TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

January 31, 1984

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket No. 50-390
Tennessee Valley Authority	)	

Please refer to D. G. Eisenhut's letter to "All Applicants for Operating Licenses and Holders of Construction Permits for Power Reactors" dated July 5, 1983 (Generic Letter 83-26) which transmitted revised Technical Specification Surveillance Requirements for the diesel fuel impurity level tests.

Through discussions with other utilities, TVA was made aware of efforts being pursued by the Standardized Nuclear Unit Power Plant System (SNUPPS) to propose more prudent Technical Specification Surveillance Requirements with respect to the subject diesel fuel impurity level tests. Having reviewed the NRC Technical Specification revisions and the recommended surveillance requirements/ supporting technical justifications resulting from the SNUPPS efforts, we wish to endorse the proposed changes/technical justifications developed through SNUPPS (see enclosed report). Accordingly, we request that the Watts Bar Nuclear Plant unit 1 Technical Specifications be revised consistent with the recommended changes identified in the enclosed report.

If you have any questions concerning this matter, please get in touch with D. B. Ellis at FTS 858-2681.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L.M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 31st day of January 1984

Paulette H. White

Notary Public
My Commission Expires 9-5-84

Enclosure

cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Mr. James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

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SURVEILLANCE REQUIREMENTS FOR EMERGENCY DIESEL FUEL OIL SYSTEMS IN NUCLEAR POWER PLANTS

Prepared for SNUPPS

by

Kurt H. Strauss, Consultant

September 23, 1983

116 Hooker Avenue
Poughkeepsie, NY 12601

I. INTRODUCTION

On July 19, 1983 the writer was requested by Standardised Nuclear Unit Power Plant System (SNUPPS) of Rockville, Maryland to review the surveillance requirements of the Emergency Diesel Fuel Oil System as stated in Standard Technical Specification 4.8.1.1.2 in the light of other government and industry fuel quality control procedures. The writer was further requested to recommend possible revisions which would result in a prudent and complete surveillance program. This report is in reply to the SNUPPS request.

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II. PROPOSED SURVEILLANCE REQUIREMENTS

4.8.1.1.2.d. By sampling new fuel oil in accordance with ASTM D4057 prior to addition to storage tanks and:

(1) By verifying in accordance with the tests specified in ASTM D975-81 prior to addition to the storage tanks that the sample has:

(a) An API Gravity of within 0.3 degrees at 60°F or a specific gravity of within 0.0016 at 60/60°F, when compared to the supplier's certificate or an absolute specific gravity at 60/60°F of greater than or equal to 0.83 but less than or equal to 0.89 or an API gravity of greater than or equal to 27 degrees but less than or equal to 39 degrees,

(b) A kinematic viscosity at 40°C of greater than or equal to 1.9 centistokes, but less than or equal to 4.1 centistokes, if gravity was not determined by comparison with the supplier's certification,

(c) A flash point equal to or greater than 125°F, and

(d) A clear and bright appearance with proper color when tested in accordance with ASTM D4176-82.

(2) By verifying within 30 days of obtaining the sample that the other properties specified in Table 1 of ASTM D975-81 are met when tested in accordance with ASTM D975-81 except that the analysis for sulfur may be performed in accordance with ASTM D1552-79 or ASTM D2622-82.

e. At least once every 31 days by obtaining a sample of fuel oil in accordance with ASTM D2276-78, and verifying that particulate contamination is less than 10 mg/liter when checked in accordance with ASTM D2276-78.

III. RATIONALE FOR PROPOSED SURVEILLANCE REQUIREMENTS

A. Basic Premise

The basic premise for the proposed specification is that the petroleum industry manufactures diesel fuel to ASTM Specification D975 and, although the distribution methods preclude(as a general rule) the supplier from providing a Certificate of Compliance, a low risk of having non-compliant fuel added to the diesel fuel oil storage can be obtained by having a program designed to test for contamination of the fuel which might have taken place during the transmission and distribution process prior to addition to the storage tank. Therefore the parameters tested are those that are most likely to take the delivery and the existing inventory out of specifications due to mixing. The post-addition analysis of the sample provides complete assurance that the fuel oil is maintained well within all the requirements of ASTM D975. The alternate test methods proposed for sulfur are in line with other goverment and industry specifications and sound analytical practices.

