concentration already exceeds the standard. Construction activities would be conducted so as to minimize further impacts on ambient air quality.

Water and Soil. During construction of the conversion facility, concentrations of any potential contaminants in soil, surface water, or groundwater would be kept well within applicable standards or guidelines by implementing storm water management, sediment and erosion

controls, and good construction practices. During operations, no impacts would be expected because no contaminated liquid effluents are anticipated.

Socioeconomics. Under the action alternatives, construction and operation of the conversion facility would create more jobs and personal income in the vicinity of the Portsmouth site than would be possible under the no action alternative. The number of jobs would be approximately 190 direct and 280 total during construction, and 160 direct and 320 total during operations.

Ecology. For the action alternatives, the total area disturbed during conversion facility construction would be up to 65 acres (26 ha). Although vegetation communities in the disturbed area would be impacted by a loss of habitat, impacts could be minimized (e.g., by appropriate placement of the facility within each location), and negligible long-term impacts to vegetation and wildlife are expected at all locations. Impacts to wetlands could be minimized, depending on where exactly the facility was placed within each location and by maintaining a buffer near adjacent wetlands during construction. During construction, trees with exfoliating bark (such as shagbark hickory or dead trees with loose bark) that can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer would be saved if possible.

Waste Management. Under the action alternatives, waste generated during construction and operations would have negligible impacts on the Portsmouth site waste management operations, with the exception of possible impacts from disposal of CaF2. If the aqueous HF were not sold but instead neutralized to CaF2, it is currently unknown whether (1) the CaF2 could be sold, (2) the low uranium content would allow the CaF2 to be disposed of as nonhazardous solid waste, or (3) disposal as LLW would be required. The low level of uranium contamination expected (i.e., less than 1 ppm) suggests that sale or disposal as nonhazardous solid waste would be most likely. Waste management for disposal as nonhazardous waste could be handled through appropriate planning and design of the facilities. If the CaF2 had to be disposed of as LLW, it could represent a potentially large impact on waste management operations.

The U3O8 produced during conversion would amount to about 5% of Portsmouth's annual projected LLW volume.

Cylinder Preparation at ETTP. The cylinders at ETTP will require preparation for shipment by either truck or rail. Three cylinder preparation options were considered for the shipment of noncompliant cylinders: cylinder overpacks, shipping ``as-is'' under a U.S. Department of Transportation (DOT) exemption, and use of a cylinder transfer facility (there are no current plans to build such a facility at ETTP). The operational impacts (e.g., storage, handling, and maintenance of cylinders) from any of the options would be small and limited primarily to external radiation exposure of involved workers. If a decision was made to construct and operate a transfer facility at ETTP in the future, additional NEPA review would be conducted.

Conversion Product Sale and Use. The conversion of the DUF6 inventory produces products having some potential for reuse. These products include aqueous HF and CaF2, which are commonly used as commercial materials. DOE is currently pursuing the establishment of authorization limits (allowable concentration limits of uranium) in these products to be able to free-release them to commercial users. In addition, there is a small potential for reuse of the depleted uranium oxide product.

D&D Activities. D&D impacts would be primarily from external radiation to involved workers and would be a small fraction of

allowable doses. Wastes generated during D&D operations would be disposed of in an appropriate disposal facility and would result in low impacts in comparison with projected site annual generation volumes.

Cumulative Impacts. The FEIS analyses indicated that no significant cumulative impacts at either the Portsmouth or the ETTP site and its vicinity would be anticipated due to the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions.

Option of Expanding Conversion Facility Operations. The throughput of the Portsmouth facility could be increased either by making process efficiency improvements or by adding an additional (fourth) process line. The addition of a fourth process line at the Portsmouth facility would require the installation of additional plant equipment and would result in a nominal 33% increase in throughput compared with the current base design. This throughput increase would reduce the time necessary to convert the Portsmouth and ETTP DUF6 inventories by about 5 years. The construction impacts presented in the FEIS would be the same if a fourth line was added, because the analyses in the FEIS used a footprint sized to accommodate four process lines. In general, a 33% increase in throughput would not result in significantly greater environmental impacts during operations than with three parallel lines. Although annual impacts in certain areas might increase up to 33% (proportional to the throughput increase), the estimated annual impacts during operations would remain well within applicable guidelines and regulations, with collective and cumulative impacts being quite low.

