

***Task Force – Transformer Tank Rupture and
Mitigation
Review Group #2***

**Document 1: “Prevention of Tank Rupture Due to Internal
Fault of Oil-Filled Transformer” – Y.Abiru, et. al**

**Document 2: “Fires and Explosions in Substations” – D.J.
Allan**

Review Group: Craig Swinderman/ Jim Zhang

Introduction

- **Internal transformer fault causes:**
- **Generation of large volume of decomposed gas**
- **If arc current is high and arc length is long, rate of pressure rise can exceed pressure relief device capability**
- **Tank can rupture at its weakest point**

Types of faults

Causes of arcs:

- **inter-turn failure**
- **inter-section failure**
- **inter-winding failure**
- **inter-phase failure**
- **line to tank failure**

- low energy

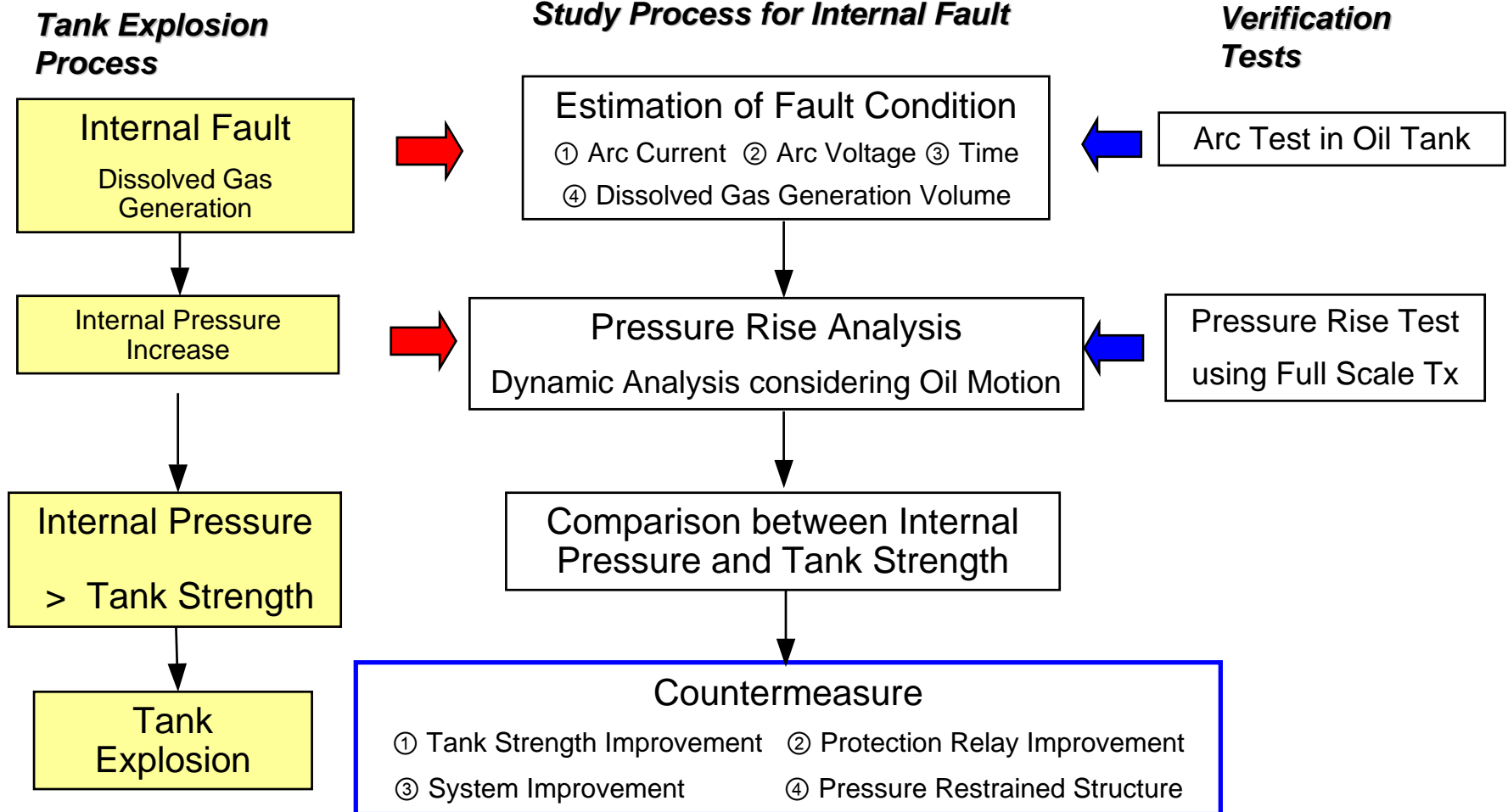


**Increasing
energy
release**

- high energy

•Worst-case is fault near HV line lead (low impedance = high arc current, long arc length)