Therefore several modifications have been made in the NRC Surveillance Requirements stated in 4.8.1.1.2. The proposed specifications are designed to provide improvement in the level of confidence in the quality of the diesel fuel over the current specifications. The changes include:

a) The substitution of monthly ASTM D2276-78 for Determination of Particulate Contamination in lieu of quarterly ASTM D2274,

b) The substitution of the Free Water and Particulate Content in Distillate Fuel (Clear and Bright Pass/Fail Procedures) by ASTM D4176-82 in place of the Water and Sediment by Centrifuge,

c) The substitution of selected pre-addition inspection tests on all deliveries,

d) The relaxation of the time interval for the complete ASTM D975 tests on all receipts,

e) And the elimination of the ASTM D975 tests every 92 days on the fuel in the storage tank.

B. Surveillance of Deliveries

1. Selection of Inspection Tests

A variety of fuels are present in the transportation system from the refinery onward and can therefore be accidentally delivered in place of diesel fuel. Such misbranding can most readily and reliably be detected as follows:

Delivery of Wrong Product

Product	Detected By
Gasoline (All types)	Gravity and flash point
Jet Fuel (JP-4 type)	Gravity and flash point
Jet Fuel (Jet A type)	Gravity (possibly flash point)
Fuel Oil (Residual-black)	Gravity and appearance
Other (fertilizer etc.)	Appearance and odor

The same products can also be mixed accidentally with diesel fuel and put the diesel fuel off-specification. In such cases specific properties of the diesel will go off-specification first and can be detected as follows:

Delivery of Contaminated, Off-Specification Diesel Fuel

Contaminant	Property to Go Off-Spec	Detected By
Gasoline	Flash point	Flash point
Jet Fuel (JP-4)	Flash point	Flash point
Jet Fuel (Jet A)	Viscosity	Viscosity or comparative gravity*
Fuel Oil (black)	Carbon residue	Appearance
Water	Water and sediment	Clear and Bright
Solids	Water and sediment	Clear and Bright

*direct comparison of terminal shipping gravity versus delivered gravity

Based on the above, the acceptance of the wrong type of fuel or of off-specification fuel can be avoided by the following testing at the time of receipt:

Inspection Tests and Limits

A. If gravity is available from the delivering terminal

1. Comparative gravity - within $\pm$ 0.3°API ($\pm$0.0016 sp gr)
2. Appearance - clear and bright and proper color
3. Flash point - 125°F minimum

B. If comparative gravity is not available

1. Gravity - 27 to 39°API at 60°F(0.83 to 0.89 sp gr at 60/60°F)
2. Appearance - clear and bright and proper color
3. Flash point - 125°F minimum
4. Viscosity - 1.9 to 4.1 cs at 40°C

The proposed revised STS then requires obtaining complete ASTM D975 tests on each delivery by a qualified laboratory. Because of the high degree of protection afforded by the delivery inspection program, allowing 30 days for complete specification verification as a double check is considered appropriate.

2. Reasons for Selection of Inspection Tests

Some of the tests selected, such as flash point or viscosity, are part of the diesel specification D975. However other tests such as gravity are not limited by D975 and typical values are used for screening limits. Such typical tests are published annually by the DOE Bartlesville Energy Technology Center[1]. The detailed reasons for test selection follow.

Gasolines have API gravities higher than 55 (sp gr below 0.76) and flash points below room temperature. A 1% addition of gasoline to diesel fuel lowers the flash point about 40°F and below specification minimum. Other diesel tests degrade at a much slower rate and flash point is therefore the most sensitive gasoline contamination indicator.

