SPARK ignited to share

(A Power Engineers WhatsApp Group)

Frequently Asked Questions & its Answers

January 2017

About SPARK...ignited to share

During September-2016, few Engineers all across the country extended the views of starting a technical group on WHATSAPP application and opined for the exchange the technical discussions in soft format. So far bringing this idea into reality and its acceptance in greater domain, the name of the group was suggested as **"SPARK ignited to share"** and the 1st group was created on 18th September-2016.

Then on the request of these committed members, the technical stalwarts all across our country and also some from outside, agreed of extending their kind consent to become the members of this group. The basic objective of this group is to discuss the technical queries, thoughts, views and experiences among the esteemed members of this group. Because of overwhelming response and to accommodate all the members in the discussion, the 2nd and 3rd group was created on 9th October-2016 and 19th November- 2016 respectively.

We are glad and excited to declare the information that all our highly distinguished members at each point of time on the situation of technical front used to develop healthy technical deliberations. At present we have 715 (2x256 + 203) members all across the country including 12 foreign members and on request being on continuous trend, the 4th group is likely to be created soon.

In these groups we strictly discuss the technical points anything and everything on electrical stream and its allied subjects. **Posting of Social message in these groups is strictly prohibited and on any violation of such, the concerned member with reminder gets removed from the group.**

I am glad to know that CBIP is going to publish these valuable discussions on its monthly Water and Energy International Journal to reach its members all across the globe.

The Journey of thousand miles always begins with one step

We have already began the journey with our first steps and proceeded ahead with leaps and bound. Hence I being the Admin of these groups and on behalf of our all the esteemed members, take this opportunity to extend my gratitude of heartfelt thanks to CBIP to bring this endeavour a grand success.

P.K. PATTANAIK
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Question : By A.N. Mishra : For single phase meter box which is better option-smc material or poly carbonate. Is it difficult to cut small pocket on smc sheet for installing push button?

Answer : By llango: While Polycarbonate is relatively better in terms of FR withstand, UV withstand and durability, Smc is less expensive. It is a matter of trade off to choose one of them. It is not difficult to take cut-out on a Smc box provided it is still fresh and properly stored. Since, Smc can get brittle after many years of exposure to direct sunlight

Question : By Er. Tuni Nayak OPTCL : One small clarification that If the trip / closing coil of 245 kV Sf6 bkr will be 1300 W for reaching breaking time of 50 msec. Will it be acceptable?

Answer :

1. By Er. Potnis EMR: What is the voltage of coil?
2. By Er. Tuni : The voltage of coil is 220 V
3. By Er. Ilango : It should be fine as long as the backup battery is capable of sourcing for the short time current. Relay's trip contact or close contact having not less than 2500 W make & carry capacity for short time. CB's aux. Contacts (52A & 52B) have required breaking current capacity.
4. By Er. Potnis EMR: As expressed by Mr Ilango battery wise there will be no issue... as long as auxiliary contacts are capable of breaking trip coil current comfortably there is no issue.
5. by P.K. Pattanaik: As per our experience we have seen the burning of contacts due to this reason The situation as described of 1300 watt coil, with severest low voltage of 170 volt dc, the current comes 1300/170= 7.65 amp momentarily to pass through the aux contact and tripping relay contacts or its aux circuit. So spark may result the ionization of the gap on the contact and may aggravate till burning of the contacts. So suitable coil of res approx 120~190 ohm, with max 500 watt may be suitable for the circuit.
6. By Er. Potnis EMR: You are right...this point only is reqd to be checked...people have so far used 600 to 650 watt coils comfortably but 1300 watts needs to be verified.
7. By Er. Ilango: I do agree, in general it is in the range of 600 to 650 W. I recall 110 kV-245 kV SF6 CB tech spec of CGL, where Max current of Tripping /Closing coil is 6A @ 110 vdc, i. e 660 W max.
8. By Er. Potnis EMR: But if the wattage is increased just to get 2-3 m sec advantage to bring it below 50 m sec spec limit one needs to ask a question to himself...does it really matter if the trip time is 51 or 52 m sec? It is always better to have wattage around 500 to 600 so as not to burden contacts unnecessarily.
9. By Er. Ilango Ganeshan: To certain extend YES, but not always. As the battery ages, it will not be able to source such a momentary rise in current, hence will lead to drastic dip in voltage.
10. By Er. Potnis EMR: Current wise I have not seen any issues even with old batteries for trip coil operation but if you have any other equipment e.g. DC charging motors etc then it definitely poses problems.
11. By Er. Huda, OPTCL : For a 220 V 1300 watt coil R=220×220/1300=37.23 ohm. Current at 170 V will be =170/37.23= 4.56 Amps. Here resistance of coil is fixed..
12. By Er. Potnis EMR: That's right.
13. By Er. Surya Prakasa Rao: Now I am getting a fundamental doubt that how much DC power is required to trip EHV/UHV Breaker through trip coil. If it is 600 watts or 1300 watts, whether my thumb can pass that much of power during Local Manual pushbutton trip .
14. We are highly impressed upon your most valid query to this group reg power required for coil.

    By P.K. Pattanaik:

    1. The action as reqd by coil depends upon MMF (magnetomotive force= NI).
    2. To design this value we need to raise more N (Number of turns) or I (current).
    3. But best idea to raise More N (so resistance of coil shall be more with thinner coil of more turn).
    4. Accordingly the wattage on rated voltage of 220 V would be lesser for better attraction of plunger.
    5. Hence it is always advisible to have higher resistance coil of lower wattage.
    6. So in this condition, 500 to 650 watt could be the choice.

Regarding manual pressing for tripping or closing of the breaker we definitely need that pressure as required by the coil of 600 watt or 1300 watts.

15. Er. Potnis EMR: The discussions on the trip coil started with 1300 watts required for achieving the desired opening time of 50 m secs. If I have understood the basic question correctly The wattage went up to get faster tripping time and not because the breaker was hard to trip. The force required to trip the breaker could be same but in order to get lesser trip time perhaps wattage was increased which is one of the ways to get lesser tripping times but of course this has certain limitations and one can not get much leßer time even if wattage is increased multifold... So 600 watt or 1300 watt may require same manual force. Many a times these mechanisms. For electrical tripping and manual tripping... are also different and with additional mechanical advantage you can also reduce the required force during emergency manual tripping and that is why it could be totally independent of coil wattage . Hope this explains your basic query.
16. By P.K. Pattanaik : Special thanks for the appropriate basic answer reg the action of trip coil.
17. By Er. Surya Prakask Aptransco: Dear respected sirs, I am very happy to know about latest developments in trip coils of circuit breakers. I convey my sincere thanks to all the esteemed personalities of the group.

