ENGINE FUEL STORAGE
OPERATING METHODS

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1. GENERAL

1.01 This section lists requirements for engine fuels for use in stationary engines; describes the use of an inhibitor to stabilize fuels; recommends fuel storage system operating practices; and covers methods of detecting and removing water or inorganic solids in fuel tanks.

1.02 This section is revised to:

(1) Delete KS-19298, L4 inhibitor and add KS-21923, L1 inhibitor

(2) Delete the color comparator requirement at each fuel delivery

(3) Eliminate previous modification to the water drainoff pipe and eliminate use of the water drainoff pipe for measuring free water level of tank

(4) Revise Parts 3 through 6 to include the latest recommended procedures

(5) Revise Table A

(6) Add Table B

(7) Add Figures 1 and 2

(8) Add Appendixes 1, 2, and 3

(9) Change the requirement of pour point temperature to cloud point temperature.

Since this is a general revision, arrows ordinarily used to show changes are omitted. The Equipment Test List is affected.

1.03 Virtually all gas turbine or diesel engine fuels are unsatisfactory for long term storage as delivered by the fuel supplier. KS-21923, L1 fuel inhibitor must generally be added to retard sludge formation and prevent internal corrosion of metal fuel storage tanks. The inhibitor contains a ***stabilizer*** to retard sludge formation; a ***dispersant*** to keep the sludge that does form from agglomerating into large particles that could clog filters; a ***metal deactivator*** to reduce the tendency of metals such as copper, brass, and zinc to accelerate sludge formation; a ***corrosion inhibitor*** to prevent internal tank corrosion; and a ***biocide*** to prevent microbiological growth in the fuel storage system. ***The inhibitor should preferably be added just prior to a fuel delivery to take advantage of the mixing action.***

1.04 At the initial fill and when fuel is added to the tank, the vendor should be cautioned not to introduce dirt into the storage system. If feasible, allow new fuel to settle for at least six hours before starting the engine(s).

> ***DANGER: Keep open flames and sparks away from the fuel and fuel tanks. Partially filled tanks and even empty tanks that have held fuel may contain explosive gases.***

2. APPARATUS

2.01 ***List of Tools and Materials:***

TOOLS

Dipstick, length as required

MATERIALS

KS-21923, L1 Fuel Inhibitor (See paragraph 3.02)

Water Finder Paste, (Renick & Mahoney, Inc., 10 East Grand Blvd., Deer Park, N.Y.)

Sampling Kit (provided by testing laboratory)

3. FUEL REQUIREMENTS

A. Diesel and Gas Turbine Engines

3.01 The preferred fuels for diesel engines are those fuels conforming to the American Society for Testing and Materials Standard D975, grades 1 and 2 as certified by the supplier. The preferred fuels for gas turbine engines are those fuels conforming to the ASTM standard D2880, grade 1-GT. Grade 1-GT fuels will, in general, provide the best possible exhaust quality, longest engine component life, and greater starting reliability. ***It is important for the reliability of the using system that the user specify that the cloud point of the fuel (initial wax appearance point which could clog filters) shall be specified 6°C below the lowest temperature to which the fuel will be subjected.*** This condition can be reversed as the temperature of the fuel increases. Table A summarizes the ASTM specification requirements.

3.02 Fuel inhibitor KS-21923, L1 should be used as covered in Part 7 for all fuels stored for use in diesel or gas turbine engine reserve power plants. Fuel inhibitor KS-19298 is compatible with the KS-21923, L1 inhibitor and existing stocks of KS-19298 should be used up first.

3.03 In emergencies, such as those due to disruption of normal supply sources, diesel fuel oil grade 1 or 2 not known to be in compliance with the above specifications may be used in diesel engines. When normal supply sources are re-established, area supervision should be consulted as to replacement or treatment of any fuel found to be substandard.

3.04 Some gas turbine plants will operate satisfactorily on fuels conforming to ASTM D2880, grade 2-GT. It is recommended that the engine manufacturer be consulted concerning the use of grade 2-GT fuels before such fuels are utilized.

3.05 ***KS-20460 gas turbine-alternator sets are restricted to the use of fuels meeting the requirements of ASTM D2880, grade 1-GT.*** The additional requirement of a luminometer number greater than 40 must also be satisfied. Due to the present design of the combustion system for this set, engine life could be adversely affected by the use of fuels that do not meet these requirements.

B. Gasoline Engines

3.06 For gasoline engines, white (unleaded) gasoline is the preferred fuel. When engine starting becomes difficult because of carburetor gumming, a commercially available gum solvent should be used to clean out the carburetor.

