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SEP 04 1986

MEMORANDUM FOR: Ben B. Hayes, Director  
Office of Investigations

FROM: Victor Stello, Jr.  
Executive Director for Operations

SUBJECT: OI INVESTIGATION INVOLVING KERR-MCGEE/SEQUOYAH FUELS  
CORPORATION (4-86-005)

This is in response to your memorandum dated August 12, 1986, in which you asked several questions related to the safety of heating cylinders of UF<sub>6</sub> that have been overfilled by varying amounts. Responses to the questions are enclosed.

Original signed by,  
Victor Stello

Victor Stello, Jr.  
Executive Director  
for Operations

Enclosure: As stated

DISTRIBUTION EDO 002051 w/enclosures

VStello	WTCrow	CJenkins	JSniezek	RBangart, RIV
JGDavis	NMSS R/F	SECY	RMartin, RIV	JPartlow, IE
DBMausshardt	FCUF R/F	JRoe	GCunningham, OGC	JAxelrad, IE
RECunningham	BClausser	TRehm	✓ Docket File 40-8027	JLieberman, OGC
DACool	VLTharpe	EYShum	FC Central File	EDO 2051
	Region IV	RFonner, OGC		

IE 105C by phone  
JAxelrad 9/3/86  
OGC by phone  
JLieberman 9/3/86

ee previous concurrence sheet

C: FCUF*	:FCUF*	:OGC*	:RIV*	:IE *	:FCUF	:NMSS	:NMSS	:EDO
ME:WTCrow/as	:VLTharpre	:RFonner	:RBangart	:JPartlow	:RCunningham	:DMausshardt	:JGDavis	:VStello
TE:8/10/86	:8/19/86	:8/18/86	:8/18/86	:8/19/86	9/3/86	:8/18/86	:8/17/86	:8/17/86

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MEMORANDUM FOR: Ben B. Hayes, Director  
Office of Investigations

FROM: Victor Stello, Jr.  
Executive Director for Operations

SUBJECT: OI INVESTIGATION INVOLVING KERR-MCGEE/SEQUOYAH FUELS  
CORPORATION (4-86-005)

This is in response to your memorandum dated August 12, 1986, in which you asked several questions related to the safety of heating cylinders of UF<sub>6</sub> that have been overfilled by varying amounts. Responses to the questions are enclosed (Enclosure 1).

Regarding the relative safety of heating cylinders containing UF<sub>6</sub>, if one assumes that the hazard of heating a cylinder of UF<sub>6</sub> is hydraulic rupture, then heating any cylinder that has zero void space may result in the rupture of the cylinder. The Department of Transportation defines an overfilled cylinder as a cylinder of UF<sub>6</sub> containing less than 5 percent free void space at 250°F. (See Enclosure 2, memorandum from W. H. Lake to W. T. Crow dated 7/31/86.) Please note the statement in the memorandum that "overheating and overfilling of UF<sub>6</sub> cylinders can result in hydraulic rupture." In responding to your questions, the staff assumes that the cylinders contain only pure UF<sub>6</sub> and are heated using condensing steam at atmospheric pressure (approximately 212°F).

Victor Stello, Jr.  
Executive Director  
for Operations

Enclosures: As stated

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\*See previous concurrence sheet

FC: FCUF\* :FCUF\* :OGC\* :RIV\* :IE <sup>nd phone</sup> :FC :NMSS :NMSS :EDO  
NAME: WTCrow/as :VLTharpre:RFonner :RBangart :JPartlow :RCunningham:DMAusshardt:JDavis :VStello  
DATE: 8/19/86 :8/19/86 :8/18/86 :8/18/86 :8/19/86 :8/19/86 :8/19/86 :8/ /86:8/ /86

OFFICIAL RECORD COPY

MEMORANDUM FOR: Ben B. Hayes, Director  
Office of Investigations

FROM: Victor Stello, Jr.  
Executive Director for Operations

SUBJECT: OI INVESTIGATION INVOLVING KERR-MCGEE/SEQUOYAH FUELS  
CORPORATION (4-85-005)

This is in response to your memorandum dated August 12, 1986, in which you asked several questions related to the safety of heating cylinders of UF<sub>6</sub> that have been overfilled by varying amounts. Responses to the questions are enclosed (Enclosure 1).