Question : By Er. sasmita parhi OPTCL : Which busbar is preferably better for Ac distribution board & DC distribution board in between Al & Cu? What is the basis of selection?

Answer :

1. By Er. Potnis Srikant Emr: No issue as long as cross section is adequate to carry the rated currents and temp rise is within IEC limits...now a days AL only being used almost at all places.
2. By Er. Er. Surya Prakask Aptransco: I would like to prefer copper busbars to aluminium one specially for DCDB.
   (a) Copper is superior to aluminium in many ways, low resistivity, less ductile etc.
   (b) D.C. supply is used for protection, controls etc.we use copper cables from DCDB to individual breaker panels. From busbars through HRC FUSES/MCBS /ON -OFF switches, DC cables are connected.

   All the above protective one are provided with copper connecting strips. From Busbars to above protective equipment we use copper connecting strips /cable leads. Connecting copper strips /cable leads to aluminium bus bars may create Bi-metallic problem.

   Only advantage with aluminium bus bars is low cost.

   DCDB has got one positive and one negative bus .

   So my view is copper bus bars are preferable for DCDB .
3. By Er. A.N. Mishra: Very relevant, precise and consized analysis. Rao saheb, round shaped or rectangular flat bus bar?
4. By P.K. Pattanaik, OPTCL:

   The decision for any current carrying conductor depends upon 1. Current density 2. Environment withstand capacity (temp rise, corrosion etc..) 3. Handling the current path.

   For copper both 1&2 is better as compared to Al. But for point 3, use of connecting strip to the bus is considered. Now bi-metallic issue may come into account.

   So consideration of CU or AL as the material shall not affect if all above 3 points taken care in line with the allowable standard.

   But use of flat bus and round bus has the significance on contact surface for connection of out going feeders from the bus. Flat bus is preferable.
5. By Er. Nihar Raj, ABB: I would also recommend also check on the ambient conditions. Incase these panels are placed in harsh environmental conditions with high corrosive gases (some industrial plants) then different metals will have different tendencies towards these gases.
6. By P.K.Pattanaik, OPTCL: Sir you are absolutely right. But We think these two metals may be environmental friendly. But sir your point should be considered for such design.
7. By Er. Nihar Raj, ABB: Majority of the installation in transmission and distribution go with offerings of Al or Cu.

   But installation aspects and environmental factors if considered in addition to above recommendations made by Rao saab then the life is more. This is more critical for industrial applications.

8. By Er. Vikash Saxena, PGCIL: I agree. However if there are no adverse environmental issues, in my opinion as long as temperature rise is getting met as per standards Al should be OK and economical.

Question : By Er. A.N. Mishra: Esteemed engineers may kindly comment as IS 2026 allows variation in impedence volt of transformer by ± 10% However,allows lesser impedence volt by virtue of agreement between supplier and purchaser. Besides cost factor, what are other aspects of lower impedence volt ?

Answer :

1. By Er. Ramachandran, ABB: Lower impedance means higher over current during faults ie higher forces in winding as forces vary as square of the current. Costs will increase with both increase and decrease from the optimum impedance value. Lower impedance means less number of turns- lower copper loss and higher core loss, becoming an iron machine with less copper and more silicon steel. Advantage is less voltage regulation (drop in secondary voltage) with loading. When transformers were developed first time, engineers were trying to design with as low impedance as possible to get minimum voltage drop. Later they understood the benefit of impedance as it limits fault current, saving the windings from devastating short circuit forces, internal buckling, external bursting and oscillating axial forces in tonnes.
2. By Er. Surya Prakask, Aptransco

   With lower percentage impedances of transformers fault levels on the transformers wil increase but voltage regulation (no load to full load voltage) will decrease.

   With higher percentage impedances fault levels will decrease but voltage regulation will increase, thereby when load is suddenly thrown off from transformers secondary voltages will raise to the tune of percentage value of impedance. So the connected switch gear shall be designed to withstand higher HSV. Further running transformers with different percentage impedances in parallel is a difficult task. The difference between impedances shall not be more than 10%. Some establishments compare resistances and reactances of different transformers.

Question : By Er. Guru Mishra, OPTCL: Inviting attention to a topic which is least prioritized or thought over, i.e. whether during filtration the filter machine should be earthed or not.. as there are some articles in IEEE which provides investigations about generation of huge amount of static electricity discharge and under that condition filtration chamber will behave as an infinite condenser provided the flow rate of oil circulation is more than a certain value.

Answer :

1. By Er. Nihar Raj, ABB: It is recommended that All metallic within the charged environment needs to be earthed (to avoid any huge potential differences). There are good NFPA documents which cover this aspect.

   This point is very critical for tank farms in Refineries. There are special tools used to take care of this aspect of earthing static charges.
2. By Er. Guru Mishra, OPTCL: As per the IEEE PAPER, if the oil flow rate is higher than a specific value and body of oil chamber of the filtration machine is earthed, then static electricity charges will be produced and earthing will act as an electrode resulting which capacitance will be formed and it will behave as an infinite condenser.
3. By Er. Ramachandran, ABB: Static charges from oil filtration was discussed in a Doble Conference paper 5-7 of 1996 by a BPA engineer. Of course bonding and grounding is a must , but this alone is not enough to avoid explosion from charges. Grounding of machine and transformer shall be common. Do not splash oil. Fill to tank or Trf from bottom. Avoid turbulence. Limit oil velocity in hose to 1 m/s. See the continuity of metallic spiral casing over the hose. Leave a relaxation time of 30 sec between filter and tank oil. After oil filling allow 30 min for any activity on tank. Be more careful when handling oil saturated with combustible gases. E.g. Draining oil from a failed transformer with severe internal arcing. Transformer designers always limit oil velocity below 1 m/s inside Trf when designing forced oil cooling. Many trfs failed in 1980's from static electrification inside insulation parts due to high oil velocities

Question : By Er. Quireshi Kryfs: I'd like to seek the group's views on the newly notified efficiency of BEE levels from January 1st 2017 for distribution transformers.

Is it in national interest to keep increasing the efficiency levels without any reference to cost?

Earlier the utilities decided the loss levels required based on capitalisation cost formula where both savings due to higher efficiency was weighed against the higher capital cost to decide the payback period.