Jet Fuel (JP-4 type) has a specification gravity range of 45 to 57°API (sp gr of .775 to 0.802) and a flash point at or below room temperature. A 1% contamination in diesel fuel decreases the flash point about 20°F. Again flash point is the most sensitive contamination indicator.

Jet Fuel (Jet A type) has a specification gravity range of 37 to 51°API (sp gr of 0.775 to 0.840) and a minimum flash point of 100°F. Actual typical minimum gravities tend to be around 40°API (sp gr of 0.825) and minimum flash points of 115 to 125°F. Considerable mixing of Jet A and 2D is therefore possible (up to 50% Jet A) before the mixture fails D975. The most critical property is viscosity if a minimum viscosity jet fuel (about 1.0 cs at 40°C) is mixed with a minimum viscosity 2D with a viscosity of 1.9 cs at 40°C. Although such circumstances are unlikely a viscosity determination eliminates the possibility.

Fuel Oil (black) - residual fuels are carried in completely segregated systems and contamination of distillates is rare. If contamination occurs it tends to be in systems which have been switched from black fuel to distillate service and improperly cleaned. The primary adverse effect will be on carbon residue which is typically about 8% for No. 6 fuel. Thus approximately 5% residual fuel equals the 0.35% maximum of D975. However less than a 5% presence of black fuel can be detected by the clear and bright test.

Other products such as fertilizer solutions, occasionally handled in petroleum terminals, are water-soluble and are readily detected by their appearance and odor.

3.Modifications of Specification Tests

The purpose of the proposed change to STS 4.8.1.1.2.e.2) is to allow the use of additional test methods for the measurement of sulfur content. Presently ASTM D975 permits only D129 (Bomb method) for sulfur determination. However many laboratories use other, more rapid methods and use D129 only in cases of dispute. Both the Federal diesel specification, VV-F-800C, and ASTM D396, Specification for Fuel Oil, permit the use of D1552 (High Temperature) and D2262 (X-Ray Spectroscopy) for the No. 2 grade. These methods are therefore proposed as alternates with D129 to be run in case of dispute.

STS 4.8.1.1.2.d. requires the use of D270-75 for obtaining fuel samples. Reference to the latest ASTM Book of Standards indicates that D270 is to be dropped in 1984 because it has been replaced by D4057-81, entitled Standard Practice for Manual Sampling of Petroleum and Petroleum Products and by D4177-82, Automatic Sampling of Petroleum and Petroleum Products. Since D4057 is the manual sampling portion of D270-75, this editorial change is recommended to assure a readily available ASTM method for sampling.

C. Surveillance of Fuel in Storage

The preceding has dealt with assuring on-specification product into storage. It is now necessary to establish the testing required of fuel in storage to assure satisfactory quality fuel going to the diesel engine.

A large body of literature, dating back to the 1950's, proves changes in fuel characteristics during extended storage to involve the oxidation of very low concentrations of heteroatoms containing nitrogen, sulfur and/or oxygen[2,3,4,5] and not to affect the overall composition of the fuel. In turn those properties which depend on overall composition are not affected by storage. Such specification properties, including sulfur, flash point, cloud point, carbon residue, ash, distillation, viscosity and cetane number, will only change through the inadvertent addition of other petroleum products[2,3]. Certain aenerobic, sulfate-reducing bacteria can liberate hydrogen sulfide and cause fuel to fail copper corrosion, but such bacteria are kept from growing by constant water removal[6] and furthermore their presence is readily detected by the foul odor and black color of the water bottom samples.

With regard to fuel cleanliness the presence of water is checked for and, if present, is removed every 92 days or more frequently per 4.8.1.1.2.b and c. These procedures are also effective against other microorganisms which like all other living things need water to exist. Sediment can and does form after extended storage [2,3,4,5,7,8] and is therefore monitored by a sensitive test for particulates (ASTM D2276). Given enough time the total sediment, including the particulates delivered in the fuel plus any insolubles formed in storage, can reduce the life of the engine filter. Although duplicate filters may be provided the measurement of fuel solids level upon every delivery and at least every 92 days provides the type of redundancy needed for a critical system such as the Emergency Diesel Generator.