4. RECOMMENDED FUEL STORAGE PRACTICES

A. Maintenance Considerations

4.01 Fuel storage practices for reserve power plants require additional precautions beyond those normally applied to commercial fuel storage systems. The necessity for additional precautions arises primarily because of Bell System requirements that central offices be self-sufficient during extended emergencies.

4.02 The installed fuel storage capacity should be based on the anticipated central office essential load, and not necessarily on installed engine plant capacity and full load consumption rates. Fuel consumption rates at full and partial loads are available for all Bell System standard engine sets in the appropriate engine plant J-specification or Section.

4.03 Part 7 covers the use of fuel inhibitors to extend the useful life of stored fuels. The anticipated useful life of fuels as treated and tested according to this section is expected to be at least 20 years.

4.04 Steel fuel tanks that ***are*** installed should be filled with inhibited fuel and maintained as full as possible to prevent tank corrosion due to condensed atmospheric moisture. Fiberglass tanks are not subject to corrosive failure, but should also be filled with inhibited fuel and maintained according to this section.

4.05 It is of obvious importance to obtain a satisfactory grade of fuel that is free of contaminants, pumpable and pourable at low temperatures, at the initial and subsequent fillings of the fuel storage system. At the initial fill, one gallon of KS-21923, L1 inhibitor per 2000 gallons of fuel should be added to the tank. Obtain a sample for analysis after the fuel has been allowed to settle for six hours. If subsequent test reports indicate that more inhibitor is needed, additional inhibitor should be added as recommended in Table B. Wait 48 hours after additional inhibitor is added to resample the fuel.

B. Laboratory Test Methods

4.06 The recommended tests to be performed by the testing laboratory, together with the test method for each, are listed below and covered in detail in Appendixes 1, 2, and 3.

(a) Particulate Matter and Ash Content (See Appendix 1)

(b) Metal Strip Corrosion (See Appendix 2)

(c) Accelerated Aging (See Appendix 3)

4.07 Fuels remaining in both storage and day tanks shall be sampled and tested ***at least every two years.*** Where usage is such that periodic deliveries of new fuel occur, a sample should be obtained at each fuel delivery and from the storage tank at intervals not to exceed two years.

4.08 This part of the section contains general procedures and requirements without designating a specific testing laboratory. Independent laboratories such as Faber Laboratories, 1115 Venice Blvd., Los Angeles, Calif., 90015; United States Testing Co., Inc., 1415 Park Ave, Hoboken, N.J., 07030; and E. W. Saybolt and Co., Inc., 400 Swenson Dr., Kenilworth, N. J. 07033, can perform these tests according to the specific requirements contained herein. The Test Method Appendixes listed in paragraph 4.06 should be made available to the prospective laboratory.

5. WATER DETECTION AND REMOVAL

5.01 Free water (water not in emulsion with the fuel) will settle to the bottom of fuel storage tanks and must be pumped out.

5.02 Each storage tank must be checked for water accumulation at least once a year and prior to taking a fuel sample for testing. Water accumulation can be determined with a dipstick coated with water finder paste. The dipstick should be coated with water finder paste for at least the bottom six inches of the stick. The dipstick should be inserted through the fill port until it touches the bottom of the tank. (See Fig. 1.)

Warning: Do not drop the dipstick into tanks. Even though some tanks contain local reinforcement below dipstick openings, the bottom of the tank could be damaged.

The instructions provided by the water finder paste manufacturer should be followed in the application of the paste and in interpreting paste color changes.

5.03 Some fuel tanks have water drainoff piping built into the tank and in some cases this pipe is the only tank opening available for inserting the dipstick. In all cases, remove and discard the water drainoff pipe prior to measuring the amount of water in the bottom of the tank.

5.04 A certain amount of water may be expected in any storage tank due to condensation of atmospheric moisture. The accumulation of water is an undesirable condition and any water should be pumped out as often as practicable. In any event, water must be pumped out before it reaches a maximum depth of one half the distance from the bottom of the tank to the bottom of the foot valve. Pump the water from the fill port by using a flexible suction hose or tube.