However now this is being notified by BEE, without any reference to cost thereby increasing the investment of utilities in distribution trafos and reducing their purchasing power to buy more transformers due to limited budgets they have for new purchases.

Besides these low losses can only be achieved using amorphous metal and not crgo, and amorphous metal has limited suppliers and increases the size.

Does an already efficient non - consumer equipment like distribution trafo require increase in efficiency and at what cost? Where does this stop?

Would be good to have the esteemed group's view on this subject

Answer :

1. By Er. A.N. Mishra: If I remember correctly, IS2026 did not cover parameters for dist. T/F above 100 kva. In 2014, BIS issued IS 1180 and covered dist. T/F up to 2500 kva. Instead of separating core loss and Cu loss, overall loss at 50% and 100% loading has been specified for level 1, 2 and 3 for BEE ratings of 3, 4 and 5 star. Thus, liberty has been given to adjust core and Cu loss. How ever, core loss being constant loss ,it is not affordable to allow higher core loss. Engg is application of fundamental science to the optimum social and economic benefit.It is opined sir that the said T/F could be manufactured selecting crgo with appropriate core loss.Amorphous is not very much recommended taking difficulty being faced in its repair.permissible top oil rise in temp has also been reduced from 45 to35°.Energy is costly.Reduction of 1% in efficiency in100 kva T/F means loss of Rs. 20000 per annum. Besides this,reduction in temp.assures better life expectancy of T/F. Lesser loss also ensures better carbon credit ensuring fulfilment of social cause and lesser loading of power System. As such, there appears little harm to go by more efficient T/f. Pls correct me if I am wrong.
2. By Er. Mamtora Tr : This is regarding the suggestion of Mr. Amar Mishra for reducing the core loss of distribution Transformers. The core losses should be dependent on the load factor of the Transformers. It is cheaper in all respect to increase the core losses for the transformers with the higher load factor. As a thumb rule the core losses should be equal to the load losses for the given load factor.
3. By Er. A.N. Mishra: For maxim efficiency cu loss equals iron loss, for minimum cost, cost of core equals cost of Cua and for minim volume, volume of Cu equals volume of core. But, sir dist T/F operates at high LF during peak hrs only and for rest 18-20 hrs, it is partially loaded. Loss parameters to be selected taking this into account. Kindly correct me if wrong.

Question : By Er. Jena Sittal : Lot of discussion on many issues of day to day concern. One issue I need to flag is grid connected solar power which is getting momentum. Already a 20 MW plant at Manmunda is connected at 33 kV to OPTCL system. About 8 nod, may be more, 1 MW solar is connected to Discos system. Because of DC to AC conversion in case of GRID CONNECTED solar system the inverters are synchronised to grid frequency. It can not generate without grid supply. Experts in the power electronics or solar power may comment about practices elsewhere and how not to loose generation as interruptions are common in Dist net work. And battery support for large capacities are unacceptable. Within a year CTC BBSR GOVT BUILDINGS will have 4 MW cap. Suggestion how reliability can be ensured in these installations. This is coming in a big way.

Answer :

1. By Er. Shreedhar Bits Pilani : I have executed a 30 MW solar power plant in MP. However, I could not able to understand the concern. Could you please elaborate the problem.
2. By Er. PP Wahi CBIP : The solar power can not deliver energy if Grid is not on .

   So best way to tap full energy and to have stability of the frequency , we should switch to Energy storage through battery bank . So entire solar energy can be firmed up and can be real eased as and when load demands on the grid needs it. Particularly for shaving off the peak.
3. This reply is from Mr R.K.Kaura, who is specialist on solar power and electronics. He is chairman of Bergen group of lndustries, New Delhi

Question : By Er. A.N. Mishra: Actually I am working with jharkhand vitran. One of 50 MVA Power Transformer failed at 132/33 kV grid at Hatia (Ranchi). Being member of enqiry Committee, I observed that tertiary and body grounded at common pt. I recommended to make separate earthing arrangements for body and neutral. Your response to my query justifies my recommendation.

Answer :

1. By Dr. Debabrat Guha: Actually earthing is a little complex than it appears. It is also prone to mis-application sometimes
2. By Dr. Debabrat Guha : If the neutral is a conductor then the potential of the transformer neutral will

be close to zero held by e earth mass. If the flow of the current is largely through the earth mass back to the transformer neutral, the potential of the earth mass around the transformer will rise. All neutrals irrespective of separately earthed will attained this voltage of earth mass. It is difficult to all conditions here, as a rule separate earthing up to the ground level is preferred if you want to avoid any 'loop' or undesirable flow of current into different circuits. In case of upstream line fault(single phase to ground) of the transformer, the fault current will take available paths like ground path. Or ground path up to the nearest tower, then club the tower and thereafter the ground wire of the transmission line. It may also take the neutral of the downstream transformer and return through the two healthy phases. These can be simulated in the as system study and the actual potential worked out. Sorry for the intrusion and bad typing once again. Dr Rajamani is an authority on earthing and system grounding. He may throw some light on the subject.

3. By Er. A.N. Mishra: 1 was member of enquiry commitee detecting reason of failure of 50 mva ptr at 132/33 kV grid.It was case of tertiary failure. It was observed that body, neutral and tertiary, all 3 earthed at common pt.I recommended to make them separate and wanted to know as to what extent was I correct.
4. By Er. Venkareswarulu Reliance: When all earth electrodes are connected as an earth grid then the potential being same why separate earthing is recommended. It is better to investigate the tertiary winding with proper RCA. Yes if earthing system is designed or executed wrongly then it is a separate issue.
5. By Er. A.N. Mishra: In any case, it is believed sir that neutral should be separate and distinct.
6. Not to be aligned to body earth.
7. By Er. Venkareswarulu Reliance: It is a general practice to blame earthing system whenever there is a failure. No one is bothered to check it in normal operation. All of a sudden it becomes a villain
8. By P.K.Pattanaik OPTCL

   Your concern on the earthing practice of PTR and it's auxiliaries are really to be addressed properly with engg back up.

   The pattern of TERTIARY wdg Earthing discussion has already been covered in the GROUP. which is summarised once again.

   1. TERTIARY if not loaded one then one of the terminal to be solid earth on separate pit or tripod pit (3 no of interconnected earth pit being separated by 3.3 MTR among them) and finally thus tripod must be connected to earth mat.
   2. If loaded TERTIARY wdg and but not loaded, then this can be also solid grounded or to be connected with suitable LA, but BIL of the insulation used must be high.
   3. Winding Neutral has also to be solid grounded as like tripod on point 1 and again to be connected to mat.
   4. Body earthing to be connected to separate pit and again connected to mat.
   5. So earthing practice as discussed to be taken to separate pit but finally to all connected to mat.

