

CHAPTER 5

RESEARCH RESULT

After knowledge base part and graphical user interface part of expert system had been finished, the testing and evaluation of developed expert system in all general cases of power transformer faults are needed to be done by following 4 groups of alarm signal characteristics.

5.1 A Sample Case of Developed Expert System

The complete set of test of a sample case following differential relay operated scheme will be represented in Appendix B.

5.2 Test When Single Alarm Happened

The signals of happened abnormal events which will normally be alarmed at control room and control panel at a side of the power transformer for an alarm signal must be diagnosed by grouping signals into 3 categories respectively to types of alarm signals as follows :

5.2.1 Test When Trip Happened

Trip is a violent signal alarmed when trouble happened which needs to the cut power transformer out of the power system.

The expert system can be tested by considering on combination of alarm signal at the control room and control panel at the side of power transformer as shown in Table 5.1 :



When the expert system operated, some information is needed to be asked as additional information until gathering the final result.

Table 5.1 Testing condition when trip happened

No.	Annunciator at Control room	Annunciator at Power transformer
1	- KTxA Tx Lockout Operated - Major Trouble	- Tx. Press. Relief Dev. Trip
2	- KTxA Tx Lockout Operated - Major Trouble	- Div.Sw. Press. Relief Trip
3	- KTxA Tx Lockout Operated - Major Trouble	- Buchholtz Trip
4	- KTxA Tx Lockout Operated - Major Trouble	- Fault Press Relay Trip
5	- KTxA Tx Lockout Operated - Major Trouble	- LTC Press Relay Trip or Oil Flow Relay Trip
6	- KTxA Tx Lockout Operated - KTxA Relay Lockout Operated - KTxA High Side OC relay Op.	- None
7	- KTxA Tx Lockout Operated - KTxA Relay Lockout Operated - KTxA Low Side OC/OCG relay	- None
8	- KTxA Tx Lockout Operated - KTxA Relay Lockout Operated - KTxA Tertiary OCG relay Op.	- None
9	- KTxA Tx Lockout Operated - KTxA Relay Lockout Operated - 87K51-51G converter fail	- None
10	- KTxA Tx Lockout Operated - KTxA Relay Lockout Operated - 87K51-51G OC. supply fail	- None
11	- KTxA Relay Lockout Operated - KTxA Diff. Relay Operated	- None

Result of testing : All of the gathering results from all simulated cases are true.

5.2.2 Test When Alarm

Alarm is a quite violent signal when trouble happened on power transformers but the operation of power transformer is still performed.

The expert system can be tested by considering on combination of alarm signal at the control room and control panel at the side of power transformer as shown in Table 5.2 :

Table 5.2 Testing condition when alarm happened

No.	Annunciator at Control room	Annunciator at Power transformer
1	- Major Trouble	- Oil Temperature
2	- Major Trouble	- Buchholtz Alarm
3	- Major Trouble	- AC. Supply Failure
4	- Major Trouble	- DC. Supply Failure
5	- Major Trouble	- AC. Control Failure
6	- Major Trouble	- Fan Thermal Relay Stage 1
7	- Major Trouble	- Fan Thermal Relay Stage 2
8	- Major Trouble	- Fan Breaker Stage 1
9	- Major Trouble	- Fan Breaker Stage 2
10	- Major Trouble	- DC. Trip Circuit Failure

When the expert system operated, some information is needed to be asked as additional information until gathering the final result.

Result of testing : All of the gathering results from all simulated cases are true.

5.2.3 Testing When Minor Trouble Alarm Happened

Minor Trouble is a nonviolent signal when trouble happened on power transformers but the operation of power transformer is still performed.

The expert system can be tested by considering on combination of alarm signal at the control room and control panel at the side of power transformer as shown in Table 5.3 :

Table 5.3 Testing condition when minor trouble happened

No.	Annunciator at Control room	Annunciator at Power transformer
1	-Minor Trouble	- Transformer Oil level
2	-Minor Trouble	- Diverter Switch Oil Level
3	-Minor Trouble	- Rubber Bag Rupture
4	-Minor Trouble	- AC. Regulator Failure
5	-Minor Trouble	- DC. Control Failure
6	-Minor Trouble	- Load Tap Change Over Current
7	-Minor Trouble	- Tap Change Delay
8	-Minor Trouble	- Tap Differential
9	-Minor Trouble	- Load Tap Change Drive Motor Breaker
10	-Minor Trouble	- Oil Filter Trouble

When the expert system operated, some information is needed to be asked as additional information until gathering the final result.

Result of testing : All of the gathering results from all simulated cases are true.

5.3 Testing when Multiple Alarm Happened

Multiple alarm is a set of multi-signal happened at the same time when a power transformer problem is established.

The expert system can be tested for each alarm by considering on some possible cases of combination of alarm signal at the control room and control panel at the side of power transformer as shown in Table 5.4 :

When the expert system operated, some information is needed to be asked as additional information until gathering the final result.

Table 5.4 Testing condition when multiple alarm happened

No .	Annunciator at Control room	Annunciator at Power transformer
1	-KTxA Tx. Lockout Operated -KTxA Relay Lockout Operated -KTxA High Side OC.Relay operated -KTxA Diff Relay Operated -Major Trouble	-Buchholtz Trip -Buchholtz Alarm or -Fault Pressure Relay Trip or -Tx. Pressure Relief Div. Trip
2	-KTxA Tx.lockout Operated -Major Trouble -Minor Trouble	-Buchholtz Trip -Buchholtz Alarm -Rubber bag rupture -Tx. Oil Level
3	-Major Trouble -Minor Trouble	-Buchholtz Alarm -Rubber bag rupture -Tx. Oil Level
4	-KTxA Tx.lockout Operated -Major Trouble	-Fault Pressure Relay Trip -Buchholtz Alarm -Pressure Relief Operated
5	-KTxA Tx. Lockout Operated -KTxA Relay Lockout Operated -KTxA Diff. Relay Operated -Major Trouble	-Buchholtz Trip -Sudden Oil Flow Trip -LTC. Pressure Relay Trip -Fault Pressure Relay Trip -Buchholtz Alarm
6	-Major Trouble -Minor Trouble	-DC. Trip circuit failure -DC. Supply failure -DC. Control failure
7	-Major Trouble -Minor Trouble	-Fan Bkr Stage 1,2 -AC. Control failure -LTC Drive Motor breaker
8	-Winding Temp Alarm 1,2 -Major Trouble	-Oil Temperature
9	-KTxA Tx.lockout Operated -Major Trouble	-Fault Pressure Relay Trip -Buchholtz Trip
10	-KTxA Tx.lockout Operated -Major Trouble	-Tx. Pressure Relief Device Trip -Div. Sw. Press Relief Trip

Result of testing : All of the gathering results from all simulated cases are true.