6. FUEL SAMPLING PROCEDURE

6.01 For best results, samples from the fuel storage tank(s) should be taken at the same level as the foot valve, approximately 3 inches from the tank bottom, using the suction pump furnished

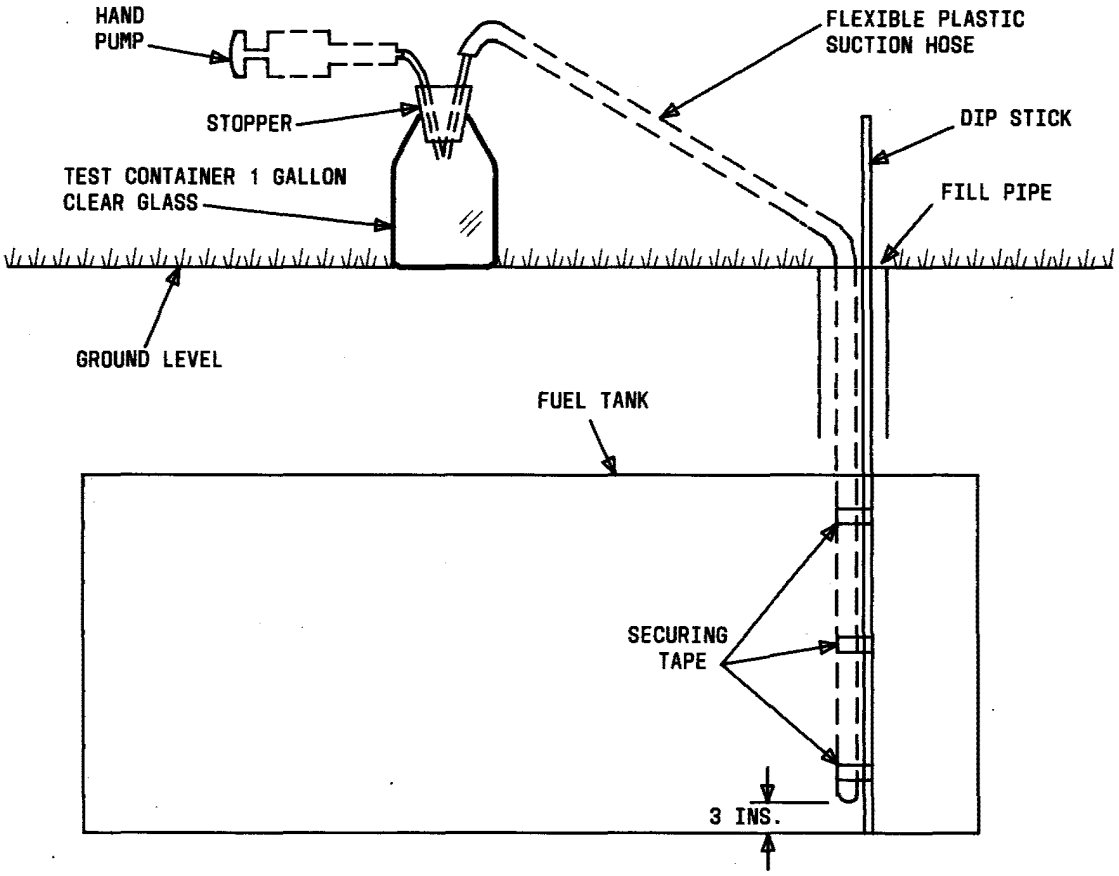

Fig. 1—Typical Sampling Configuration

with the sampling kit. ***Do not use the water drainoff pipe for sampling.*** If no other access port is available, remove and discard the water drainoff pipe and use this tank port for sample taking. Consult the testing laboratory selected as to obtaining a sample kit, sample containers, quantity of sample required, and assistance in taking sample, if required.

6.02 Use Fig. 1 as a typical sampling configuration; obtain fuel sample using the following set of instructions.

(a) Check for water accumulation as in Part 5 and pump all water from the bottom of the tank.

(b) Unpack sampling kit and clean contents with a soft, dry cloth.

(c) Wipe and clean dipstick used for water detection.

(d) Attach flexible hose to dipstick using the tape provided with the kit and making sure that end of hose is about 3 inches from the end of dipstick.

(e) Lower dipstick into tank through sample port until it touches bottom of tank.

(f) Insert stopper securely into neck of test container.

(g) Insert top portion of flexible hose securely into stopper.

(h) Insert hand pump securely into stopper.

(i) Operate hand pump until test container is half filled with fuel. (To stop fuel flow, break vacuum by carefully removing stopper.)

(j) With a swirling action, empty contents of test container into oil waste container. (Do not empty container into fuel tank.)

(k) Reconnect sampling kit and once again operate hand pump until test container is half full. (Break vacuum by carefully removing stopper.)

(l) Transfer fuel sample from test container to sample container furnished by testing laboratory. Leave 25 percent air space in container to allow for vapor expansion. This will prevent bursting from internal pressure.

(m) Place insert and cap securely onto sample container.