The conversion facility operations could be extended to process any additional DUF6 for which DOE might assume responsibility by operating the

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facility longer than the currently anticipated 18 years. With routine facility and equipment maintenance and periodic equipment replacements or upgrades, it is believed that the conversion facility could be operated safely beyond this time period. If operations were extended beyond 18 years and if the operational characteristics (e.g., estimated releases of contaminants to air and water) of the facility remained unchanged, it is expected that the annual impacts would be essentially unchanged.

V. Environmentally Preferred Alternative

In general, the FEIS shows greater impacts for the no action alternative than for the proposed action of constructing and operating the conversion facility mainly because of the relatively higher radiation exposures of the workers from the cylinder management operations and cylinder yards and because the cylinders and associated risk would remain if no action occurred. However, considering the uncertainties in the impact estimates and the magnitude of the impacts, the differences are not considered to be significant. The no action alternative has the potential for groundwater contamination with uranium over the long-term; this adverse impact is not anticipated under the proposed action alternatives. Beneficial socioeconomic impacts would be higher for the action alternatives than for the no action alternative.

The impacts associated with transportation of materials among sites would be comparable whether the transportation is by truck or rail.

With all alternatives, there is the potential for some high-consequence accidents to occur. The risks associated with such

accidents can only be completely eliminated when the conversion of the DUF6 inventory has been completed.

Although there are some differences in impacts among the three alternative locations for the conversion facility, these differences are small and well within the uncertainties associated with the methods used to estimate impacts. In general, because of the relatively small risks that would result under all alternatives and the absence of any clear basis for discerning an environmental preference, DOE concludes that no single alternative analyzed in depth in the FEIS is clearly environmentally preferable compared to the other alternatives.

VI. Comments on Final EIS

The Final EIS was mailed to stakeholders in early June 2004, and the EPA issued a Notice of Availability in the Federal Register on June 18, 2004. The entire document was also made available on the World Wide Web. Two comment letters were received on the DUF6 Conversion Facility Final EISs. The State of Nevada indicated that it had no comments on the Final EISs and that the proposal was not in conflict with state plans, goals, or objectives. The U.S. Environmental Protection Agency, Region 5 in Chicago, stated that the Portsmouth Final EIS adequately address its concerns, and that it concurs with the Preferred Alternative and has no further concerns.

Decision

I. Bases for the Decision

DOE considered potential environmental impacts as identified in the FEIS (including the information contained in the classified appendix); cost; applicable regulatory requirements; Congressional direction as included in Pub. L. 105-204 and Pub. L. 107-206; agreements among DOE and the States of Ohio, Tennessee, and Kentucky concerning the management of DUF6 currently stored at the Portsmouth, ETTP, and Paducah sites, respectively; and public comments in arriving at its decision. In deciding among the three alternative locations at the Portsmouth site for the conversion facility, DOE considered environmental factors, site preparation requirements affecting construction, availability of utilities, proximity to cylinder storage areas, and potential impacts to current or planned site operations. DOE has determined that Location A is the best alternative. DOE believes that the decision identified below best meets its programmatic goals and is consistent with all the regulatory requirements and public laws.

II. Decision

DOE has decided to implement the actions described in the preferred alternative from the FEIS at Location A. This decision includes the following actions:

DOE will construct and operate the conversion facility at Location A within the Portsmouth site. Construction will commence on or before July 31, 2004, as intended by Congress in Pub. L. 107-206.

DUF6 cylinders currently stored at ETTP will be shipped to Portsmouth for conversion; a new cylinder yard will be constructed, if necessary, based on the availability of storage yard space when the cylinders are received.

All shipments to and from the sites, including the shipment of UF6 cylinders (DUF6 and non-DUF6) currently stored at ETTP to Portsmouth, will be conducted by either truck or rail, as appropriate. Cylinders will be

shipped in a manner that is consistent with DOT regulations for the transportation of UF6 cylinders.

Although efficiency improvements can be accomplished, which would increase the conversion facility's throughput and decrease the operational period, DOE has decided not to add the fourth processing line to the conversion facility at this time.