The Federal diesel fuel specification, VV-F-800C, contains a particulate maximum of 10 mg/liter or approximately 10 parts per million. Much of the 2D purchased under this specification is used in high speed diesels with single filters and particularly critical filtration requirements. Because of the flexibility of the Emergency Diesel System such an arbitrary limit based on differing experience is not desirable and the development of limits for each set of Emergency Systems is much more appropriate. However such limits can only be established after operating experience is available. This proposal therefore recommends starting operations with a very conservative maximum particulate limit of 10 mg/l and then using acceptable filter life as the criterion for an acceptable contamination alert level. In other words, if engine filter life becomes unacceptably short at some contamination level, a lower concentration should be used as the alert level at which corrective action should be taken. Such action could include the recirculation of the fuel in the storage tank through a permanent or temporary filter between the storage and day tanks.

D. Changes from NRC Surveillance Requirements

Several modifications have been made in the NRC Surveillance Requirements stated in STS 4.8.1.1.2. The changes include the substitution of ASTM D2276 for ASTM D2274, the substitution of ASTM D4176, Clear and Bright test, for ASTM D1796, Water and Sediment by Centrifuge, the addition of some inspection tests and the elimination of complete ASTM D975 tests on storage every 92 days.

In assessing fuel cleanliness the actual solids content is of paramount interest and the use of ASTM D2274 is not recommended because of the design of the test. D2274 is a high temperature oxidation test in which fuel is prefiltered and then exposed to pure oxygen at high temperature (203^{o}F) for 16 hours. The resultant deposits and solids are recovered and weighed. The test does not indicate the solids actually in the fuel - these are removed in the prefiltration step - but is intended to predict the oxidative stability by severely accelerating the test conditions. However, as pointed out in Section X3.6.4 of ASTM D975-81, the relationship between fuel suitability in storage and the results of accelerated tests such as D2274 is tenuous. The poor relationship between storage performance and D2274 results have also been reported by several research teams[4,5,7]. Although the basic problem is one of oxidation a number of investigations have indicated that oxidation mechanisms change as temperatures increase, thereby forming the basis for the unreliability of the high temperature tests[4]. Unfortunately the only test considered reliable has to be run for a number of weeks at 43.3^{o}C and is therefore only useful as a research tool. There is no agreement in the industry on the suitability of any accelerated oxidation test. The recommendation of monthly D2276 in place of quarterly D2274 recognises this state of the art and concentrates on the measurement of actual solids which are the primary concern in operating a satisfactory fuel system. Neither D2276 nor D2294 are recommended on receipts because test results are available only after the delivery is completed and cannot be used to accept or reject the delivery. Instead the Clear and Bright test is required as the cleanliness acceptance criterion.

The replacement of the Water and Sediment by Centrifuge by the Clear and Bright test is recommended for the following reasons.

The Clear and Bright test is more sensitive to free water. The lower level detection of the centrifuge is 0.025% or 250 parts per million (ppm) while the Clear and Bright test will detect down to 50 ppm. However the actual rejection ratio is closer to 10:1 because D975 permits a maximum of 0.05% or 500 ppm of water in the absence of sediment, while the proposed procedure has a lower limit of 50 ppm.

The Clear and Bright test is also more sensitive to solids because a larger sample is examined directly. Running the centrifuge test, on the other hand, requires at least one container transfer and a sample size reduction, thereby increasing the uncertainty of having a representative sample and particularly creating the problem of removing all solid particles from the original sample container and assuring their presence in the centrifuge tube.

By running the Clear and Bright test on site there is the additional advantage of being able to resample immediately in case of a questionable result.

