

# IEEE Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers

Sponsor

**Transformers Committee  
of the  
IEEE Power Engineering Society**

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**IEEE-SA Standards Board**

**Abstract:** The evaluation and handling procedures for less flammable hydrocarbon transformer insulating fluids are covered. The guide's purpose is to assist the transformer operator in receiving new fluids, filling transformers, and maintaining the fluids in serviceable condition.

**Keywords:** high molecular weight hydrocarbon fluid, HMWH fluid, hydrocarbon fluid, insulating fluid, less flammable hydrocarbon fluid, LFH fluid, transformer

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## Introduction

(This introduction is not a part of IEEE Std C57.121-1998, IEEE Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers.)

This guide was prepared by the Insulating Fluids Subcommittee of the Transformers Committee of the IEEE Power Engineering Society. The purpose of this guide is to identify standards for acceptance and maintenance of high-temperature hydrocarbon fluids in transformers.

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# IEEE Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers

## 1. Overview

### 1.1 Scope

This guide recommends tests<sup>1</sup> and evaluation procedures, as well as criteria and methods of maintenance, for less flammable hydrocarbon (LFH) transformer insulating fluids. These liquids are also known as high molecular weight hydrocarbon (HMWH) fluids. HMWH dielectric fluids are hereby defined as those fluids having an ASTM D92 fire point of 300 °C or greater, being primarily composed of, but not restricted to, hydrocarbons. These fluids meet the requirements of the National Electrical Code® (NEC®) (NFPA 70-1999),<sup>2</sup> Article 450-23, as a less flammable dielectric for use in indoor applications when used in properly designed and installed transformers. Ester- and silicone-based fluids are not covered by this guide. Methods of reconditioning LFH fluids are also described. It is not the intent of this guide to address retrofilling transformers with LFH fluids. Any such substitution of fluids should be performed only after consultation with the manufacturers of fluid and equipment. Where instructions given by the transformer or fluid manufacturers differ from those given in this guide, the manufacturer's instructions are to be given preference.

### 1.2 Purpose

The purpose of this guide is to assist the transformer operator in evaluating and processing LFH fluids received in new transformers, as received from the fluid manufacturer for filling transformers, and as processed into such equipment. It also assists the operator in maintaining the fluid in serviceable condition. This guide, therefore, recommends standard tests and evaluation procedures, methods of reconditioning and reclaiming LFH fluids, and the analysis results at which these processes become necessary. It will also address the routines for restoring resistance to oxidation, where desired, by the addition of inhibitors.

<sup>1</sup>All test methods used to evaluate LFH fluids should be the latest versions available from the American Society of Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA, 19428-2959, USA (<http://www.astm.org/>).

<sup>2</sup>Information on references can be found in Clause 2.

## 1.3 System design

The reliable performance of LFH fluids in an insulation system depends upon certain basic fluid characteristics that can affect overall apparatus characteristics. Such fluid characteristics are integral to equipment design for which the manufacturer has final responsibility. The reliable operation of the equipment in service, for which the transformer operator has final responsibility, also depends on maintaining certain basic fluid characteristics. Adherence to the recommended fluid characteristics will assist in obtaining the desired equipment characteristics. Other tests or verification of the integrity of the insulation system are often necessary.

The essential properties of insulating fluids used in transformers must be maintained if the fluid is to perform its multiple role as an electrical insulating and heat transfer agent. It must have adequate dielectric strength to withstand the electric stresses imposed in service. It must have a certain combination of thermal conductivity, specific heat, and viscosity so that its ability to transfer heat is sufficient for the particular equipment. It must have sufficiently high flash point and fire point to meet safety requirements. The fluid's dielectric losses should not become excessive. The LFH fluid should not be allowed to become so deteriorated or contaminated that it adversely affects other materials in the apparatus, nor should deterioration products (sludge) impair its circulation through cooling ducts. If the purpose of using an HMWH is to comply with NEC Article 450-23 requires that less flammable transformer liquids have an ASTM D92 fire point of not less than 300 °C and that the installation complies with all restrictions provided for in the listing of the fluid.

## 1.4 Background information

### 1.4.1 Mixtures of LFH fluids with other liquids

LFH fluids are miscible and compatible with other hydrocarbon insulating liquids as well as with halogenated hydrocarbons. Mixtures with conventional transformer oil will lower the flash and fire points of the LFH fluid. If the fire point (ASTM D92) of the contaminated LFH fluid is less than 300 °C, the transformer will not meet the requirements of NEC Article 450-23.

### 1.4.2 Mixtures of different types of LFH fluids

Although in many cases different types of LFH fluids are miscible (e.g., synthetic hydrocarbons, petroleum-based hydrocarbons), such mixtures should generally be avoided in transformers and fluid processing equipment due to a possible unacceptable decrease in flash and fire points. Consult the manufacturer of each fluid for advice if mixing has occurred or is necessary.

## 2. References

The following references should be used in conjunction with this guide. When any of the following standards is superseded by an approved revision, the revision shall apply.

ASTM D5222-92, Standard Guide for High Fire-Point Electrical Insulating Oils of Petroleum Origin.<sup>3</sup>

IEC 60156: 1995, Insulating liquids—Determination of the breakdown voltage at power frequency—Test method.<sup>4</sup>

<sup>3</sup>ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

<sup>4</sup>IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).