Current cylinder management activities (handling, inspection, monitoring, and maintenance) will continue, consistent with the Depleted Uranium Hexafluoride Management Plan included in the Ohio EPA Director's final findings and orders effective February 1998 and March 2004, which cover actions needed to meet safety and environmental requirements, until conversion could be accomplished.

The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits as appropriate. If necessary, CaF2 will be produced and reused, pending approval of authorized release limits, or disposed of as appropriate.

The depleted U3O8 conversion product will be reused to the extent possible or packaged for disposal in emptied cylinders at an appropriate disposal facility. DOE plans to decide the specific disposal location(s) for the depleted U3O8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

III. Mitigation

On the basis of the analyses conducted for the FEIS, the DOE will adopt all practicable measures, which are described below, to avoid or minimize adverse environmental impacts that may result from constructing and operating a conversion facility at Location A. These measures are either explicitly part of the alternative or are already performed as part of routine operations.

The conversion facility will be designed, constructed, and operated in

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accordance with the comprehensive set of DOE requirements and applicable regulatory requirements that have been established to protect public health and the environment. These requirements encompass a wide variety of areas, including radiation protection, facility design criteria, fire protection, emergency preparedness and response, and operational safety requirements.

Cylinder management activities will be conducted in accordance with applicable DOE safety and environmental requirements, including the Cylinder Management Plan.

Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility will be controlled by the best available practices, as necessary, to comply with the established standards for PM10 and PM2.5.

During construction, impacts to water quality and soil will be minimized through implementing storm water management, sediment and erosion controls, and good construction practices consistent with the Soil, Erosion, and Sediment Control Plan and Construction Management Plan.

If live trees with exfoliating bark are encountered on

construction areas, they will be saved if possible to avoid destroying potential habitat for the Indiana bat.

Issued in Washington, DC, this 20th day of July, 2004.
Paul M. Golan,
Principal Deputy Assistant Secretary for Environmental Management.
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(3) MFS-2

U.S. Nuclear Fuel Cycle Projections 2000-2025

January 2003 (Next Release: January 2004)

U.S. Nuclear Fuel Cycle Projections, Reference Case, 2000-2025							
			Requirement			Spent Fuel	
Year	Net Summer Capability of Operable Units[a]	Electricity Net Generation	Annual Uranium	Cumulative Uranium	Enrichment Services	Annual	Cumulative
	Gigawatts Electric	Billion Kilowatthours	Million Pounds U_3O_8 Equivalent		Million SWU[b]	Thousand MTHM[c]	
2000	98.14	753.9[d]	58.49	58.49	13.31	1.93	42.33[e]
2001	98.24	768.8[d]	51.03	109.52	12.78	2.30	44.63
2002	98.63	777.0	59.07	168.59	13.70	2.16	46.80
2003	98.93	781.0	53.95	222.54	14.01	2.35	49.15
2004	99.61	787.0	57.84	280.38	14.03	2.39	51.54
2005	100.20	793.0	55.35	335.73	14.56	2.33	53.86
2006	100.40	796.0	62.72	398.46	13.53	2.44	56.30
2007	99.91	804.0	51.84	450.30	15.17	2.25	58.56
2008	99.12	797.0	60.56	510.86	13.61	2.53	61.09
2009	99.12	798.0	55.87	566.73	14.56	2.19	63.28
2010	99.31	800.0	49.06	615.79	12.93	2.37	65.65
2011	99.31	801.0	66.00	681.79	15.68	2.07	67.72
2012	99.40	803.0	51.75	733.54	12.90	2.52	70.24
2013	99.79	807.0	62.11	795.65	15.33	1.98	72.22
2014	99.25	811.0	50.53	846.18	13.44	2.53	74.75
2015	99.53	805.0	63.70	909.89	15.40	2.02	76.77
2016	99.63	806.0	49.54	959.43	14.87	2.37	79.14
2017	99.63	807.0	63.49	1,022.92	13.74	2.28	81.42
2018	99.63	807.0	48.50	1,071.41	14.10	2.09	83.51

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2019	99.63	807.0	62.72	1,134.13	15.37	2.17	85.68
2020	99.63	807.0	50.57	1,184.70	13.49	2.29	87.97
2021	99.63	807.0	58.99	1,243.69	13.99	2.03	89.99
2022	99.63	807.0	55.27	1,298.96	15.32	2.07	92.07
2023	99.63	807.0	60.83	1,359.79	13.57	2.29	94.36
2024	99.63	807.0	54.05	1,413.84	13.12	2.03	96.39
2025	99.63	807.0	52.33	1,466.17	14.23	1.96	98.35