Lastly the centrifuge test is run at 120°F, thereby possibly allowing a water haze to go into solution due to the increase in temperature. The Clear and Bright test is conducted at ambient temperature and a haze would be cause for fuel rejection on delivery. There is also the possible problem of free water removal by the toluene diluent if the toluene is not completely water saturated as required by D1796.

In this connection it should be noted that the Clear and Bright test has been used very extensively for many years before its standardisation by ASTM and has proven to be a simple and reliable procedure.

The changes in inspection tests on fuel receipts have been explained in detail in Section IIB, while the deletion of complete D975 tests every 92 days is covered in Section IIC. The Water and Sediment by Centrifuge, required every 92 days, is considered to have been replaced and the surveillance tightened by measuring particulate content by ASTM D2276 every 31 days, by checking all receipts for free water and particulates by ASTM D4176 and by checking for and removing water from the storage and day tanks every 31 days.

E. Bibliography

[1] EM Shelton, "Diesel Fuel Oils, 1982", DOE/BETC/PPS-82/5, Bartlesville Energy Technology Center, US Department of Energy, Bartlesville, OK, published November 1982.

[2] Anon., "Fundamentals of Petroleum", Bureau of Naval Personnel, NAVPERS, pp 88 et al, 1953.

[3] "Symposium on Stability of Distillate Fuel Oils", American Society for Testing and Materials, ASTM Special Technical Publication STP 244, Philadelphia, June 1958.

[4] MQ Garner and EW White, "Correlation of Long-Term Storage and Accelerated Stability Tests", ASTM Special Technical Publication STP 751, Philadelphia, 1981*.

[5] LL Stavinoha and SR Westwood, "Accelerated Stability Test Techniques for Middle Distillate Fuels", ASTM Special Technical Publication STP 751, Philadelphia, 1981*.

[6] ES Littman, "Microbiological Contamination of Fuels During Storage", ASTM Special Technical Publication STP 751, Philadelphia, 1981*.

[7] LL Stavinoha, SR Westbrook and ME LePera, "Army Needs for Diesel Fuel Stability and Cleanliness", ASTM Special Technical Publication STP 751, Philadelphia, 1981*.

[8] JF Boyle, RP Lane, T McGee and EW White, "Navy Needs and Experience with Distillate Fuel Stability and Cleanliness", ASTM Special Technical Publication STP 751, Philadelphia, 1981*.

* ASTM Special Technical Publication 751 is entitled "Distillate Fuel Stability and Cleanliness" and is edited by LL Stavinoha and CP Henry. It is the record of a symposium and contains these papers.

Note: The above ASTM references can be obtained from the Publications Department, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA, 19103.

KURT H. STRAUSS
CONSULTANT QUALIFICATIONS

Employment

U. S. Army	1943-1946
Texaco Inc.	1949-1982
Consultant	1982-

Schools

U. S. Army ASTP, Oklahoma State U.	1943
U. S. Army, U. of Biaritz, France	1945
U. of Connecticut, BSME magna cum laude	1946-1949
Rolls Royce Dart Engine School	1952
General Electric CJ805 Engine School	1954

Work as Consultant

Prepared analysis report on the temperature relationship between diesel vehicle fuel temperature and ambient temperature in winter conditions under US Army MERADCOM contract. Report is currently under review prior to public release.

Acting as technical coordinator and expert witness in two cases involving insurance claims and litigation regarding fuel contamination in marine transport.

Acting as official fuel consultant to the Federal Aviation Agency.

Served as panel chairman and session summariser in a Naval Research Laboratory symposium on middle distillate instability in October 1982.

Acted as aviation fuel consultant to major oil company (BP North America).

Continuing as committee chairman in several ASTM committees and maintaining active participation in Coordinating Research Council.

Prepared quality control program for emergency diesel fuel system in nuclear power plant.

Prepared extensive section on Aviation Turbine Fuels for 1984 edition of Ullman's Encyclopedia for Industrial Chemistry.

Job Assignments with Texaco

Retired as Senior Technologist on Products Staff of Research, Environment and Safety Department

Coordinated Texaco aviation fuel research activities for last 15 years and middle distillate research for last 5 years.

