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guide for acceptance and maintenance of insulating oil in equipment

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**IEEE Guide for Acceptance and
Maintenance of Insulating Oil in Equipment**

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

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Foreword

(This Foreword is not a part of ANSI/IEEE C57.106-1977, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.)

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Contents

SECTION	PAGE
1. Introduction	7
2. Evaluation of Oil Received in New Equipment.	7
3. Evaluation of Oil for Use in Filtering Apparatus at the Installation Site and After Filling Such Apparatus	8
3.1 Shipping Containers	8
3.2 Check Tests on Receipt	8
3.3 Handling of Oil by Customer and Placing Oil in Storage	9
3.4 Handling and Testing of Oil for Installing in Apparatus.	9
3.5 Water Content	9
3.6 Dielectric Breakdown Voltage	11
3.7 Gas Content	11
3.8 Check Testing of the Oil Before Energizing the Transformer.	11
3.9 Standing Before Energizing	11
4. Classification of Service-Aged Insulating Oil.	11
5. Economic Factors	11
6. Sampling	12
7. Oil Tests and their Significance	12
8. Testing Procedures	15
8.1 Field Screening	15
8.2 Laboratory Screening	15
9. Methods of Reconditioning and Reclaiming Service-Aged Insulating Oil	16
9.1 Reconditioning	16
9.2 Reclaiming	17
10. Addition of Inhibitors	20
11. Special Considerations	21
11.1 Insulating Oil for Circuit Breakers.	21
 APPENDIX	
A1. General	23
A2. Transformer Oil Testing of Used Oil	23
A3. Circuit Breaker Oil-Testing of Used Oil	26
A4. Amount of Testing	28
 FIGURES	
Fig 1. Schematic Diagram of Gravity-Percolation Refining Apparatus.	18
Fig 2. Schematic Diagram of Trisodium Phosphate/Fuller's Earth Refining Apparatus	19
 TABLES	
Table 1 Test Limits for Insulating Oil Received in New Equipment.	8
Table 2 Test Limits for Bulk Shipments of Insulating Oil	9
Table 3 Test Limits for Insulating Oil During Filling	10
Table 4 Test Limits for Insulating Oil After Filling and Recommended Standing Time but Before Energizing.	10
Table 5 Insulating Oil Tests	12

TABLES	PAGE
Table A1	Average Reported Values for Continued Use of Transformer Oil 23
Table A2	Classification of Service-Aged Transformer Oil 24
Table A3	Acceptable Limits for Service-Aged Oil versus Voltage Class 24
Table A4	Frequency of Test versus Voltage Class Per Cent of Utilities 24
Table A5	Test Values on New Oil as Received and on Oil in Equipment Prior to Energizing 25
Table A6	Test Limits for Transformer Oil Before and After Reconditioning and Reclaiming 25
Table A7	Field and Laboratory Tests on Circuit Breaker Oil in Service 26
Table A8	Classification of Service-Aged Circuit Breaker Oils 27
Table A9	Field and Laboratory Tests Made on New Circuit Breakers Prior to Energizing 27
Table A10	Test Limits for Circuit Breaker Oil Before and After Reconditioning and Reclaiming 27
Table A11	Reconditioning and Reclaiming of Oil 28

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IEEE Guide for Acceptance and Maintenance of Insulating Oil in Equipment

1. Introduction

The reliable performance of oil in an insulation system depends upon certain basic oil characteristics which can affect overall apparatus characteristics. Such oil characteristics are integral parts of the equipment design for which the manufacturer has final responsibility. The reliable operation of the equipment in service for which the electric power producer has final responsibility also depends on maintaining certain basic oil characteristics. Adherence to the recommended oil characteristics will assist in obtaining the desired equipment characteristics. Other tests or verification of the integrity of the insulation system are often necessary and required.

While design and operating requirements have been adequately met with oils available through 1977, it should be expected that in the ensuing years changes will occur in the ways these liquids are produced and perhaps even in the types of raw crudes from which future oils will be refined. It is not the intent of this guide to suggest or recommend either the crude type, refining methods or design characteristics of oils which are the responsibility of the refiner and equipment manufacturer.

Insulating oil contained in equipment such as transformers, circuit-breaking devices, regulators, series and shunt reactors, as received from the manufacturer and as filled at the installation site but prior to service operation, should exhibit certain properties in order to insure satisfactory performance. It is expected that oil contained in equipment as received from the manufacturer when properly sampled from such equipment usually exhibits characteristics slightly different from those obtained from new oil, which has not been in contact with apparatus constructional materials.

