Allianz Risk Service
Special Issue
Allianz Fire Protection Service

Fire Test on a Transformer filled with MIDEL® 7131 SD7

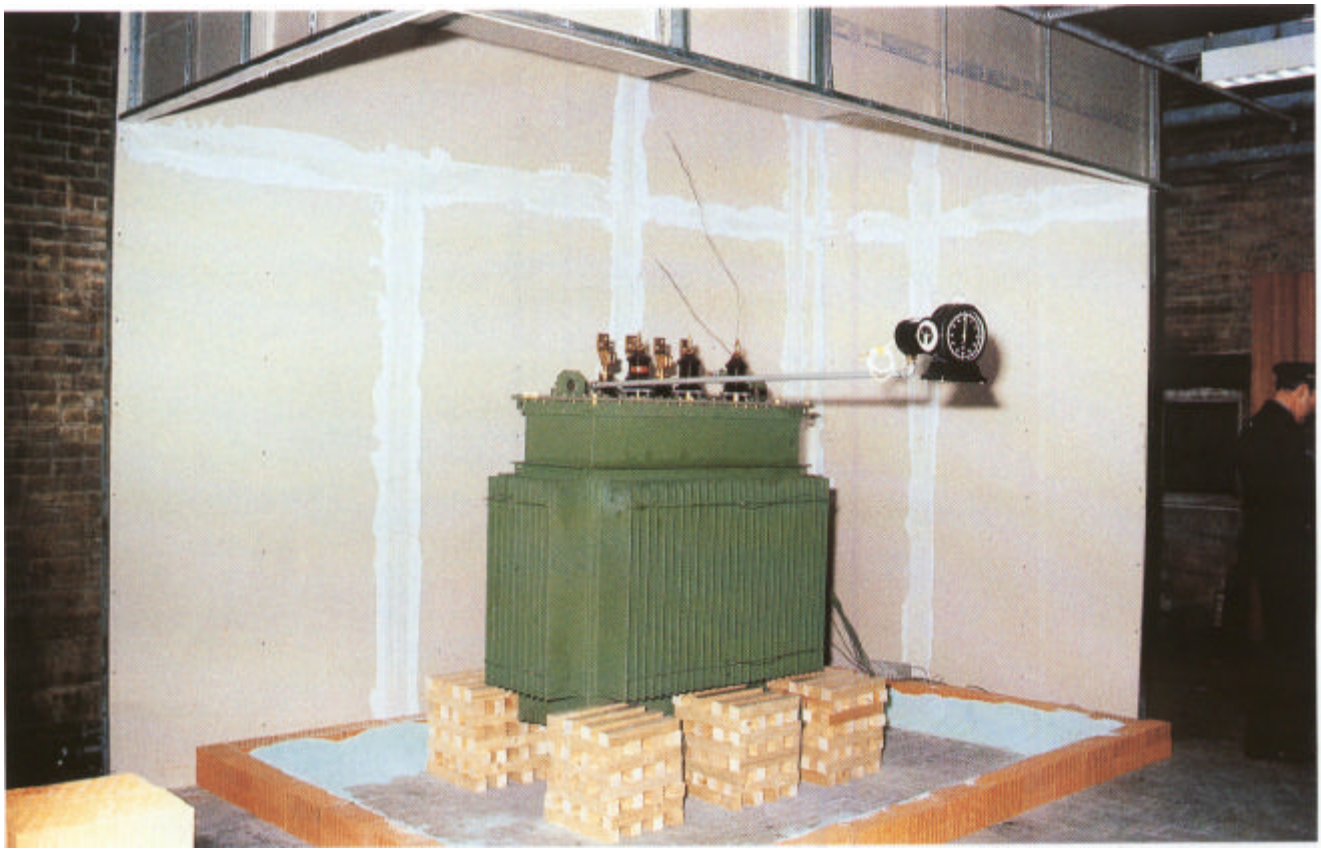


Figure 1

A 630 KVA BBC Transformer, which was filled with MIDEL 7131 (from BASF) as the dielectric, was subjected to a fire behaviour test by the Allianz Brandschutz Service in the fire test room of the Allianz Versicherungs-AG.

The transformer withstood approx. 50-minute fire behaviour test perfectly. No critical temperatures were reached in the coolant, nor did the coolant escape at any point.

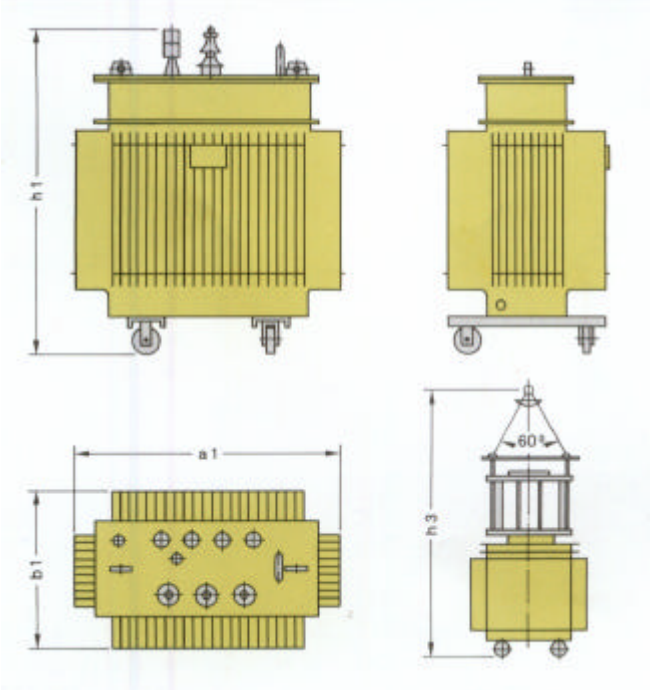
1 Introduction

1.1 General

For technical and economic reasons, transformers should be installed as near as possible in the area of the power consumers. This means that transformers may be installed inside large production workshops or warehouses.

In the event of fire, either the transformer must be protected, for example by structural partitions, in such a way that it cannot contribute to the fire, or the coolant itself must not be allowed to escape from the transformer container over a fairly long period of time and accelerate the fire. In such an event, no extremely toxic fumes should be allowed to develop either, as can happen, for example with transformers filled with Askarel (chlorinated diphenyl).

When it is installed inside a building, the probability of the transformer being attacked by fire from outside is much greater than the danger of the transformer itself being the cause of the fire.



Rating	Dimensions (mm)				Weight	
					Tot.	Midel 7131
(kVA)	a1	b1	h1	h3	(kg)	
630	1540	870	1715	3700	1840	365

Figure 2

In order both to reduce the fire risk (e.g. due to mineral oil filling) and to prevent highly toxic fire fumes from being given off (e.g. from polychlorinated biphenylene), non-hazardous coolants such as, for example, silicone liquids or newer types of transformers such as, for example, cast resin transformers have been used for quite some time now and have been tested in fire behaviour tests. For the same reason, BASF Farben & Lacke AG, Hamburg, arrange for a transformer filled with MIDEL 7131 to undergo a fire behaviour test in the Allianz fire test room (figure 1).

1.2 Coolant MIDEL 7131

The dielectric MIDEL 7131 is an aliphatic ester based on penta-erythrite which is manufactured under licence by the client. The most important data regarding fire protection are:

Flash point (DIN ISO 2592)	257°C
Fire point (DIN ISO 2592)	310°C
Ignition temperature (DIN 51794)	405°C
Thermal value	33 kJ/g
Vapour pressure (at 23°C)	10^{-7} mbar

1.3 Transformer

For the fire behaviour test, the firm BBC, Berlin, made available a commercial 630 KVA transformer, which was filled with about 365 kg of MIDEL 7131. Its external dimensions were 1540mm x 870 mm x 1715 mm (figure 1).

During normal operation the overpressure in the dome (corresponds to the pressure compensation tank) amounts to a maximum of around 0.2 bar. In order to reduce higher and possibly hazardous overpressures that occur, for example, with faults between the turns, a pressure relief valve (figure 3) is incorporated which is designed to come into action at 0.3 bar.

2 Fire Behaviour Test

2.1 Arrangement

The BBC transformer filled with MIDEL 7131 was arranged roughly in the middle of the fire test room (floor area 10m x 6m).

In order to prevent any effects due to the flow of supply and discharge air drawn through the fire test room, and in order to make both the radiant and convective heat act wholly on the transformer, a “corner” was erected around the transformer, consisting of two walls and a roof with an apron hanging down to a depth of about 60 cm (figure 4).

The temperature trend inside and outside of the transformer was monitored by means of a total of 12 Ni-Cr-Ni thermocouples (installation points: figure 5). The temperature changes were recorded automatically.

A manometer was connected to the dome in order to monitor the pressure rise in the dome and to check the proper functioning of the pressure relief valve (figure 5).

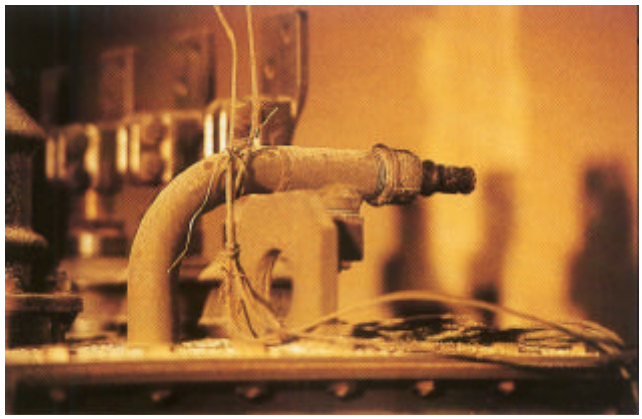


Figure 3

In order to be able to catch the oil immediately if a leakage occurred and, if necessary, to extinguish it immediately, an oil collecting trough made from bricks and heaped-up absorbent (“Ekoperl”) was provided around the transformer (figure 1).

The fire load consisted of a total of 180 kg of well pre-dried white deal in 2x7 wooden cribs each with 32 squared timbers (35 cm x 5 cm x 5 cm). Firstly, 7 cribs were ignited and then after about 35 minutes the next 7 cribs were added (3 cribs on each of the longitudinal sides, 1 crib on the left-hand narrow side). The cribs were pushed up to the transformer container, so that they stood about half way under the cooling fins (“flutes”) (figure 6 – here, still without the 7th crib). The first seven cribs were each ignited with two soft fibre sticks soaked in kerosene (10cm x 2cm x 2cm).

2.2 Progress of Fire/Observations

The progress of the fire in the seven wooden cribs was extremely quick (figures 7). After about 3 minutes the first flames had already reached the upper edge of the transformers, the flames being drawn up above all in the “chimneys” between the cooling flutes. After about 5 minutes the fumes in the observation area had become so dense that the progress of the fire and the pressure manometer could only be observed with the use of a powerful respirator.

After 35 minutes the first seven wooden cribs had already largely burnt away and collapsed. The temperatures were now as follows at the measurement points indicated:

1 Oil bottom	180°C
7 Oil top	204°C
2 Core bottom	144°C
8 Flute bottom/outside	420°C
12 beneath “room” ceiling	164°C

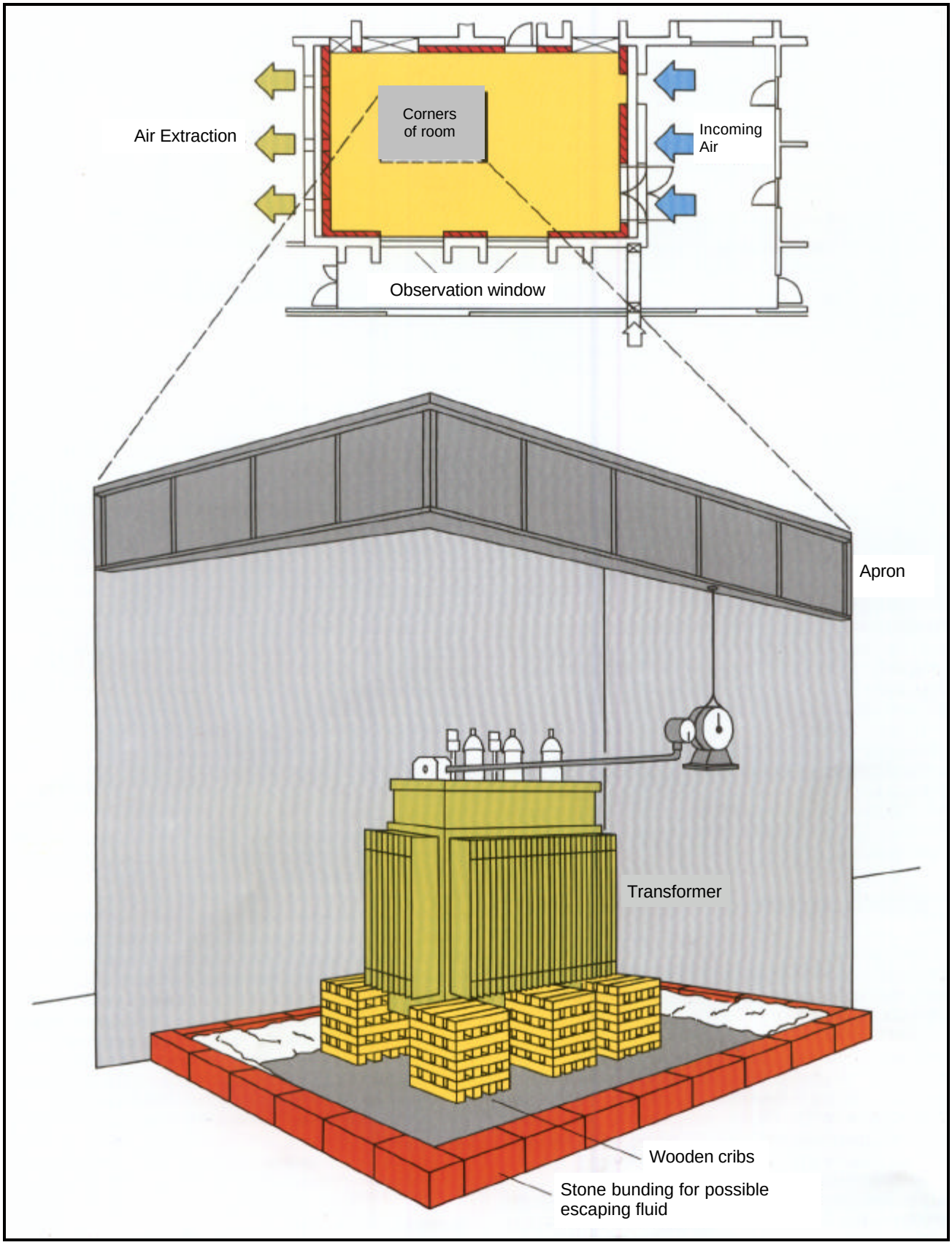

Air Extraction
Corners of room
Incoming Air
Observation window
Apron
Transformer
Wooden cribs
Stone bunding for possible escaping fluid

Figure 4

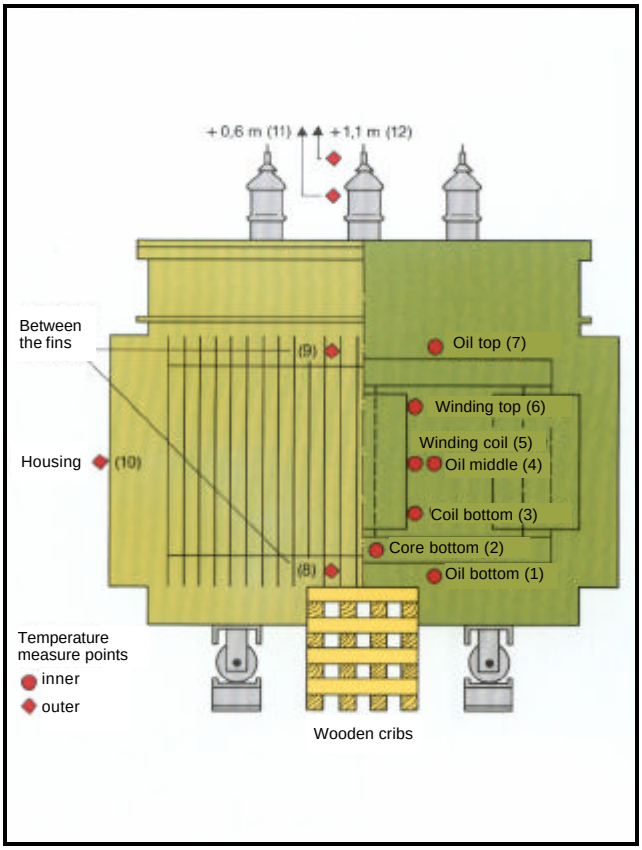


Figure 5

Figure 6

The temperature curves are plotted in figure 8a /8b.

The next prepared seven wooden cribs were placed onto the burnt-down cribs between the 37th and the 40th minute. From the 45th minute the temperatures rose again considerably and in the 53rd minute they reached the same values as those given above for the 35th minute.

At this point the measuring cable insulation melted, so that the automatic temperature measurement had to be discontinued. The wooden cribs carried on burning, however, until they collapsed in the 70th minute; only then were they cleared away. The pressure manometer was observed throughout the duration of the test. It rose several times to a little over 0.3 bar and then fell to 0.25 to 0.20 bar as soon as the pressure relief valve opened. The gases coming from the pressure relief valve could not be ignited with burning wicks.

2.3 Observations after the Fire

In the area where the flames shot up high above the wooden cribs, the transformer was blackened. The paint was burnt off in places in the lower region (figure 9) .

Despite the high temperatures over a period of around 70 minutes, no cracks or leakages arose in the transformer. No dielectric liquid escaped.

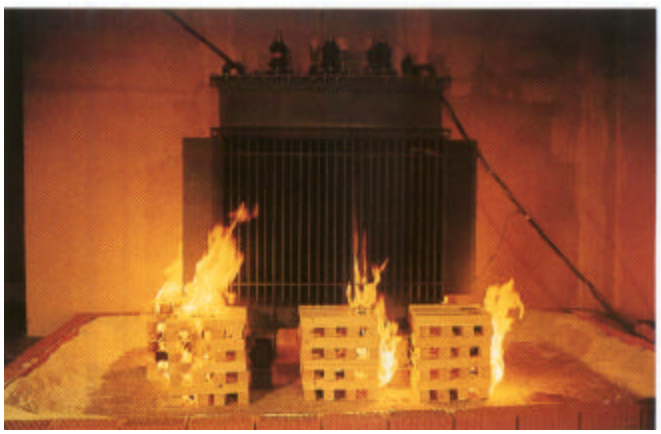


Figure 7

Testing of the transformer in the manufacturer's works showed that it was electrically still in working order. No relevant loss of liquid dielectric was measured.