      Comments by Venkateswarulu is correct and to be interpreted properly.

      The reason of TERTIARY failure could be different. Pl go through our article. Others pl comment because the handling of TERTIARY wdg becomes the regular query of members.
9. By Er. Surya Prakask Aptransco:

   Your case study, testing analysis on failure of tertiary winding is educative and useful. Sir,In our state we carry out double earthing of neutral and body of PTR. Neutral-- one earth to electrode , electrode to earth mat. Second earth direct to earth mat. PTR body --one earth on one side of body to seperate earth electrode, electrode to earth mat. Second earth on other side of body direct to earth mat.
10. By Er. Ramachandran, ABB : I believe the earthing arrangement described by Mr Rao is the appropriate one and generally followed everywhere. But double earthing at two different positions is only for more reliability to avoid accidentally any earthing part getting open. I think it is not for any voltage rise during fault conditions etc. If that is the issue, best is only one point common earthing. Many years back I came across a case of earthing of tank body of a rectifier Trf in an aluminium smelter. The current in body earthing were of the order of 800 A. I suggested to work with one body earthing and

then current came down to 150 A. Most of the time the failure of tertiary is only due to inadequate and / or inappropriate design / spec of tertiary. With a LG fault on secondary lines, the current circulating in tertiary delta can be more than even a 3L fault at tertiary line terminals. Dynamic forces due to this over current in slender tertiary winding, can destabilise the innermost tertiary, buckling it to core or telescopically slipping axially and in the process insulation get damaged leading to inter turn fault or earthing to ground, resulting in extensive damages .

11. By Er. A.N. Mishra: Knowledge improving discussion
12. By Er. Raman Narayanswami, PRDC : wish to point out that we should differentiate between safety earthing and other types of earthing.Failure of insulation in 3-winding transformers is caused by transferred lightning voltages rather than L-L-G type of faults, in my opinion. My opinion should not be taken as the last word. During the beginning of my career, my boss, a high voltage specialist introduced me to the subject of transferred surges in 3-winding transformers. I am only speaking from my own personal experience. I also came across a CBIP report on failure of 3-winding transformers due to lightning surges.
13. By Er. Ramachandran, ABB: Tertiary windings are tested for transferred surges during impulse testing at factory. The only part that is not tested is the terminal bushings of tertiary as during impulse testing of the windings near to tertiary, tertiary terminals will be in earthed condition. But tertiary winding will see transferred surges. Except in case of EHV auto transformers, tertiary will be inside of LV winding and hence transferred surges is not an issue with tertiary. It is true that nearly 40 years back in some 220 kV auto trfs, tertiary failed as bushing flashed to earth from transferred surges. This resulted in 2LG fault on tertiary causing fault current in winding which tertiary could not withstand. This is no more a issue as specifications changed, increasing tertiary bushing voltage class one step higher in auto trfs. 33 kV for 11 kV winding etc. In case of normal two winding trfs, this is not required and not adopted in tertiary bushings. But with every LG fault in lines, high current will flow in tertiary winding, without any transferred surges.
14. By Er.Sabyasachi Ray, WBSETCL
    1. Tertiary can be kept floating with higher bil considering inter winding capacitance.
    2. L.A. (ph-ph ; ph-earth) & surge capacitor may be used to provide additional protection.
    3. Single point earthing may be done to cover it under diff protection for second earth fault.
    4. Open delta protection is another option to protect the un earth system.
15. By Er. A.N. Mishra: Do we apprehend disaster in case common earthing is adopted and instead of surge, lightning stroke hits the system ?
16. By Er. Surya Prakask Aptransco

    In 1996 or so at Gachibowli (Hyderabad) 220/132/33 kV SS, Crompton Greaves 100 MVA Auto transformer one phase brazing at neutral got opened due to a line fault on a 33 kV feeder connected to a 132/33 kV SS which was fed from Gachibowli SS.

    My doubt is when we connect PTR neutral and tertiary to one point and in case two phases are opened at neutral what happens.
17. By Er. A.N. Mishra: The failure under discussion resulted after heavy lightning stroke at Hatia grid S/S. It was opined that had the earthings for neutral and LA , tertiary been made separatly, failure could have been avoided. Kindly comment and correct me if I am wrong.
18. By Er. Raman Narayanswami PRDC.

    Obviously you have a lot of practical experience. My knowledge is purely theoretical. I know that the winding capacitances to other windings and to earth will have impact on the transferred surges. These C values are normally obtained from transformer manufacturer.
19. By Er. Vijayan T, Tr: Substation earthing system is designed to keep step voltage not harm full to human, during a Bus bar to earth fault. Therefore even if earth pits are few meters apart, potential difference will not vary more than 1 or 2 kV.
20. By Er. Nihar Raj, ABB : Under power frequency fault conditions the voltage variation may be small. (Considering earth grid as equi potential).

    However it will be interesting to see the variation under high frequency conditions (lightning). The earth lead inductance becomes highly dominant with increase in lead. Better to have electrodes as close to LA as possible and connected to the grid. Also for aged substations pls also check the contact

resistance at the test points of LA electrode and the electrode resistance (when disconnected from the grid) this will also give a good estimate of the electrode health and it's efficiency.

21. By Er. Ramachandran, ABB: When LA grounding lead length is more and the grounding of arrester is not connected with Trf earth, the voltage seen by Trf insulation will be arrester residual voltage + inductive drop in lead which can be substantial. So common grounding is required as per NFPA 780 std for lightning protection system. Also see Industrial Power System Grounding Design Handbook by Dunki Jacobs (2007) best book on the subject. Let me explain the inductive drop. When surge current (say 10 kA) flow through the lead from arrester base to earth, the whole area between the arrester earth lead to ground vs transformer tank side and ground level vs the live connection wire between the arrester top to Trf bushing top gets charged up with flux lines. Since this current change is so fast (rise 10 micro seconds and decay by 100 micro seconds) by Faraday's law, a voltage is developed at the base of arrester, adding to the cut off voltage of arrester. This voltage rise is proportional to the above area explained. If arrester is near to the transformer, area comes down. If earthing points are nearby also the square size comes down, reducing the voltage rise at arrester base.

Question : By Er. Jena Sittal : In the absence of grid power can the grid connected solar plants generate. This 30 MW plant cannot generate in the absence of grid power. That is the concern for reliability of on grid solar power.