Additionally, certain essential properties of insulating oil, used in transformers and circuit-breaking devices, must be maintained if the oil is to perform its multiple role of electrical-

insulating, arc-quenching, and heat-transferring agent reliably. It must have adequate dielectric strength to withstand the electric stresses imposed in service. It must retain a sufficiently low viscosity so that its ability to circulate and transfer heat is not impaired. It must pour readily at low temperatures and have high flash point and fire point for safety. Its dielectric losses should not become excessive. It should not be allowed to become so deteriorated or contaminated that it adversely affects other materials in the apparatus, nor should deterioration products sludge it sufficiently to impair its circulation through cooling ducts.

The purpose of this guide is to assist the power equipment operator in evaluating the serviceability of oil received in equipment; oil as received from the refiner for filling new equipment at the installation site, and as processed into such equipment. It also assists the operator in maintaining his oil in serviceable condition. The guide, therefore, recommends standard oil tests and evaluation procedures, methods of reconditioning and reclaiming, the levels at which these become necessary, and the routines for restoring oxidation resistance where required by the addition of inhibitors.

It is recognized that oil in service may contain certain dissolved gases useful in assessing the continued serviceability of certain types of transformers. It is not the intent of this guide to cover this subject. A separate guide treating this subject is being prepared.

Should instructions given by the manufacturer differ from recommendations made in this guide, the manufacturer's instructions are to be given preference.

2. Evaluation of Oil Received in New Equipment

Some users of power equipment find it desirable to make field screening tests while others find it more desirable to perform all tests on

Table 1
Test Limits for Insulating Oil Received in New Equipment

ASTM methods		
Dielectric breakdown voltage	20 kV minimum	D1816 — 0.040 in gap
	25 kV minimum	34.5 kV class and below
Dielectric breakdown voltage	(30 kV minimum desirable)	above 34.5 kV class
	30 kV minimum	D877
Neutralization number-mgKOH/g	0.04 maximum	D665, D974
Color	1.0 maximum	D1500
Condition — visual	clear	D1524
Water content, ppm	25 maximum*	below 115 kV class
	20 maximum*	115 kV—230 kV class
	15 maximum	345 kV and higher class D1533
Interfacial tension-dynes/cm		
(millinewtons/m)	40 minimum	D971
Power factor at 25°C	0.001 (0.1 percent) maximum	D924
	0.010 (1.0 percent) maximum	above 34.5 kV class
	0.015 (1.5 percent) maximum	34.5 kV class and below

*Some manufacturers recommend maximum water content values as low as 15 ppm for transformers.

insulating oil in a laboratory. For those using field screening tests it is quite common to use such tests as dielectric breakdown voltage (most significant), neutralization number, color, and visual condition. Some operators with suitable equipment and trained personnel may wish to gain additional information by use of the interfacial tension test. If water content or power factor results are desired, such tests usually are performed in the laboratory.

In sampling oil contained in apparatus care must be used in order to obtain a representative sample. ASTM Method D923¹ should be followed.

Oil exhibiting the characteristics presented in Table 1 is considered acceptable:

3. Evaluation of Oil for Use in Filling Apparatus at the Installation Site and After Filling Such Apparatus

Manufacturer's instructions for field preparation and oil filling vary because of differences in the design of units and individual preference. Some demand more rigorous quality control. The customer and the manufacturer should agree on minimum standards.

3.1 Shipping Containers. Insulating oil is ordinarily shipped in three types of containers: Oil

drums, tank trailers, and rail cars, all of which should be clean and dry. Rail cars are usually under control of the refiners and restricted to insulating oil shipment, so that they tend to be cleaner. Highway trailers may be used for transport of many different chemical products as well as insulating oil; therefore, these trailers are more subject to contamination. Because of this, special cleaning and drying procedures are necessary.

Oil drums are the least desirable method of transport but are often used for smaller quantities. Oil drums should be stored either vertically or on their side with the bungs down to prevent moisture entrance. It is a necessity to check the oil in each individual drum or to pump the oil into a single tank for test before processing.

Each tank load or each shipping unit of the oil as received at the customer's site should undergo check test to determine whether the integrity of the oil has been impaired during shipment as the result of handling and storage. The most frequent contaminant is moisture, but the most difficult to detect is chemical.

Sampling procedures should follow recommendations made in ASTM D-923.

3.2 Check Tests on Receipt. Oil exhibiting the characteristics presented in Table 2 is considered acceptable:

If chemical contamination is expected or is to be guarded against, a 100°C power factor test may be used. This test is very sensitive to chemical contamination. With this test, the limit suggested is 0.5 percent maximum. Other tests may be performed as desired.

¹ ASTM Methods referred to in this guide are obtainable at headquarters of the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA.