Office Hr :

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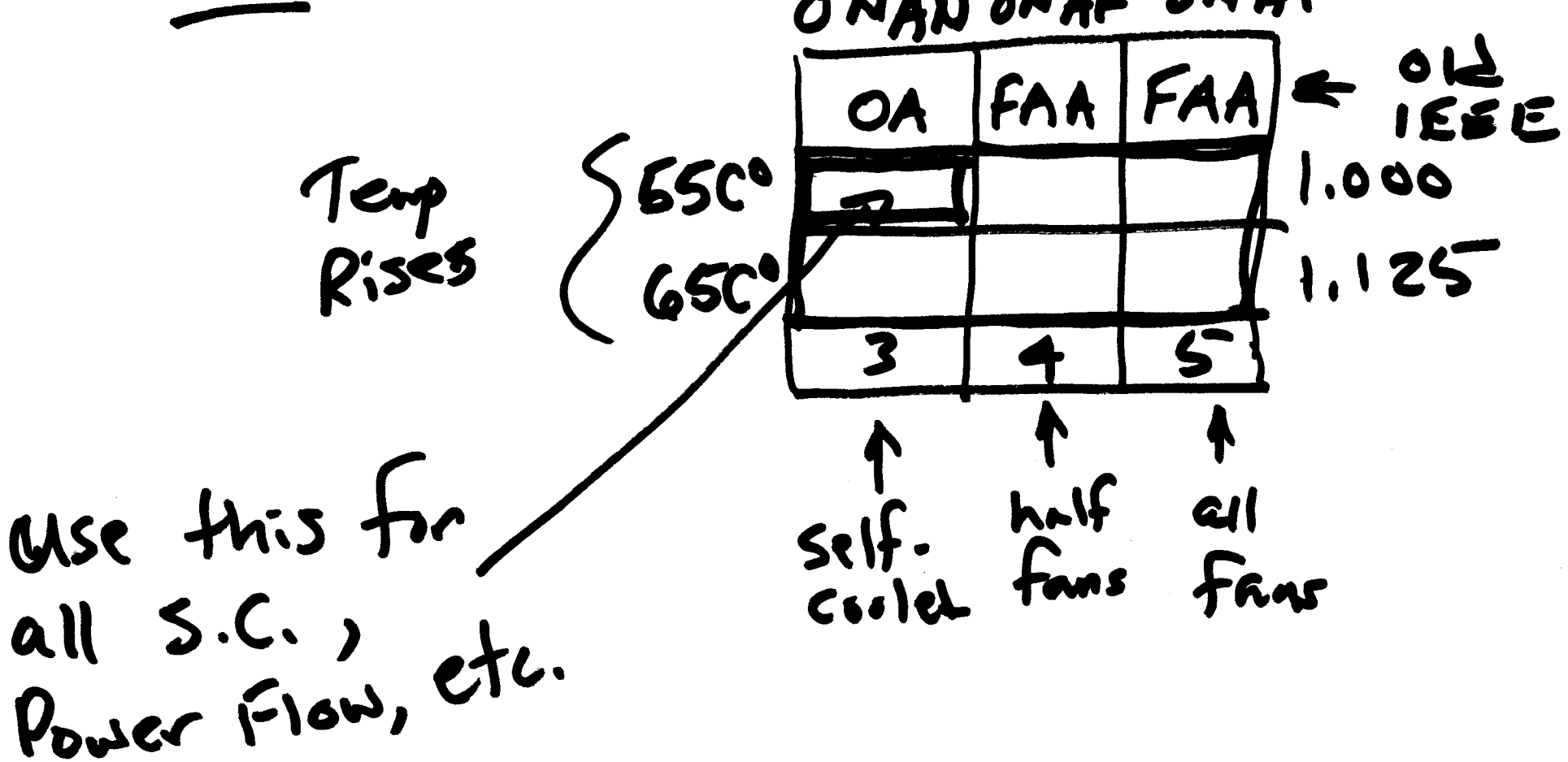
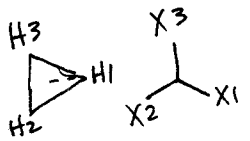
Q.5 : "Self-Cooled" MVA rating.



ANSI C57.12

Power Transformers -



Ratings: Typical to See 18/24/30 MVA 55°C
20.25/27/33.75 MVA 65°C

OA - self-cooled — OA/FA/FA
FA - fan-cooled through radiators, oil moves by convection (heat) — ~~OA~~/FA/FOA
FOA - oil is pumped (circulated) through radiators and air is blown through radiators — OA/~~FA~~FW/FOW
FOW - oil pumped through heat exchanger - water cooled.

p. 105 (W) T&D, 1964

EX:

OA/FA/FA

	1 - self-cooled
75°C,	2 - stage one fans
85°C,	3 - stage 1 + stage 2 fans

OA/FA/FOA

	1 - self-cooled
75°C	2 - stage one cooling - fans
85°C	3 - stage two cooling - fans + pump
	4 - alarm

Hot spot Winding Temp

75 - #1
85 - #2
110 - Alarm
120 - trip

Temp ratings:	Windings	Top Oil Temp
Max Ambient	40°C	40°C
Rated Temp Rise	65°C	65°C
Winding Hot spot allowance	15°C	
Actual Max Temp:	120°C	105°C

[cummulative T - Temp damage above 120°C]

5.1 Cooling classes of transformers

Transformers shall be identified according to the cooling method employed. For liquid-immersed transformers, this identification is expressed by a four-letter code as described below. These designations are consistent with IEC 60076-2: 1993.

First letter: Internal cooling medium in contact with the windings:

O mineral oil or synthetic insulating liquid with fire point[7] ≤ 300 °C
K insulating liquid with fire point > 300 °C
L insulating liquid with no measurable fire point

Second letter: Circulation mechanism for internal cooling medium:

N *natural* convection flow through cooling equipment and in windings
F *forced* circulation through cooling equipment (i.e., coolant pumps), natural convection flow in windings (also called nondirected flow)
D forced circulation through cooling equipment, *directed* from the cooling equipment into at least the main windings

Third letter: External cooling medium:

A air
W water

Fourth letter: Circulation mechanism for external cooling medium:

N natural convection
F forced circulation [fans (air cooling), pumps (water cooling)]

NOTES:

1—In a transformer with forced, nondirected cooling, (second code letter F), the rates of coolant flow through all the windings vary with the loading, and are not directly controlled by the pumps. The pumped oil flows freely inside the tank and is not forced to flow through the windings.

2—In a transformer designated as having forced directed coolant circulation (second code letter D), the rate of coolant flow through the main windings is determined by the pumps and not by the loading. A minor fraction of the coolant flow through the cooling equipment may be directed outside the main windings to provide cooling for core and other parts. Regulating windings and/or other windings having relatively low power may also have nondirected coolant circulation.

A transformer may be specified with more than one power rating (also referred to as cooling stages). The transformer nameplate shall list the rated power and cooling class designation for each rating. The ratings shall be listed in order of increasing power. The cooling class designations are normally listed in order with a diagonal slash separating each one.

Examples:

ONAN/ONAF. The transformer has a set of fans which may be put in service as desired at high loading. The coolant circulation is by natural convection only.

ONAN/OFAF. The coolant circulation is by natural convection only at base loading. However, the transformer has cooling equipment with pumps and fans to increase the power-carrying capacity at high loading.

Examples of the cooling class designations used in IEEE Std C57.12.00-1993 and in previous revisions, and the corresponding new designations, are provided in Table 2.

"New Designations"

[7]Fire point—The lowest temperature at which a specimen will sustain burning for 5 s. (ASTM D92-1998, "Cleveland Open Cup" test method.)

Table 2—Cooling class designation

Present designations	Previous designations
ONAN	OA
ONAF	FA
ONAN/ONAF/ONAF	OA/FA/FA
ONAN/ONAF/OFAF	OA/FA/FOA
ONAN/ODAF	OA/FOA[a]
ONAN/ODAF/ODAF	OA/FOA[a]/FOA[a]
OFAF	FOA
OFWF	FOW
ODAF	FOA[a]
ODWF	FOW[a]

[a]Indicates directed oil flow per Table 9, NOTE 2 of IEEE Std C57.12.00-1993.

5.2 Frequency

Unless otherwise specified, transformers shall be designed for operation at a frequency of 60 Hz.

5.3 Phases

5.3.1 General

Transformers described in this standard are either single-phase or three-phase. Standard ratings are included in the product standards for particular types of transformers. When specified, other phase arrangements may be provided.

5.3.2 Scott-connected or T-connected transformers

5.3.2.1 Phase transformation

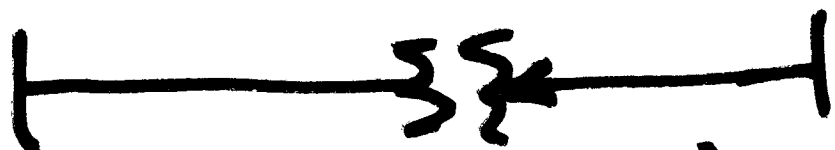
These may be provided to accomplish three-phase to two-phase transformation, or vice versa; or to accomplish three-phase to three-phase transformation. Several arrangements commonly utilized to accomplish such transformations are described here.

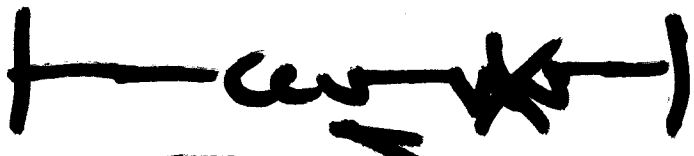
5.3.2.2 Dissimilar single-phase transformers

Two single-phase transformers are assembled in an enclosure, and permanently interconnected, with the following characteristics:

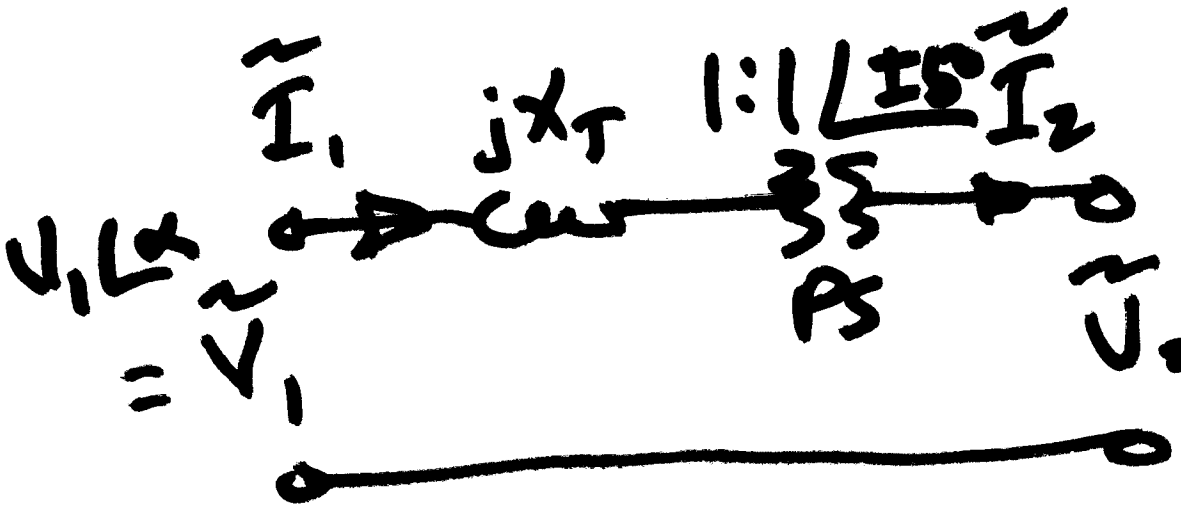
a) Performance characteristics shall be based on bank operation of three-phase to two-phase transformation or vice versa.

b) The single-phase transformers may not be identical or interchangeable.





P_{12}



$$P_{1\to 2} = \frac{V_1 V_2}{X_T} \sin(\alpha - \beta)$$

Increase $P_{1\to 2}$: decrease β (increase $\alpha-\beta$)

Decrease $P_{1\to 2}$: increase β (decrease $\alpha-\beta$)

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