Answer : 1. By Er. Shreedhar Bits Pilani : That's true

Question : By Er. Das Essar: Our 40/50 MVA trafo radiators started pitting at Paradip. We want to open and apply some special paint. Requested to guide which paint should we apply to restrict future rusting. Trafo is 5 years old.

Answer : 1. By Er. Sushil Sindhe, Raj Petro

Remove the loose paint with scrapping or with wire brush, clean it with sandpaper & solvent, dry it and apply interplus 256 (akzo paint). Result depends upon how good surface preparation is done. For solving long term corrosion problem use hotdip galvanized radiators & accessories on transformers Use C5 M category paint system for high salinity atmosphere. Prepare the surface by use of suitable avaliable tools for oil, salt, grease and dust free. The C5M paint systems are available with Akzo Nobel.

2. By P.K.Pattanaik, OPTCL : If surface preparation is not good applying anything will result to failure. There are certain rust preventing paints available with Dow Corning India. They have factory in Tarapur by name of USL Universal Silicones Limited. They come with guarantee

Question : By Er Susanta : For a CT of CTR 800/400/200 : 1/1/1. When we open the CT found P1 is shorted with main tank why so?

Answer : 1. By Er. Vijayan T. Tr: This is standard practice followed by all manufacturers. This is done to avoid floating of the tank. To avoid discharge all conducting elements are to be connected to earth or to a potential terminal.

2. By Er. Pramod Rao Yash : As mentioned by Mr. Er. Vijayan, One terminal of the primary is connected to Tank, to ensure the Tank is connected to system Voltage, otherwise there is no other mechanism to do so. Also the insulation needs to have a HV electrode built on the insulation by using Aluminium or copper foils. This HV electrode is also connected to tank, thus HV potential is brought from Primary to Tank to HV electrode.

3. By Getco Er. A R Shah: It's also to avoid circulating current due to potential difference in case of live tank CT.

4. By Er. Surya Prakask Aptransco: I got the same doubt when I have opened a 66 kV C.T. in 1974. My boss told me that between high voltage primary and tank there is insulating oil which acts as capacitor and there is leading leakage current and to avoid that incoming primary lead is shorted with tank.If I am wrong please correct me.

5. By Er. Sabyasachi Ray WBSETCL: The tank is shorted with primary terminal to make it equipotential for avoiding capacitive discharge between these two.

Question : By P.K. Beura: Please share the calculation of voltage dip during charging of Transformer.

Answer : 1. By Dr Sridhar: I have a communication written on my PC in Word, on the question raised by Sudhir on Voltage Drop during charging of Transformers.

Question : By Er Neeraj, BSES : We have ABB relays, spacom series SPAJ140C, in some of our substations, the

problem we are facing is that program cards spcj4d29 of many relays are greeting faulty repeatedly showing either IRF or one phase current showing zero. Kindly put some light on this.

Question : By Er Sushil

Please guide to know the total surface area of members of 132 kV transmission towers of IN97E & NZE1 for cost estimation for painting of towers. I tried data from websites but unable to get it.

Answer : 1. By Construction Pragyan:

To find the surface area we can take the help of bill of material of the particular type of tower where the detailed data like length, breadth and width of each member are mentioned. From those data we can find the surface area.

Question : By Er Pawan I want to know what should be height of bushing for 2300 m altitude.

Answer : By Tarun Garg, ABB: For 2300 m altitude, bushing arcing distance needs to be increased and it may call for selecting next higher voltage level bushing.

Question : By Er Wasif, NTPC Wish to know the Utilities having Generator Transformer Temp rise limits for oil/ Wdg. as 35/45 deg.

By Rakesh Jain : Want to know the safe operating load limit of 100 MVA transformer .

Answer :

1. By Er. Surya Prakask Aptransco: The optimum loading on the transformer is not more than 80% of its capacity. The efficient loading is 50% of its capacity Under any circumstances the temperature of Wdg and oil is to be within the guaranteed values . At the same time oil temperature shall not exceed 100 deg centigrade even for short duration. The flash point of oil in new PTR as received is 120 deg. centigrade. In a in service PTR it will be much more lower due to deterioration of oil. When our atmospheric temperature is 50 deg.cen.. at full load on PTR the oil temperature may touch 100deg.cen.We take LV side values as loading When LV side current is rated full load current and we are operating the PTR at highest tap due to low voltages of the system, the HV side current will be 25% more than rated full load current on HV. Taking all these in to account the optimum loading on PTR shall not be more than 80% of its capacity. However time to time temperature rise is to be taken in to account. We have to delete the terms" over loading and over voltage operation" of both power and distribution transformers from the dictionary of transformers. In 1996 we have seen in UK that they operate transformers at not more than 50% their capacities. They have paralleled DTRs on LV side shifted load from one DTR to another DTR to carry maintenance on one DTR.
2. By Rakesh Jain

   Further, in the wind industry where the utilisation of the equipment over the year is approx 20% and most of the time the equipment remain unutilized. However, during high wind period in summers for very less period it goes near full load. In such case in a time when temp is near design temp and voltage tap is with in 5% up, normally we exceed the load upto 10% in emergency like short period overloaded. However, the trip setting is kept near full load. In such circumstances can we overload depending upon the oil or winding temp monitoring basis depending upon the trip setting of oil temp or winding temperature.
3. By Er. Surya Prakask Aptransco:

   Under the above given circumstances, when there is no option, we may over load for short duration by providing additional cooling equipment like cooling fans. However as you said maintaining temperatures within limits is essential. However we may seek opinion of experts in the field of PTRs.
4. By Er. A.N. Mishra: Rating of m/c is based on heating. Ignoring unhealthy competition among manufacturers, power T/F is well designed to withstand continuous o/L Heat run tests are conducted by feeding cu loss plus core loss and run continuously till rise in temp. Of top oil above ambient is stable. The permissible temp. rise above ambient is 35 for top oil and 40 for winding as per IS1180 and REC guidelines .Earlier , allowable rise above ambient was 45 for top oil and 50 for winding. If risr in temp. is within the limit we can go for desired short time or constant overloadings. Kindly correct me if wrong.
5. By Er. Mamtora Tr : I would like to answer the question raised by Rakesh about the safe limits of loading the transformers. There is a loading guide on the transformers. The loading depends on the ambient temperature and the oil and winding temperature rise as mentioned in the specification and limiting the hot spot temperature. The temperature rise test is done on all of the new designs to ensure that none of the limits exceed the specified values. But there is a catch here. Unless specified by the client the

temperature rise test is carried out feeding the losses at 75 deg. But with higher ambient the absolute temp. may be more than 75 deg. Many utilities asked for the temperature rise test by feeding the losses at highest absolute temp which the winding and oil rise can attain in the worst of the conditions.