Regarding the relative safety of heating cylinders containing UF<sub>6</sub>, if one assumes that the hazard of heating a cylinder of UF<sub>6</sub> is hydraulic rupture, than heating any cylinder that has zero void space may result in the rupture of the cylinder. The Department of Transportation defines an overfilled cylinder as a cylinder of UF<sub>6</sub> containing less than 5 percent free void space at 250°F. (See Enclosure 2, memorandum from W. H. Lake to W. T. Crow dated 7/31/86.) Please note the statement in the memorandum that "overheating and overfilling of UF<sub>6</sub> cylinders can result in hydraulic rupture." In responding to your questions, the staff assumes that the cylinders contain only pure UF<sub>6</sub> and are heated using condensing steam at atmospheric pressure (approximately 212°F).

Victor Stello, Jr.  
Executive Director  
for Operations

Enclosures: As stated

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FC: FCUF *WTC* :FCUF :OGC *WTC* :RIV *WTC* :IE :FC :NMSS :NMSS :EDO

NAME:WTCrow/as :VLTharpe :RFonner :RBangart :JPartlow :RCunningham:DMAusshardt:JDavis :VStello

DATE:8/19/86 :8/19/86 :8/19/86 :8/16/86 :8/ /86 :8/ /86 :8/ /86 :8/ /86:8/ /86

## RESPONSE TO OI QUESTIONS

The series of questions posed by OI concerned the safety of heating cylinders containing UF<sub>6</sub> that had been overfilled by varying amounts. The two cylinders involved at the Sequoyah Fuels Corporation are identified in terms of nominal shipping weight of the UF<sub>6</sub> contained within the cylinders -- either a "10-ton cylinder" or a "14-ton cylinder."

In answering the questions it has been assumed (1) that the cylinders are built, maintained, and tested in accordance with applicable ASME codes; (2) that "overfilling" -- for the purposes of the procedural requirements of the Sequoyah Fuels Corporation -- means an amount in excess of 21,030 pounds for the 10-ton cylinder and 27,560 pounds for the 14-ton cylinder; (3) the hazard associated with heating of an "overfilled" cylinder of UF<sub>6</sub> is hydraulic rupture resulting from expansion of the UF<sub>6</sub> resulting from the heating; and, (4) the cylinders contain only pure UF<sub>6</sub> and are heated using condensing steam at atmospheric pressure (approximately 212°F).

In general, the cylinders are designed so that free void space exists when filled to nominal shipping weight at 212°F. According to drawings, the minimum volume capacity of a "10-ton cylinder" is 108.9 ft<sup>3</sup>; the minimum volume of a "14-ton cylinder" is 142.7 ft<sup>3</sup>. Assuming these minimum cylinder volumes and a UF<sub>6</sub> density of 212.7 lb/ft<sup>3</sup> at 212°F, the staff calculates the maximum amount of UF<sub>6</sub> that can be placed into a 10-ton cylinder is 23,163 pounds; into a 14-ton cylinder is 30,352 pounds. For the 10-ton cylinder this is 2,133 pounds in excess of the "fill weight" specified in the SFC procedures; for the 14-ton cylinder; this is 2,792 pounds in excess. Any amount greater than those quantities could result in the hydraulic rupture of the cylinder. If the temperature is in excess of 212°F amounts less than those quantities could result in hydraulic rupture of the cylinder.

In reply to the first three questions, progressive increasing of the amounts of "overfill" should not cause hydraulic rupture of the cylinders until, for the 10-ton cylinder, the overfill exceeds 2,133 pounds and for the 14-ton cylinder, the overfill exceeds 2,792 pounds at 212°F. However, below those quantities, the margin of safety is progressively reduced as the amount of "overfill" is progressively increased. The following table provides information concerning this:

### For 10-ton cylinder

<u>Amount in cask</u>	<u>Relation to overfill</u>	<u>Free void space</u> <u>@ 212°F</u>
21,030 pounds	0 overfill	9%
21,130 pounds	100 pound overfill	9%
21,530 pounds	500 pound overfill	7%
22,030 pounds	1,000 pound overfill	5%
22,530 pounds	1,500 pound overfill	3%
23,163 pounds	2,133 pound overfill	0%

<u>For 14-ton cylinder</u> <u>Amount in cask</u>	<u>Relation to overfill</u>	<u>Free void space</u> <u>@ 212°F</u>
27,560 pounds	0 overfill	9%
27,660 pounds	100 pound overfill	9%
28,060 pounds	500 pound overfill	7%
28,560 pounds	1,000 pound overfill	6%
29,060 pounds	1,500 pound overfill	4%
29,560 pounds	2,000 pound overfill	3%
30,352 pounds	2,792 pound overfill	0%