(n) Dismantle sampling kit and clean all components with a soft, dry cloth.

(o) Repack sampling kit to make ready for next test sample location.

(p) Fill in mailing label on sample container furnishing as much of the information as possible shown in Fig. 2.

(q) Indicate on the label from what port the sample was taken.

6.03 ***Fuel samples should be sent to the testing laboratory as soon as possible after the sample is taken.*** Fuel samples that are contaminated in some way or mishandled (eg, subjected to excessive temperatures for long periods of time) will not give meaningful test results. Table B provides guidelines as to what action should be taken based on the results of the independent laboratory tests.

6.04 If unable to obtain fuel sample as shown in paragraph 6.02, proceed as follows with alternate sampling procedure.

(a) Determine the first fuel filter location inside the building (in day tank or engine).

(b) Obtain a new filter element if throw away type.

(c) Remove filter element from canister, wipe canister clean and replace with new filter element.

(d) Use wobble pump to refill canister, drain and refill canister as required until a sufficient amount of fuel is obtained for a sample.

(e) Proceed with (i) through (p) of paragraph 6.02.

(f) Test run engine under load for a minimum of 30 minutes to insure proper operation.

DATE OF SAMPLE_____TYPE ENGINE: PISTON_____TURBINE_____

SAMPLE PORT LOCATION_____

LOCATION CODE_____TYPE FUEL: DIESEL_____KEROSENE_____

ADDRESS OF STORAGE TANK LOCATION_____

CITY_____STATE_____ZIP CODE_____

NO. GALLONS IN TANK WHEN SAMPLE TAKEN_____

PREVIOUS SAMPLE DATE_____AREA_____DISTRICT_____

DISTRICT OFFICE ADDRESS_____ROOM NO._____

CITY_____STATE_____ZIP CODE_____

Fig. 2—Typical Sample Container Information Label

(g) Contact the building supervisor and report information on the inaccessibility of sampling port and forward via proper channels so that condition may be corrected.

7. FUEL INHIBITOR

7.01 The KS-21923, L1 inhibitor is a liquid solution of organic chemicals containing stablizers, dispersants, corrosion inhibitor, biocide, and metal deactivators. The inhibitor, when used in recommended quantities, will not interfere with engine operation.

Danger: While the vapor is nontoxic, adequate ventilation should be provided and contact with the skin, eyes, or clothing should be avoided. While contact with the skin generally will not produce excessive irritation, such contact should be held to a minimum. In case of contact with the skin, wash the skin thoroughly with kerosene and then with soap and water. In case of contact with the eyes, the eyes should be flushed with water for 15 minutes and then given medical attention.

8. ON-SITE FUEL FILTRATION

8.01 Fuel supplies that have become contaminated with inorganic solid material such as sand, rust, etc., should be filtered only when the amount of ash content in the sample (taken as prescribed in paragraph 6.02 or 6.04) is in excess of the allowable amount shown in Table B. ***Fuel filtration should never be considered when contaminant is organic,*** in which case inhibitor treatment in this section should be used. Companies such as Fuel Tank Services, Inc., 24244 Cloverlawn, Oak Park, Michigan, 48237 and most major oil companies offer this type of service using mobile pumping and filtration equipment. The fuel is pumped from the storage tank through filters and back into the storage tank. This process of recirculation is continued until the fuel is sufficiently clean. Pumping rates should be high enough to promote strong circulatory currents in the tank to stir up material that has settled to the bottom of the tank and to remove loose material from the tank walls. The filters should be able to remove solid particles down to 1 micron with at least 90 percent efficiency and must also have water removal capability. ***It should never be necessary to discard fuel. For cases not covered by this section, call the Lubrication and Fuel Studies Group of Bell Laboratories, Murray Hill, N. J.***