Under the circumstances you can load the transformer till the temp rises are within the limits. Meeting the above limits there shall not be any risk on the life of the transformers.

Regarding the transformers for the windmills, the peak load occurs when the wind velocity is at its peak and the heat dissipation from the radiators is more than that in case of ONAF cooling beside the fact that heat dissipated through the tank wall also increases. Therefore the limitations on loading should be based on the temperature rises.

I shall appreciate the comments from the Industry stalwarts.

6. By Er. Raman Narayanswami PRDC: Please don't forget that there are protections such as winding temperature and oil temperature with alarm and trip settings.
7. By Er. Mamtora Tr : Yes, but you should set a deg or two lower than the maxm specified.
8. By Er. A.N. Mishra: Allowable rise is 35°.considering maxm summer temp as 46°,top oil temp of 81°or so could be operating range.
9. By Er. Raman Narayanswami PRDC: We are all greedy!

   Forget about transformers, I have seen LT switchgear cooled by external fans to limit temperature rise in India.
10. By Dr Sridhar: T V Sridhar

    Cooling Switchgear Cubicles with temporary External Fans, e.g. Almonard Man Cooler is more common than one may think. Most high current, e.g. LV cubicles, or 1600 A 11 kV, develop high contact Resistance and "boil over". Indian ingenuity!
11. By Er. Jayanta Dutta, DVC: In some of the Power Transformers the allowable temperature rise for oil is 40 degree and 45 degree above ambiant. Hence with constant monitoring of the temperature the transformer loading can be monitored.
12. By Dr Sridhar: T V Sridhar

    But you forgot to say what you hope to achieve by constantly monitoring top oil temp.
13. By Er. Ramachandran ABB: Let me give some facts on transformer loading : (1) max top oil and winding rise is same whether Trf is in India, Saudi Arabia or Europe as local standards
14. By Er. Mamtora Tr : Temperature rise in general in Europe is 60/65 and in India is 50/55 based on the weighted avg ambient. Pl correct me if I am wrong. The life of the insulation is based on the absolute temperature and the thermal shocks, may be because of the extreme temperatures of day and night and not on the temperature rises in isolation.
15. By T.V. Sridhar : The use of the integrated I^2 t, with piecewise linear life expectancy at segments of temperature will probably be the most appropriate. But my own feeling is that Transformers never die peacefully of old age in India, but catastrophically due to wounds inflicted, e.g. poor manufacturing techniques.
16. By Er. Ramachandran, ABB:
    (1) Adjust oil and wdg rise to suit local weighted annual average temperatures.
    (2) Copper loss for temperature rise is taken at 85 c in US & France and 75 c rest of the world. Frankly this difference or copper loss based on max ambient (this is an unnecessary conservative approach) has very little effect in actual oil rise. 75 c was arrived at 20 (annual average ambient in Europe) + 55 c (max wdg rise at that time) We should remember that ambient temp and load are dynamic and what ever loss of life due to higher temperature is compensated by relative gain in life at lower ambient Trfs can be overloaded for short periods within limits given in IEC 60076-7(oil) or 60076-12 (dry) In our country, rail track supply trfs used by Railways (10 MVA in the beginning and now reached 40 MVA, 100 MVA for bullet trains) are specified and regularly loaded for 150 % & 200% load for more than 50 years. So there is nothing wrong in overloading, provided with in limits. One important point is overloading may be avoided in trfs having high humidity (e.g. old trfs) as ageing rate is extremely high at high moisture content for the same temperature on paper.
17 By Er. Ramachandran ABB: to Mamtoraji, Dr Sridhar - you are right and I fully agree with your views.

In Europe weighted ambient is 20 c and in India we have taken 32 c and accordingly reduced max wig rise for India. As Dr said we are seeing failures from paper ageing very rarely but it does not mean it is not an issue. Failures are not from average heating of paper but from hot spots. When some one make a Trf using 1.8x 15 conductor for HV average wig rise will be ok, but wdg hot spot gradient will not be 110% (as per old std) but 200%. This will go unnoticed. So the old adage -Trf life depends not on passing on plethora of tests or tens of on line monitoring devices but built up quality under deep transformer knowledge with safe operation and condition based maintenance.

18. By Er. Ramachandran, ABB: 4) During the early days of transformers, copper loss was same as iron loss and maximum efficiency was at full load. Today this loss ratio is 4 - 5, thanks to the great improvement in core material and construction. Hence max efficiency will be at less than 50 % load. But this means one need not plan loading trfs at 50 % load. It will be a shear waste of resources. Today the trend is meet peak loads by short time overloading (e.g. CEGB MV Trfs) but it must be designed and tested for such operation as being done by Railways.
19. By Er. Mamtora Tr : I have experienced that the indoor installation are not provided with any cross ventilation thereby raising the ambient and then they put the main coolers even then the temperature does not drop to desired value. Once you have the cross ventilation or have the ambient temperature not more then 50 deg. one does not have the issue.
20. By Dr Sridhar: T.V. Sridhar

    What you have commented is very often borne out in Residential and Commercial complexes where a Resin cast Transformer is installed underground, and there is no ventilation at all! It would be wise to caution the user to provide fans to move the air, before he comes crying back to the manufacturer.
21. By Er. Ramachandran ABB: A good calculation for ventilation requirements for indoor transformers is given in iec std 60076-16 trfs for wind power generation.

    Experience TALK : By Er. Surya, Prakask Aptransco:

    I would like to write my experience with 132 kV SSRR3V relays (starter switched reactance relays of EEmake) at F C I (Fertilizer corporation of India) factory SS, Ramagundam, Telangana.

    I worked as ADE (Prot.and Instrumentation) at Ramagundam Power Station 'B ' for about 3 years during 1980s.

    It is a 62.5 MW thermal P. S.and was having following 132 kV feeders.

    (1) 2nos 132 kV Warangal feeders connected to grid.
    (2) one no 133 kV pochampad feeder
    (3) one no 132 kV Karimnagar feeder
    (4) 2nos 132 kV FCI feeders(parallel feeders)
    (5) one 132 kV feeder connected to 40 MVA, 132 kV /66 kV Auto transformer which in turn connected at 66 kV to Ramagundam 37.5 MW 'A' Power Station.