Summary of Research

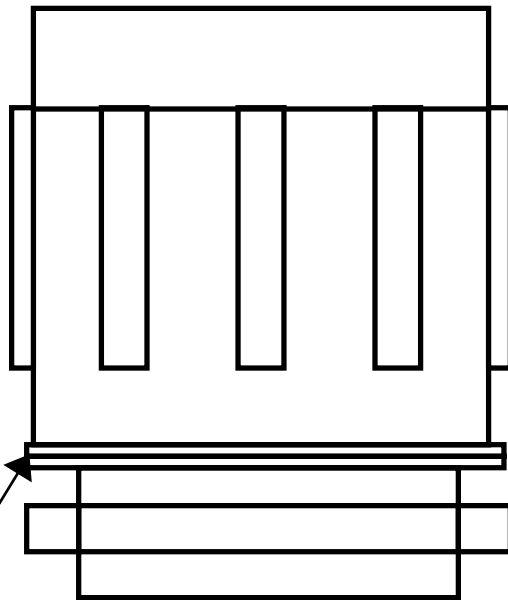


Results of Analysis

- **Decomposed gas generation calculated to be around 0.5L/kW sec for larger 275 kV class transformers at HV lead.**
- **Oil motion (kinetic energy) has a considerable influence on the pressure rise. (Dynamic Load Factor approx. 1.3)**
- **Tank expansion characteristics and tank strength are important in determining the transformer's capability to resist rupture.**
- **Reinforcements can be made at the joining flange between the tank and cover (or flange between upper and lower tank for shell-form) to significantly improve the tank strength against rupture.**

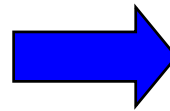
Example of Tank Strength Improvement

Conventional Type

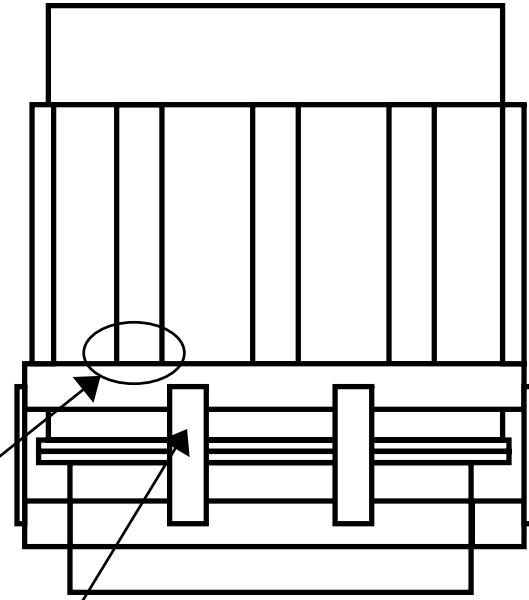


Connecting Part

Alleviation of Stress Concentration



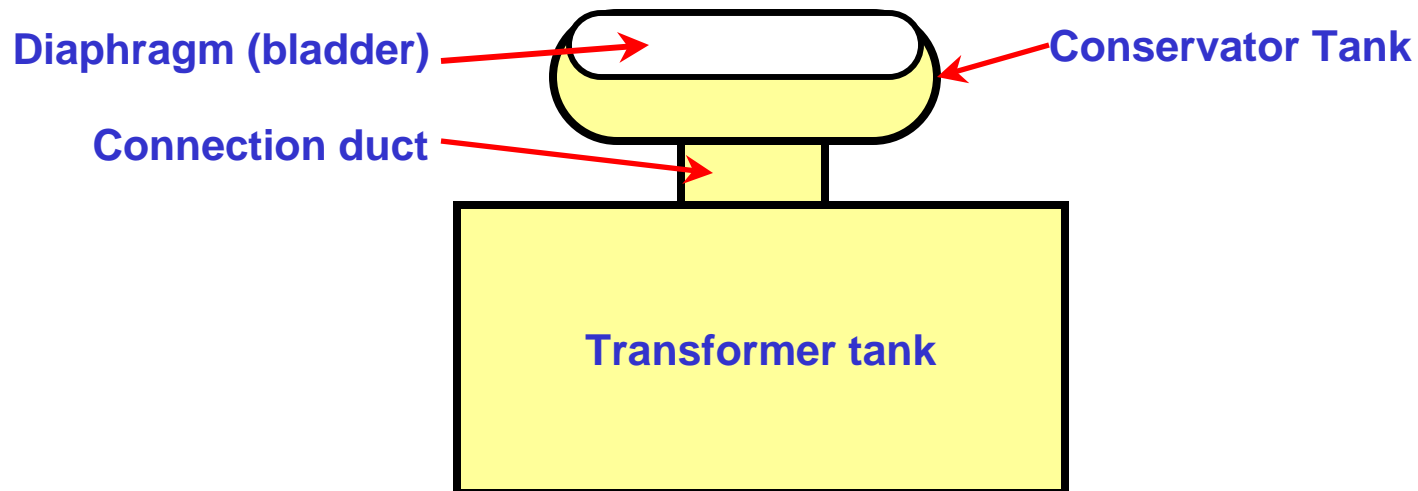
Improved Type



Improvement of Connecting Part Strength by Tie Reinforcement

Other Notes

- **Diaphragm type Conservator Tanks can be used as effective pressure reducing space if the connection duct to the main tank is short, the cross sectional area of the duct is large (approx. 0.5 m - 1 m dia.), and the air space in the conservator diaphragm is adequate**



- **Tests on 300 MVA, 230 kV single-phase units have verified ability to withstand 15,000 MVA short circuit capacity without rupture of the tank.**