TABLE A

COMPOSITE LIST OF FUEL OIL SPECIFICATIONS

GRADE OF FUEL OIL	FLASH POINT, DEG C (DEG F) MIN	POUR POINT, DEG C (DEG F) MAX	WATER AND SEDIMENT, VOLUME PRECENT MAX	CARBON RESIDUE TO 10 PERCENT BOTTOM, PERCENT MAX	ASH, WEIGHT PERCENT MAX	DISTILLATION TEMPERATURES, DEG C (DEG F) 10 PERCENT POINT MAX	DISTILLATION TEMPERATURES, DEG C (DEG F) 10 PERCENT POINT MIN	DISTILLATION TEMPERATURES, DEG C (DEG F) 90 PERCENT POINT MAX	SAYBOLT VISCOSITY, & UNIVERSAL AT 38C (100 F) MIN	SAYBOLT VISCOSITY, & UNIVERSAL AT 38C (100 F) MAX	KINEMATIC VISCOSITY, cSt AT 38C (100 F) MIN	KINEMATIC VISCOSITY, cSt AT 38C (100 F) MAX	GRAVITY DEG API MIN	COPPER STRIP CORRISON MAX	SULFUR, PERCENT MAX	CETANE NUMBER MIN	VANADIUM (V), PPM BY WEIGHT MAX	SODIUM PLUS POTASSIUM (NA + K), PPM BY WEIGHT MAX	CALCIUM (C2), PPM BY WEIGHT MAX	LEAD (PO), PPM BY WEIGHT MAX	LUMINOMETER NUMBER MIN	SMOKE POINT MIN
ASTM D 396, No. 1	38 (100)	(0)*	trace	0.15	—	215 (420)	—	288 (550)	—	—	1.4	2.2	35	No. 3	0.5	—	—	—	—	—	—	—	—
ASTM D 975, No. 1-D	38 (100)	†	0.05	0.15	0.01	—	—	288 (550)	—	34.4	1.4	2.5	—	No. 3	0.5	40‡	—	—	—	—	—	—	—
ASTM D 2880, No. 1-GT	38 (100)	-18*,† (0)	0.05	0.15	0.01	—	—	288 (550)	—	34.4	1.4	2.5	35	—	0.5	—	2	5	5	5	40	—
EMS 66A (Allison Spec)	38 (100)	†	0.05	0.15	0.01	—	—	288 (550)	—	—	—	2.5	35	—	0.5	—	2	5	5	5	40	—
ASTM D 396, No. 2	38 (100)	-7 (20)*	0.05	0.35	—	—	282 (540)*	338 (640)	32.6	37.93	2.0*	3.6	30	—	0.5	40‡	—	—	—	—	—	—	—
ASTM D 975, No. 2-D	52 (125)	†	0.05	0.35	0.01	—	282 (540)†	338 (640)	32.6	40.1	2.0*	4.3	—	No. 3	0.5	—	—	—	—	—	—	—	—
ASTM D 2880, No. 2-GT	38 (100)	-7*,† (20)	0.05	0.35	0.01	—	282 (540)	338 (640)	32.6	40.2	2.0	4.3	30	—	0.5	—	2	5	10	5	—	—

ASTM D 396 — Home Heating Fuel

ASTM D 975 — Diesel Fuel

ASTM D 2880 — Gas Turbine Fuel

ASTM D 2880 — No. 2 — Gas Turbine Fuel

EMS 66A — Gas Turbine Fuel

Notes:

* Lower or higher pour points may be specified whenever required by conditions of storage or use. When a pour point less of than - 18°C(0° F) is specified, the minimum viscosity shall be 1.8 cSt (32.0 SUS) and the minimum 90 percent point shall be waived.

† For cold weather operation the pour point for this specification should be specified 6°C below the lowest ambient temperature expected in the area where the fuel is to be used.

‡ Low-atmospheric temperatures as well as engine operation at high altitudes may require use of fuels with higher cetane ratings.

TABLE B

GUIDELINES FOR INTERPRETING FUEL TEST REQUIREMENTS

TEST	CONDITION	RECOMMENDED ACTION
Water Content	Any Visible Water	Draw Water off Bottom and Resample.
Accelerated Aging (App. 3)	Stability No. Reported:	
	0.0 - 7.0	None
	8.0 - 10.0	Add 1 Gal. KS-21923, L1 per 2000 Gal. of Fuel.
	11.0 - 15.0	Add 1 Gal. KS-21923, L1 per 1000 Gal. of Fuel. See Note 1.
	>15.0	Add 1 Gal. KS-21923, L1 per 500 Gal. of Fuel. See Note 1.
Particulate Matter (App. 1)	Particulate Matter Greater Than 2.0 mg/100 cc of Sample	Have Ash Content Test Run.
Ash Content (App. 1)	Ash Content over 1.0 mg/100 cc of Sample	Fuel Must Be Scheduled for Filtration. See Note 2.
Metal Strip Corrosion (App. 2)	If Fuel Does Not Pass Corrosion Test	Add 1 Gal. KS-21923, L1 per 2000 Gal. of Fuel. See Note 3.

Note 1: Resample after 48 hours. If results show stability number greater than 7.0, reinhibit according to the above.

Note 2: Resample and confirm before filtering. If filtering is required, resample and confirm reduced particulate after filtering.

Note 3: Resample after 48 hours. If corrosion test fails, reinhibit according to the above.