The Department of Energy (DOE) specifies the maximum allowable weight of UF<sub>6</sub> allowed in each type of cylinder as 21,030 pounds for a 10-ton cylinder and 27,560 pounds for a 14-ton cylinder. These weights are based on a 5 percent free volume at 250°F for cylinders of a minimum volume. Sequoyah Fuels loads cylinders to these maximum quantities. Also, the Department of Transportation (DOT) has adopted DOE's philosophy in developing a proposed rule on transport of UF<sub>6</sub>. (See Enclosure, memorandum from W. H. Lake to W. T. Crow dated 7/31/86.)

Enclosure: Memo from W. H. Lake  
to W. T. Crow dtd  
7/31/86



UNITED STATES  
 NUCLEAR REGULATORY COMMISSION  
 WASHINGTON, D. C. 20555

JUL 31 1985

MEMORANDUM FOR: William T. Crow, Acting Chief  
 Uranium Fuel Licensing Branch, FC, NISS

THRU: Charles E. MacDonald, Chief  
 Transportation Certification Branch, FC, NISS

FROM: William H. Lake  
 Transportation Certification Branch, FC, NISS

SUBJECT: PREPARATION OF UF<sub>6</sub> CYLINDERS FOR TRANSPORT

This is in response to your request for analysis of the effects of heating a 500 lb overfilled 10-ton or 14-ton cylinder (Models 48X and 48Y). Heating would be performed in a steam chest at essentially atmospheric pressure (212°F).

Discussion

It should be noted that overheating and overfilling of UF<sub>6</sub> cylinders can result in hydraulic rupture.

The proposed Department of Transportation cylinder specifications define overfill for transportation as UF<sub>6</sub> exceeding 95% of the cylinder volume for the system at 250°F. That is, a 5% margin as free space at 250°F. The analyses for each cylinder considered is given below:

10-Ton Cylinder, Model 48X

The net weight of UF<sub>6</sub> is specified as 21,030 lb, and the minimum cylinder volume is 108.9 ft<sup>3</sup>. We will consider the effect on the free volumes at the steam chest conditions (assume 212°F) and the 5% free volume condition (250°F). The densities for UF<sub>6</sub> at 250°F and 212°F are 203.3 lb/ft<sup>3</sup> and 212.7 lb/ft<sup>3</sup>.

T (°F)	Free Volume (%)	
	No Overfill	500 lb Overfill
212	9.2	7.1
250	5	2.7

~~21 1985~~

William T. Crow

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### 14-Ton Cylinder, Model 48Y

The net weight of  $UF_6$  is specified as 27,560 lb, and the minimum cylinder volume is 142.7 ft<sup>3</sup>. A comparison table is again presented:

T (°F)	Free Volume (%)	
	No Overfill	500 lb Overfill
212	9.2	7.6
250	5	3.3

### CONCLUSION

This analysis indicates that safety margins are reduced but hydraulic rupture would not be expected. However, it is noted that the recommendations of ORO-651 for removing  $UF_6$  from an overfilled cylinder is to use an evacuation system. This analysis should not be construed as an endorsement for heating overfilled  $UF_6$  cylinders.

  
William H. Lake

### Specific Replies to Questions

1. If a UF<sub>6</sub> cylinder is overfilled by 100-200 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?

#### RESPONSE

Any overfilling decreases the void space and, therefore, decreases to an extent the margin of safety (see Mr. Pryor's, DOE-ORO, testimony at the March 14, 1986, Synar hearing). A cylinder overfilled by 100-200 pounds and heated to 212°F would have approximately 9 percent free void space and would not be expected to fail due to hydraulic rupture.

2. If a UF<sub>6</sub> is overfilled by 500-1000 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?

#### RESPONSE

With the assumption noted above, a cylinder overfilled by up to 1000 lbs. of UF<sub>6</sub> to 212°F would have approximately 5 percent void space for a 10-ton cylinder and approximately 6 percent void space for a 14-ton cylinder. The cylinders would not be expected to fail due to hydraulic rupture. The margin of safety would have been reduced to less than that of Question 1.