[a] At end of period.
[b] Separative Work Units
[c] Metric tons of heavy metal.
[d] Actual data, Short-Term Energy Outlook, January, 2003, Table A8..
[e] Cumulative spent fuel as reported on Form RW-859, Nuclear Fuel Data survey, as of 12/31/98 plus 2000 MT estimated for 1999 plus the annual value for 2000.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels; International Nuclear Fuel Cycle Model, January, 2003.

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USEC – Heading Into the Perfect Storm?

A Public Policy White Paper

Prepared by

Paper, Allied Industrial, Chemical and Energy Workers International Union, AFL-CIO, CLC

September 2003

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USEC – HEADING INTO THE "PERFECT STORM"?

September 2003

USEC Inc. is at a crossroad. It has the opportunity to be profitable, hold onto its market and build a new uranium enrichment plant, the American Centrifuge, that will assure its future and energy security for the nuclear power industry in the United States. PACE believes that USEC must cut dividends, pay down its debt and start saving to build a new plant in order to do that. USEC is also vulnerable to a "perfect storm" of events that can destroy any hope of profitability. These events can drive USEC to abandon production at the only remaining uranium enrichment plant in the U.S.; lose its market to imports from government controlled Russian and European producers; and force it to give up building a new plant.

If the storm hits, the U.S. government, and thus U.S. taxpayers, must either bail out USEC or take back production and control of uranium enrichment in the United States. The alternative is to become dependent on Russia and Europe for all of the uranium fuel necessary to generate 20% of this country's electricity. Most of the factors for success are in USEC's control, but it is currently dissipating cash and profits instead of paying down its debt and saving to build the new plant.

The Paper, Allied-Industrial, Chemical and Energy Workers International Union (PACE), which represents 1,172 workers at two USEC plants, believes that regulators and Congress have paid insufficient attention to this developing "perfect storm" and the continued missteps by USEC's board and managers. While USEC is a private corporation, the Company plays a unique and sensitive role in national security by being a major supplier of energy and an important cog in bringing about global nuclear disarmament. A failure of USEC will cause a crisis in American public policy. PACE offers this report as a "storm warning" to avert a potential national disaster by calling for greater government oversight. If Congress and regulators wait for USEC to be in the eye of the storm, it will be too late. Sound public policy should seek to steer around the pending storm rather than allow USEC to head directly into it.

Background on USEC

- USEC was created out of the uranium enrichment operations of the Department of Energy and was privatized by the government in 1998. USEC made an agreement with the U.S. Government in 2002 to maintain a reliable domestic source of nuclear fuel so U.S. utilities with nuclear power plants would not be totally dependent on fuel imports from foreign government-controlled enrichment plants in Russia and Europe.

- In accordance with the policy of the U.S. Government, USEC purchases low grade enriched uranium blended down from Russia's arsenal of decommissioned nuclear warheads and sells it for fuel to U.S. electric utilities. The sole purpose is to keep bomb-grade uranium out of the hands of terrorists or rogue nations. This program will run until 2013. These imports command half of U.S. utilities' annual nuclear fuel demand and are about half of USEC's supply. The other half comes mostly from USEC's operations at the plant in Paducah, KY but is threatened by more imports from Russia and Europe.

- The U.S. Government allows USEC to be the exclusive agent to obtain this uranium fuel from the Russians and approved a new USEC contract with the Russians in June 2002 that will assure USEC of a profit on this deal until 2013. In return USEC agreed to run the nation's only remaining enrichment plant at Paducah until 2010 and replace it with the new state-of-the-art plant.

USEC Finances – Profit and Debt Crunch

- USEC was created by an "insider takeover" instigated by its government managers, who issued $1.425 billion in stock and borrowed $500 million more to buy the enrichment business from the government in 1998. USEC's managers have spent almost $450 million on dividends and buying back some of its stock. The stock is now worth only $595 million, less than half of its value when first issued. USEC has not repaid any of its debt, and its credit rating is now at "speculative" or "junk bond" status. Profits have dropped steadily from $152 million in 1999 to a loss of $14.7 million by the end of 2002. Profits are projected to be $9 to $10 million in 2003. Profits will remain low for at least the next two years due to low-priced, long-term sales made in 1999 to 2002, and increased spending to accelerate the R&D on the new American Centrifuge project.