Represented Texaco at national and international levels in technical matters, including specification and test method preparation and research trends.

Directed laboratory investigations of aviation and middle distillate fuel field problems.

Established quality standards in Texaco Aviation Fuel Quality Control Procedures and Texaco Marine Cargo Manual. Represented Research Department in preparation and updating of these operational documents.

Served as expert witness in litigation and assisted Legal Department in preparation of cases.

Held approval for Texaco of aviation and middle distillate fuel test methods and specifications.

Responsible for following technical developments in fuel cleanup and monitoring procedures and introducing them into Texaco system.

Made forecasts of future quality requirements of aviation and middle distillate fuels for corporate planning use.

Directed preparation and introduction of new Petroleum Volume Correction Tables within Texaco.

Reviewed and approved for Texaco all Coordinating Rearch Council reports on aviation and diesel fuels.

Served as consultant to several US Goverment agencies icluding the US Air Force, NASA and the FAA.

Industry Committee Memberships

ASTM Committee D 02 on Petroleum Products since 1981

ASTM Technical Division J on Aviation Fuels since 1967

Chairman of Specification Review Panel since 1973

Chairman of Section VII- Combustion since 1980

Chairman of Filter Membrane Approval Panel from 1973 to 1980

Prepared Membrane Approval procedure (RR D 02- 1127)

Organiser and Chairman of ASTM Symposium on "Factors in Using Kerosine Jet Fuels of Reduced Flash Point", December 1977.

Coeditor of Symposium proceedings (STP 688)

Organiser and Chairman of ASTM Symposium on "Can Jet Fuel Cleanliness be Specified?" - December 1982

Author of Standard Practice for Aviation Fuel Sampling Containers for Tests Affected by Trace Contamination and accompanying research report.

Member of following ASTM Technical Division J Sections since 1967

Advisory Section (since 1977)

Section I - Jet Fuel Specifications

Section II - Aviation Gasoline Specifications (formed in 1979)

Section VII - Combustion (presently chairman)

Section VIII - Oxidative Stability

Section X - Fuel Cleanliness

Section XI - Electrical Characteristics

Served on numerous task forces over the last 15 years

ASTM Technical Division E on Burner, Diesel and Gas Turbine Fuels from 1972 to 1976 and from 1980 to date.

Member of following Technical Division E Sections

Section I - Burner Fuels

Secretary from 1974 to 1976

Task Force on Kerosine Specification

Section II - Diesel Fuel

Section III - Gas Turbine Fuel

Section V - Fuel Stability and Cleanliness

Coordinating Research Council (CRC)

Member of all fuel groups since 1961. Groups include oxidative stability,combustion, low temperature flow, electrical charging, safety, fuel-water separation, lubricity, aviation fuels handbook, fuels from alternative sources and supersonic fuel.

Leader of Group on Electrical Charging of Aviation Fuels since 1972

Leader of Group on Water Separation of Aviation Fuels from 1970 to 1976

Chairman of CRC Aviation Committee from 1978 to 1983

International Air Transport Association (IATA)

Member of Fuels Subcommittee from 1967 to 1982

American Petroleum Institute

Aviation Technical Services Committee from 1962 to 1968

Wrote specification for cleanliness monitor
Joint author of API bulletins on airport fuel system operation

Petroleum Measurement Committee from 1980 to 1982

Leader of Task Force on Low Temperature Volume Correction Tables

Leader of Task Force on Lubricating Oil Volume Correction Tables

National Aeronautics and Space Administration (NASA)

Member of Ad Hoc Panel on Jet Engine Hydrocarbon Fuels from 1974 to 1976

Federal Aviation Administration

Official Fuel Consultant since April 1983

Honors and Awards

NASA Certificate of Appreciation in 1976

ASTM Certificate of Appreciation in 1982

Life member of Tau Beta Pi - Honorary Engineering Society

Member of Fellowship Board from 1973 to 1983

Life member of Sigma Xi - The Research Society of America

Professional Memberships

American Society for Testing and Materials (ASTM)