    Whenever there is tripping of either Karimnagar or Pochampad feeder on fault the FCI feeders used to trip at FCI end.Since this is outside the Power Station it is not concerned to me. However the concerned ADE /MRT /Warangal requested me to be with them and help in testing the relays of the feeders. The distance relays were EEmake SSRR3V relays with Mho starters.

    We have tested the relays of one feeder with EE make ZFB test kit.

    The test results were far away from calculated values. Some times Mho relay was not picking up. These relays are of draw-out. We have interchanged Mho starters. No use.

    We have introduced 5 amps ammeter and 110 Volts volmeter between test kit and Mho relay. During the testing the current from test kit to relay was very low less than 0.5 amps. Then we got a doubt about contact between case and cradle of the relays. We have drawn out the Mho relays. They have got one bottom and one top contact block each having 10 contact strips with insulation between strips. These individual strips make contact with the strips in the case.

We have drawn out the Mho relays and lossened the side fixing screws of top and bottom contact blocks and pushed both the blocks slightly away from relay unit and tightened the fixing screws.

Inserted the relays and tested.we got test results correctly.

Afterwards there was no mal operation of relays.

Inference : Contact problem between contact strips of case and cradle of the relays.

Question : By Er. Vikash Saxena, PGCIL: I would like to receive comments on following :

A 765/400 kV 3x500 MVA transformer bank was commissioned in September 16. I have been to this location several times in past months for some other works, and noise levels have been observed to be high (experience basis including that of local operating staff- no measurement at site) till very recently. However since few days back noise levels in all three phase units have gone down. Voltage varies from 765 to 800 kV and No correlation with voltage level could be observed as noise was high even with voltage of 765-770 kV. Loading of transformer bank remains low 150- 500 MVA.

It is good that noise has gone down but if goes up again it will be matter of concern.

It would be interesting to get comments regarding possible reasons.

Answer :

1. By Er. Ramachandran, ABB : Noise in trfs- please check v/ f with respect to operating tap. In case v/ f is more, this can result in over fluxing and more noise. Second is there another bank parallel to this ? Then phenomena sympathetic inrush current can happen.if this is so noise will be alternating between these banks.
2. By Er. Vikash Saxena, PGCIL: Transformer has remained on Normal tap I. E. 765/ 400 kV and as mentioned earlier voltage variation is in 765- 800 kV range with frequency remaining close to 50 and not going below 49.9/ 49.8.

   Further high noise was observed persistently for last 3 months
3. By Dr Sridhar: T.V. Sridhar

   Mr. Ramachandran is quite correct. I have had Transformers already charged and loaded trip when a Transformer is charged in parallel. A Transformer in parallel, drawing a high magnetizing current saturated with harmonics can cause a Transfomer growl because of the Harmonic drop in the supply.
4. By Er. Vijayan T Tr: Sound level varies with loading also. Higher the load higher the noise. Vibration of tank is the source of noise.
5. By Tyagi: We had this problem of noise/ humming sound for few Transformers immediately after charging of 765/400 kV Transformers. We fine tuned Controlled switching devices so that inrush currents were reduced from 2000 Amp to about 15 Amp. The problem is no more.
6. By Er. Ramachandran ABB: When inrush current is reduced, chances for sympathetic inrush current creating humming sound is eliminated. PGCIL discussed this issue with me at that time and I explained the symptoms of sympathetic inrush current. Later, after checking, confirmed to me that it was sympathetic inrush. This was first analysed by a GE engineer in 1941. He was also the inventor of harmonic restraint feature in Trf differential relay. When a new Trf is switched on to a paralleled unit, the inrush current causes a distorted voltage drop on the incoming line. This affects the unit already running. The distorted voltage cause distorted flux in the already working unit. The net DC current circulate between the two units causing alternate peak and hence noise in the two units. Problem

   Is more when grid is weak (i.e. fault level less and hence line impedance more) because of higher voltage drop from inrush current.
7. By Dr Sridhar: T.V.Sridhar

   To Mr.P. Ramachandran

   Continuing on my own experience, I had to fit Harmonic Restraint O/C Relays. I could not use Harmonic Restraint Differential, because the system had not been planned with Differential Protection. It is hard to come by o/c relays with Harmonic Restraint in India. We had to import. I was toying with the idea of using locally available Differential Relay, and cut it out before loading the Transfomer, because I could not place Differential CTs anywhere.
8. By Er. Vikash Saxena, PGCIL: Tyagi this is not a case of noise during charging and immediately thereafter but this high noise level persisted for about 3 months and then by itself subsided. Also there is no parallel bank.

   Hope noise does not increase again. However if it increases again it may be matter of concern.

Question : By Er. PP Wahi CBIP : We have seen the life of imported Japanese transformers in lndia of the order of 50 to 60 years

Could we consider manufacturing similar quality transformers with 5 star rating as we do for distribution transformers or other 5 star appliances in the country

Quite clearly ...the cost of this quality transformer can be fixed higher by the manufacturers by declaring

special guarantee period for the same

Presently..l think our power transformers survive half the life of the said imported transformers..This is an area of concern .

I think our experts in this sector like Ramachandran, Mr Vijaykumaran, Mr lakhiani. Mr Tiwari, can better comment and play better part to create quality transformers in the country in the years to come

Answer : 1. By Dr Sridhar: Sridhar

Thanks Mr. Wahi for hitting the nail squarely on the head. Calculations of Present Worth at the stage of Tender evaluation imply an assumed Life. If the Transformer dies before this life, who bears the penalty for making a mockery of the system?. The extreme values of capitalisation of losses needs to be ameliorated in the face of practical knowledge. Let the Industry prove that they have the Technology to make Transformers consistently last 30 years.

Question : By Er. Surya Prakask, Aptransco

(1) What happens if C.T. secodaries are connected in delta and output is fed to O/C Relays. If delta output current is more than relay rating whether suitable auxiliary CTs of high accuracy can't be used.

(2) Is it not proper to use one primary and two auxiliary CTs of high accuracy to have differential relay along with O/C Relays.

If I am wrong please correct me.