- USEC currently spends $45 million per year on dividends ($0.55/share), which is a 7.5% return on a share price of $7.25. USEC spends $36 million on interest on its $500 million debt. USEC plans to spend $150 million from earnings to complete R&D and run a pilot plant over the next four years. USEC must then have the financing in place by January 1, 2007 to build its new plant estimated to cost $1.5 billion. USEC must get a joint venture equity partner or come up with 25% to 40% of that $1.5 billion to finance it. That is on top of the $500 million it already owes and at least $350 million of that comes due in 2006 and the rest in 2009.

- Even with high dividends, there is no long-term value for shareholders of USEC unless it builds a competitive replacement plant as soon as possible. USEC has agreed with DOE to do that by 2010 as part of the quid pro quo to get control of the Russian imports and a profitable contract with the Russians. If USEC does not maintain operations at the Paducah plant and build the new plant on schedule, including having its financing in place by January 1, 2007, it stands to lose control of the Russian deal and its profits. That would be a disaster for USEC's shareholders, creditors and PACE workers at the Kentucky and Ohio plant sites.

- To meet its obligations under the DOE agreement, USEC must reduce its debt, improve its credit rating and increase savings by January 1, 2007. Based on its current financial statements, it cannot do that without reducing or eliminating dividend payments for at least the next three years. There is no other available source of funds to meet these financial objectives, absent a significant increase in the price of uranium fuel, which does not appear likely under current conditions. The risk of a drop in that price is greater, if imports increase and production at Paducah decreases. That risk is part of the "perfect storm".

Critical Elements of USEC Profitability

PACE issued a report in May 2003, based on USEC's 1st Quarter 2003 report, which questioned whether USEC's profitability is currently sufficient to attain its objectives. USEC's profits are too low, and its dividends and debt are too high. USEC's 2nd Quarter Report indicates no significant changes, except USEC's decision to accelerate its R&D effort and its application to the Nuclear Regulatory Commission (NRC) for the license to build a new plant.

Average Contract Selling Price per SWU – estimated at approx. $99 for 2003.

USEC's sales contracts are typically for multiple years at a set price. As market prices change over time, the average price of delivered SWU under these long-term contracts may be more or less than current market prices. Following privatization in 1998, market prices declined from $100/SWU to $80/SWU in 1999-2001. USEC made long term contracts at these lower prices. Since then prices have risen to around $105/SWU. (See comments below on the Trade Cases.) USEC inherited high priced, long-term contracts in 1998 averaging over $110/SWU. Those higher priced contracts are now expiring and the lower priced contracts made in 1999-2001 make up a larger % of the average price of sales, which is declining as a result. This average sales price should bottom out in 2005 and start rising, assuming market prices stay around $105.

Current Market Price per SWU – approx. $105.

Current supply and demand are more or less stable, which allowed U.S. market prices to rise in 2002-2003. Prices have risen and stabilized because Russian imports are capped at 5.5 million SWU/year for the time being; USEC production at Paducah has been near 5 million SWU for the last year, and European imports have also stabilized between 2-3 million SWU per year as the result of trade cases on subsidies and dumping filed against European government-controlled producers by USEC and PACE in late 2001. USEC halted production at the Portsmouth, OH plant in June 2001, which reduced capacity and production costs.

Production Level at Paducah Gaseous Diffusion Plant (GDP)

Paducah is operating near 5 million SWU/year with capacity of 6 million. Current average production costs at Paducah are between $100-$105/SWU. That is about even with current market prices, but it exceeds USEC's average sales price to customers. It is critical for Paducah to stay at or near break even to allow USEC to become sufficiently profitable to finance construction of a new plant. If production drops to 3.5-4.0 million SWU annually, unit costs at Paducah increase to $115-$120/SWU. That loss at Paducah will reduce profits on the sale of the Russian SWU imports and sales of natural uranium inventory. Any increase in imports from Russia or Europe will also displace production at Paducah, increase unit costs, and reduce profits. Approximately 60% of the production cost at Paducah is the cost of electricity to run the plant. USEC currently has favorable contracts for electricity. USEC can cut back production and electricity purchases in Summer if electricity rates rise too much with Summer demand. Other fixed costs, including labor, remain the same, however, so unit costs go up.