Society of Automotive Engineers

Member of Fuels and Lubricants Committee from 1974 to 1978

Coordinating Research Council

Presentations and Briefings

Made presentation on US aviation fuel research to Ministry of Defence in London in 1979

Made numerous briefings and presentations on aviation fuel cleanliness, safety and availability to major aircraft engine, airframe and accessory companies as well as airlines

Made presentations on present and future quality of diesel fuels to US and off-shore diesel engine manufacturers

Publications

See attached listing

Publications

1. Strauss KH, "US Diesel Fuels- Present and Future", Texaco report, September 1981

2. Strauss KH, "Future US Jet Fuel- A Refiner's Viewpoint", presented at 1981 International Air Transportation Conference, Atlantic City NJ, May 23- 28, 1981, AIAA Paper 81- 0770

3. Strauss KH, "Jet Fuel Trends in the US", presented at the Air Force Energy Symposium, San Antonio TX, October 21- 23, 1980

4. Strauss KH, Dukek WG, "Factors in Using Kerosine Jet Fuel of Reduced Flash Point", ASTM Special Technical Publication STP 688, Philadelphia PA, 1979

5. Strauss KH, Dukek WG and Leonard JT, "Charge Generation by US Commercial Aircraft Fuels and Filter- Separators", presented at the Lightning and Static Electricity Conference, London, England, March 10, 1975. Also presented at the NFPA National Meeting,Chicago IL, May 12, 1975

6. Dukek WG, Langston RE and Strauss KH, "Electrostatic Charging Characteristics of Jet Fuel Filtration Equipment", presented at SAE National Aerospace Engineering and Manufacturing Meeting, San Diego CA, October 2- 5, 1972, Paper SAE No. 720866. Published in SAE Transactions Vol. 81 (1972)

7. Strauss KH, "Future Availability of Wide- Cut Jet Fuels", Texaco report, January 1971

8. Strauss KH, Brodie AL and Tobin FE, "Flight Power", Texaco Topics, Vol. 37, No. 1, 1968

9. Strauss KH, "Kerosine- Yesterday, Today and Tomorrow", Texaco report, June 1967

10. Strauss KH, "Factors Affecting the Use of Crude Petroleum and Residual Fuel in Aircraft", Texaco report, July 1966

11. Strauss KH, "Factors in the Use of Middle Distillate Fuels in Aircraft Gas Turbines", Texaco report, June 1965

12. Strauss KH, "Fuel for the Supersonic Transport", presented to the SAE So. California Section, March 8, 1965, SAE Paper 650297. Published in SAE Transactions 1966

13. Strauss KH, "Microbial Contamination of Jet Fuel", Texaco report, January 1965

14. Strauss KH, "Jet Fuel Handling Code", Texaco report (restricted information), 1964

15. Strauss KH, "The Detection of Water in Jet Fuel", presented to the API Aviation Technical Services Committee, Montreal Quebec, June 1963

16. Strauss KH, "Jet Fuels- Present and Future", Texaco report, March 1962

17. Strauss KH, "Fuel Contamination in Jet Aircraft", Texaco report, January 1961

18. Scarberry WF and Strauss KH, "Aircraft Gas Turbine Fuels and Lubricants", published in Petroleum Products Handbook, VB Guthrie, editor, McGraw- Hill, NY NY, 1960

19. Tobin FE, Furman GR and Strauss KH, "Contaminants and Their Effects on Aircraft Engines", presented at SAE Annual Meeting, Detroit MI, January 14- 18, 1957

20. Kuhbach CM, Ritcheske WF and Strauss KH, "Fuel Properties and Jet Engine Combustor Performance", presented at SAE Aeronautic Meeting, Los Angeles CA, October 5- 9, 1954. Published in SAE Transactions Vol. 63 (1955)