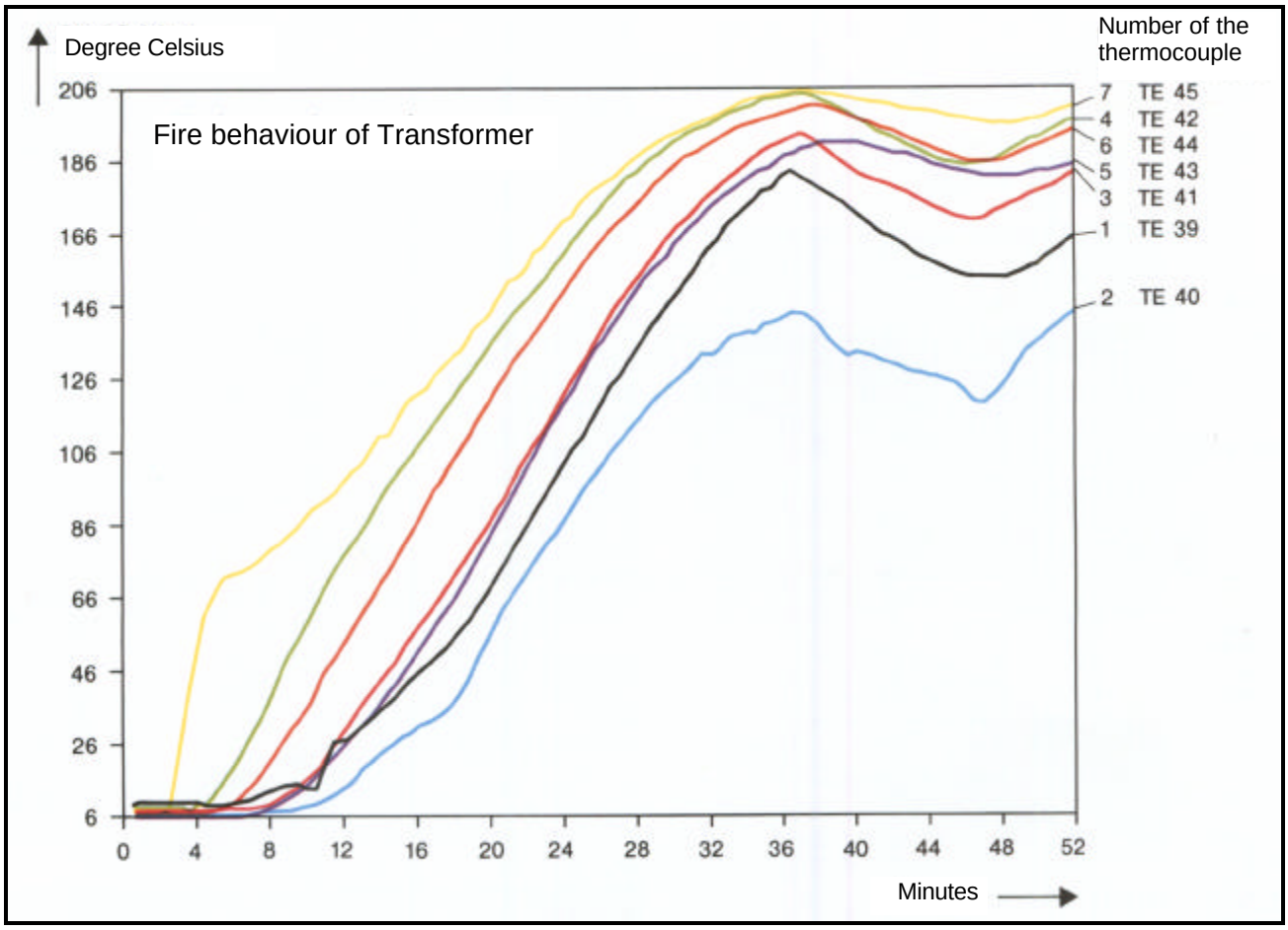


Figure 8a

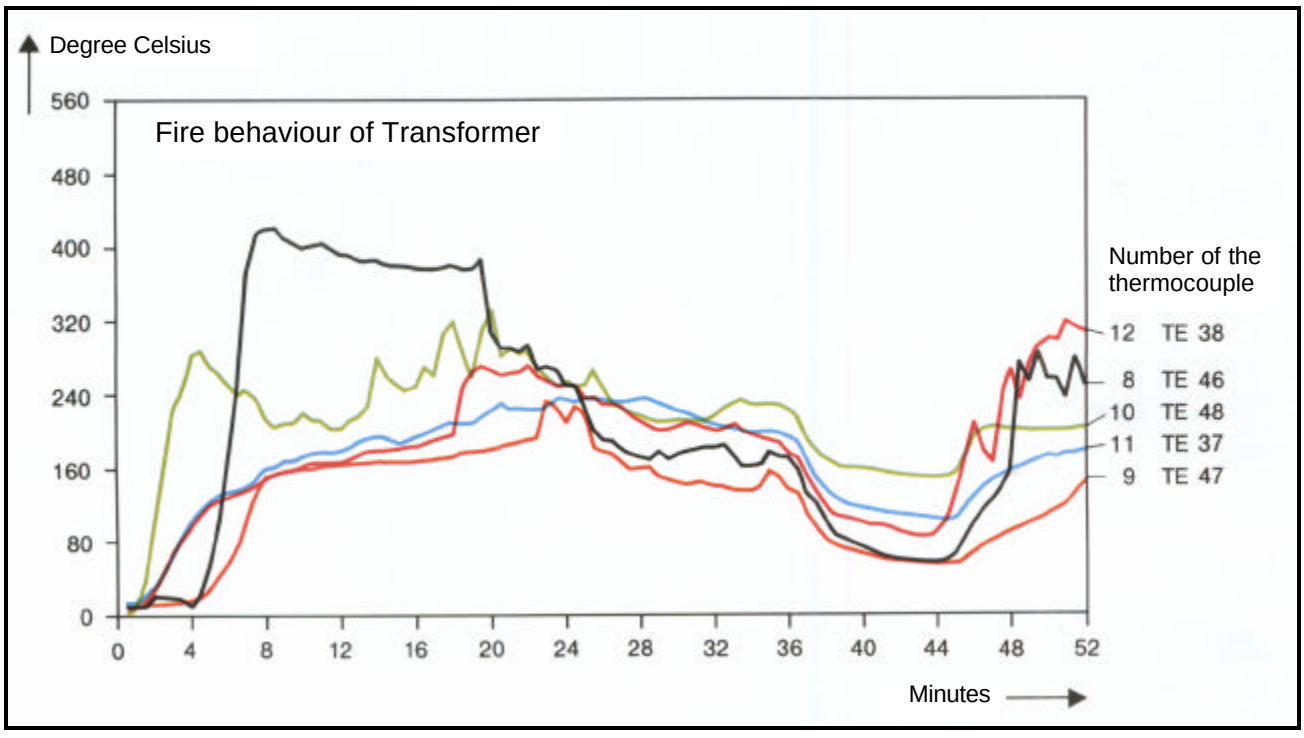


Figure 8b

Figure 9

3 Summary and Assessment

Despite a fire load of around 180 kg of wood over a period of about 70 minutes, no dangerous operating state arose in or on the BBC transformer filled with MIDEL 7131. Inside the transformer, the temperatures of the MIDEL 7131 rose to a maximum of 180°C (bottom) and 204°C (top) in the 53rd minute and were thus well below the flashpoint (257°C) and the ignition temperature (405°C) throughout the test.

Throughout the duration of the fire, the gases escaping from the pressure relief valve from the dome region could not be ignited. Nor did the transformer leak at any point; no leakage or dripping could be detected.

The BBC transformer filled with MIDEL 7131 did not contribute to the fire incident.

Fire Test:
Transformer
(synthetic cooling fluid)

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Special Issue ABS-SD7, Edition March 1988

Allianz Versicherungs-AG
Bayerische Versicherungsbank AG
Frankfurter Versicherungs-AG

F/ABS 1465/6 (0/00) 5.3.88