Profitable Russian Contract Starting in 2003 to 2013

USEC, as exclusive agent for the U.S., negotiated a new, market-based contract with the Russians to purchase the blended-down warhead uranium at a substantial discount from a rolling three-year average of market prices. This virtually assures USEC of a profit from the purchase and resale of these Russian imports. USEC also has exclusive control of the sale of these imports in the U.S. Approval of this arrangement by DOE and the Administration in June 2002, was the quid pro quo USEC received in return for promising to maintain production at Paducah at no less than 3.5 million SWU/year and building a replacement centrifuge enrichment plant by 2010. USEC also got control of the DOE technology for that new plant. This quid pro quo on the Russian contract provides USEC with the opportunity to become sufficiently profitable to maintain Paducah operations and build the new plant. Conversely, if USEC fails to meet either of its obligations, it stands to lose the Russian deal, and any chance it has for viability or profitability.

Russian and European Trade Cases Continue to Control Imports of Low-Enriched Uranium Fuel

In 1991, one of the predecessor unions of PACE (the Oil, Chemical and Atomic Workers International Union (OCAW), joined in an unfair trade case against the former Soviet Union for dumping natural uranium and low-enriched uranium fuel (LEU) in the U.S. Following the collapse of the Soviet Union the cases were continued against Russia and some other countries. Only Russia had the capability to enrich uranium, both for utility fuel and nuclear bombs, and currently has a lot of excess capacity to make commercial fuel (LEU). That case was suspended in 1993 with an agreement by the Russians to limit its imports into the U.S. The quotas for LEU have expired and no new quotas have been granted. PACE and USEC have worked to maintain this agreement since USEC was privatized. The agreement expires in March 2004. Reviews by the U.S. Department of Commerce may delay that expiration for up to one year. If that agreement is not extended or renegotiated in a favorable way, Russia could once again flood the U.S. market with very cheap LEU fuel.

In December 2001, USEC filed antidumping and subsidy cases against European producers of LEU from France, UK, Germany and the Netherlands. PACE joined as a petitioner in that case as well. These producers were proven to have oversupplied the market at unfair prices and duties were imposed. These imports were increasing at the same time the Russian imports from the HEU Agreement were peaking. This was a major cause of the decline in SWU prices from 1999 through 2001.

The European producers and several of the largest U.S. utilities appealed these duties to the U.S. Court of International Trade (CIT) on the basis that the production of enriched uranium was a service, not manufacture of a product or good. If uranium enrichment is deemed a service, the trade laws would not apply and both the Europeans and the Russians would be free to import as much LEU as they could make into the U.S. That would doom the Paducah enrichment operations and prohibit the construction of any new enrichment plants in the U.S. The U.S. would then become totally dependent on these foreign suppliers for fuel for over 20% of U.S. electricity supplies.

CIT sent the cases back to the Commerce Department to provide a better explanation of the legal and factual basis on which Commerce determined that LEU was a manufactured good under the unfair trade laws. Commerce has done so and sent the cases back to the CIT for review. PACE and USEC are strongly supporting the arguments of Commerce at the CIT and believe that the Department will be sustained by CIT. The European producers and U.S. utilities may appeal that decision as well.

Muddle Through or Perfect Storm?

Muddle Through

USEC currently pays $45 million in dividends per year and around $36 million in interest on the $500 million in debt, with no amortization. USEC guidance on earnings for 2003 is in the range of $9 to $11 million after accounting for increased expenditures on the R&D for the American Centrifuge project. PACE supports that additional spending on the centrifuge project, but net profits are still too low to reduce debt and save enough for equity to finance the $1.5 billion cost of the new centrifuge plant. USEC intends to spend $150 million on R&D between June 2002 and 2007. USEC will need another $150 to $450 million in equity to finance the $1.5 billion cost of the new plant. Profits should increase somewhat after 2005 as low-priced SWU contracts are replaced by newer contracts that reflect the higher market prices of 2002-2003. USEC now has the opportunity to increase its profitability with the Russian agreement in hand and a new collective bargaining agreement with its PACE workers. That alone may not be enough to succeed.