3. If a UF<sub>6</sub> cylinder is overfilled in excess of 1000 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?

#### RESPONSE

Heating any cylinder that has zero void space at 212°F could result in the hydraulic rupture and the release of its contents to the environment. Assuming minimum cylinder volumes of 108.9 ft<sup>3</sup> (10-ton) and 142.7 ft<sup>3</sup> (14-ton) and a UF<sub>6</sub> density of 212.7 lb/ft<sup>3</sup> at 212°F, the staff calculates that the maximum amount of UF<sub>6</sub> that can be placed into each cylinder is 23,163 pounds (10-ton) and 30,352 pounds (14-ton). This is an overfill of 2,133 pounds for a 10-ton and 2,792 pounds for a 14-ton cylinder. Anything in excess of those quantities could result in hydraulic rupture of the cylinder. Lesser quantities would not be expected to cause failure due to hydraulic rupture. However, the margin of safety would be progressively lowered as the quantity of overfill is progressively increased.

4. Sequoyah Fuels Facility Procedure N-280-1, Revision 6, indicates that cylinder filling must be stopped when it reaches 100 pounds above the maximum allowable for the cylinder being filled. Further, that the overfill should then be evacuated without heating until the maximum net weight is attained. If the management of Sequoyah Fuels Facility either

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tacitly or knowingly condoned or otherwise allowed the routine violation of this portion of Procedure N-280-1, Revision 6, is this a safety problem relative to the competency and/or integrity of the licensee management?

RESPONSE

Cylinders overfilled by no more than 100 pounds of UF<sub>6</sub> would not be expected to rupture when heated to 212°F because they will still have a free void space of approximately 9 percent. Accordingly, the practice of filling to no more than 100 pounds above the maximum allowable in Procedure N-280-1 for the cylinder and evacuation after heating does not constitute a threat of hydraulic rupture of the vessel and is not a safety problem from a scientific or technical perspective. However, the heating of an overfilled cylinder is specifically prohibited by the operating procedure. Therefore, this is a violation of the license.

In addition, any willful violation of required procedures by licensee employees is a safety problem that could raise questions about the competency and/or integrity of the licensee's management. The degree of significance of the problem depends, in part, upon the degree of knowledge of the management involved and the level of management involved. If a willful violation routinely occurred without management knowledge or involvement, it could raise questions regarding managements competence because of the lack of attention to the details of plant operations or perhaps a lack of appropriate knowledge by licensee management of required procedures or recognition of the importance of conformance with required procedures. A serious lack of management attention to the details of plant operations at Sequoyah Fuels has already been identified by the staff as a contributing factor to the accident.

If OI determines that willful violations of required procedures by employees were routinely occurring with management knowledge or involvement, such a finding raises questions about the integrity of the management individuals involved.

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

August 12, 1986

MEMORANDUM FOR: *Victor Stello, Jr.*  
Executive Director for Operations

FROM: *Ben B. Hayes*  
Ben B. Hayes, Director  
Office of Investigations

SUBJECT: OI INVESTIGATION INVOLVING KERR-MCGEE/SEQUOYAH FUELS CORPORATION (4-86-005)

At your request, the Office of Investigations (OI) is currently conducting an investigation involving Kerr-McGee Corporation and the Sequoyah Fuels Facility. The field work has essentially been completed and the Report of Investigation is presently being written. In order to complete this report and to assist in arriving at a meaningful conclusion, it has become apparent that several questions of a technical nature need to be addressed. These questions are as follows:

1. If a UF6 cylinder is overfilled by 100 - 120 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?
2. If a UF6 cylinder is overfilled by 500 - 1000 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?
3. If a UF6 cylinder is overfilled in excess of 1000 pounds and heated without first evacuating the overfill, is this a safety problem? To what degree?
4. Sequoyah Fuels Facility Procedure N-280-1, Revision 6, indicates that cylinder filling must be stopped when it reaches 100 pounds above the maximum allowable for the cylinder being filled. Further, that the overfill should then be evacuated without heating until the maximum net weight is attained. If the management of Sequoyah Fuels Facility either tacitly or knowingly condoned or otherwise allowed the routine violation of this portion of Procedure N-280-1, Revision 6, is this a safety problem relative to the competency and/or integrity of the licensee management? To what degree?

In view of the importance expressed by your staff of OI completing this investigation expeditiously, it is requested that the responses from your staff be forwarded to this office at the earliest convenience.

cc: J. Davis, NMSS  
R. Martin, Region IV  
D. Driskill, OI:RIV

EDO --- 002051

NMSS/Real Cash Material

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G. Thompson

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