USEC management has indicated it is considering various forms of partnership or joint ventures with other companies to help build the new plant. Public statements that equity could be as low as 10% or around $150 million for construction would still be challenging for USEC to achieve under the current business plan. The current guidelines by NRC for licensing construction of a new plant are 30% equity and at least five years of contract commitments from customers to cover the costs of financing and operating the new plant. USEC has suggested different criteria for its plant, but that will not be resolved before next year when USEC files its application with NRC.

PACE continues to believe that USEC must do more to reduce debt and increase savings in order to meet its obligations to maintain operations at Paducah and build the new centrifuge plant within the time frame set out in the June 2002 Agreement with DOE. It appears that USEC will require some help, either from other companies or the Federal Government, if it continues on its current course. USEC can try to muddle through, but the outcome is uncertain. PACE believes USEC can either maintain operations at Paducah, or save enough to do R&D and build a new plant, but it will be difficult to do both under the current business plan.

The Perfect Storm

USEC must maintain operations at Paducah near 5.0 million SWU/year to break even based on average unit cost equaling the market price of SWU. Currently, each is approximately $105/SWU. This will maximize profits from the Russian agreement and the sale of natural uranium inventory over the next few years. Those are the sole source of USEC's positive cash flow and profits.

In order to manage Paducah's costs, USEC must maintain favorable electricity rates to run the plant. If rates go up, Paducah does not break even. Also, if production levels at Paducah are cut back

from 4.5 to 5.0 million SWU/year to the 3.5 million SWU minimum, Paducah's average unit costs will rise to $115 to $120 per SWU, and Paducah cannot break even.

On the other side of the equation, SWU prices must stay in the $105 range. That is a function of the level and price of imports. The Russian imports under the HEU Agreement are capped currently at 5.5 million SWU/year. Paducah production and imports from Europe currently fill the rest of U.S. demand. USEC sells around 3.0 million SWU per year to Asian and other overseas customers. Paducah production has to stay in the 4.5 to 5.0 million SWU range. If there is any significant increase in imports, they will displace and lower Paducah production.

If the trade cases against the European producers are not maintained, or the Suspension Agreement restricting Russian commercial LEU imports is not renewed by the end of 2004, imports of LEU could increase significantly. If the European producers and U.S. utilities convince the Courts that enrichment of uranium is a service rather than manufacture of a product, there will be no restraints on imports from Europe or Russia. In that event, SWU prices will drop and Paducah production will be displaced by the amount of the imports. That will increase unit costs at the same time SWU prices are dropping. USEC's losses on Paducah production could consume most of the profits on the Russian HEU Agreement.

Under the "perfect storm" scenario, USEC would be forced to halt operations at Paducah, and would be unable to finance construction of a new plant in the face of a flood of cheap imports. USEC would fail to meet its obligations under the MOA with DOE, and would probably lose control of the Russian HEU deal. Direct sales by the Russians would drive prices even lower.

The U.S. could maintain energy security for 20% of its electricity production then only if the government took back the Paducah plant operations or subsidized USEC's losses. There would still be virtually no incentive for investors to finance the new plant, and the U.S. government would most likely have to guarantee or underwrite that construction as well. While this is the worst case scenario, it can be triggered by an adverse outcome in either or both trade cases.

PACE International Union

PACE represents 320,000 workers in paper, chemical, oil, atomic energy, auto parts, grain milling and industrial materials industries. PACE is concerned about the ability of USEC Inc. to continue uranium enrichment operations at the only remaining enrichment plant in Paducah, KY and replace it with a new centrifuge plant at either the Portsmouth, OH enrichment site or the Paducah site by 2010. These are two primary issues for PACE workers at the two plant sites, and addressing these issues is actually required under a Memorandum of Agreement (MOA) with the Department of Energy (DOE) dated June 17, 2002. PACE Local 5-550 at Paducah and USEC have recently concluded a long-term labor agreement for eight years, which is intended to cover the remaining years of operation of the Paducah plant. This will provide a stable labor environment and costs that will allow USEC to focus on its future.

For further information, contact Phil Potter at (202) 626-0550 and see www.usec-watch.org.