Answer : By Dr Sridhar: T.V. Sridhar

To Mr.K.V. Er. Surya Prakasa Rao

If I had the differential CTs with appropriate Knee Point I could have considered the alternatives you mention. Besides I am talking about a Test Setup, where differential Relays have no serious function. That is why even to start with I did not provide for differential protection. At the point where I started having problems on charging the Transformer, the most obvious choice was a Harmonic Restraint O/C Relay. The switchgear was too jam packed for one more CT. I did consider installing a set of outdoor CTs, but you won't believe me that the Yard was so full up that I could find no space. Further for the sake of Personnel safety (I anticipated that the Test Engineers would like access to the Yard at all times, including when the Transformer was live, and a Test was going on. Tapchanger Type Test lasts typically 20 days, and it would have been impractical to shut the Test Engineers out for so long) so I decided to cable conect all the equipment. These considerations resulted in my opting for Harmonic Restraint O/C Relays from overseas supplier.

Experience TALK: By Er. Surya Prakask, Aptransco

Today I would like to write about my experience with a new 3.15 MVA power transformer at Secunderabad circle.

A new 3.15 MVA, 33/11 kV power transformer was commissioned during 1994-95 at a 33/11 kV SS in the premises of a private hospital near Medchal (pertains to sec'bad opn.circle) to extend 500 kVA H.T. supply to hospital. It was provided with H.G. Fuse protection on 33 kV side and with a 11 kV VCB on 11 kV side of PTR. 11 kV supply to hospital was given through another 11 kV VCB.

Later on one more 11 kV VCB was erected and commissioned to extend power supply to 2nos DTrs out side hospital.

After connecting out side DTrs to this SS, with in 3 months, the 11 kV feeder breaker connected to DTrs tripped thrice on earth fault indication within three months. At the time of third tripping Main Buçholtz relay also acted. On checking the relay it was observed that gas was collected in the relay. The PTR was also tested and found to have failed. As the failure was within guarantee period we have handed over the PTR to manufacturer and got opened in our presence. The core and winding lifted from the tank and kept aside and inspected the same. It was found that a lengthy bolt was resting on the bottom core fixing channel. one end on channel and the other end on the bottom of the HV winding (33 kV delta)where the paper insulation found burnt.

Where from this bolt has come?

It was one out of the three bolts used for fixing top yoke to channels. Two were in position. One fallen to bottom channel. We got the tank and winding internal searched thoroughly. No nuts, no lock washers.

It was inferred that DURING MANUFACTURING PROCESS THIS BOLT WAS KEPT IN POSITION

AND FIXING NUTS etc was forgotten and not done.

So during first two earth faults the bolt got displaced and during third tripping bolt has fallen down and 33 kV delta winding insulation failed.

So, I feel three stage inspections by the purchaser are essential in case of transformers.

(1) Material --winding, core, insulation materials inspection. Tank, Radiators, Instruments, protective devices checking

(2) After assembling core and winding before keeping in heating chamber through inspection of core and winding.

(3) When the PTR is ready for delivery acceptance tests.

Supplement to Er. Surya Prakasa Rao By Dr Sridhar: T.V. Sridhar

To Mr. K.V. Er. Surya Prakasa Rao

I am sorry to present a constrain point of view. I am not sure any number of hawk eyed Inspectors would have noticed the kind of problem you describe. Very often the presence of a hoard of internal Inspectors is counter productive. I may sound like a Gandhian Utopian, but we have to tread the difficult path of getting the workers to respect their job, and appreciate how small acts of negligence may be costly for their own company, and the poor purchaser.

Question : By Er. A.N. Mishra: This august body may kindly like to opine. In a pf improvement project it is proposed to install shunt capacitor of 1300 kvar in each 11 kV feeder. on examination of scheme proposed by the vendor M/S EPKOS India it was observed that star connected bank has been proposed. Rep. of vendor was summoned to clarify why not we should opt for delta bank, since requirement of capacitance in delta mode will be only one third that if connected in star mode, the vendor replied that star mode will be designed for 7.5 kV and delta mode for 12 kV and the cost will be same. Not convinced, tried to search on google but without any result. kindly opine.

Answer : 1. By Er. Surya Prakask Aptransco:

I would like to write the following for your question about capacitors.

(1) I have seen two types of out door shunt capacitors --single bushing , two bushing type

Single bushing type is only suitable for star connected units.

For delta connected units invariably two bushing type are required.

The bushing rated voltages for delta connected units will be higher.

(2) The containers shall be higher in size. When in one RY capacitor, R bushing fails whole top structure will be at R voltage and BY Capacitors shall stand even for a moment.

So higher insulation is required .

I think the equal cost is not wrong.

Whether high voltage capacitors connected in delta are being used any where sir.

I have got a doubt at what angle the line current of delta connected capacitor will be leading the phase voltage of 11kV line.

If I am wrong please correct me

2. By Er. A.N. Mishra: It was for the first time I interacted with a capacitor project.Actually in Jharkhand poor pf has not been a big issue and had been receiving handsome amount under ABT regime for supply of reactive lead to system.while taking up the project, a question raised as why should we not go for delta bank.In any case current leads the voltage by a little less than 90°. Regards sir. may kindly like to comment.

3. By Er. Surya Prakask Aptransco:

During my service as ADE/MRT and DE/MRT in APSEB, I remember to have commissioned,

(1) 15 nos 33 kV, 5 MVAR Capacitor banks --all are single star or double star

(2) 20 nos 11 kV, 2 MVAR Capacitor banks --all are double star.

(3) 15 nos 11 kV, 600 kVAR, automatic switched line capacitors --all are single star.

I have not seen any delta connected HV Capacitors,

4. By Er. Mamtora Tr : Dear Amar, pl post your e-mail address so that I can send you the calculations, so

as not to disturb other members. Jitendra Mamtora

5. By Er. Mohapatra Saroj: Dear sir,

   Normally as a practice delta connection for capacitor is used in the LV system and star connected for HV systems.

   For delta connected capacitors the advantage is that, for the same cell capacitance the line capacitive reactance shall be 3 times of the value with star connection. But this also means we need insulation for phase as well as line voltages. The cost of providing insulation is becomes very incase of higher voltage. Therefore, at 11 kV normally you will see star connected. But in LV systems delta connection is highly recommended.

6. By Er. Surya Prakask, Aptransco:

   I read in one Distribution Hand Book that the star connected capacitors with earthed neutral OR delta connected capacitors may pose problems on PTRs during line faults by increasing fault levels. This may be got examined.

   Further all the capacitor units in our state are star connected with unearthed neutral.

Question : By Er. Tripathy Pc Sir: In a Power Transformer the OLTC is the only dynamic component and failure of transformer is mostly due to fault in OLTC. Also it is the most neglected and least maintained part of the transformer, for which carbon deposition and degeneration of oil occurs, which lead to fault. If the oil is substituted by SF6 gas, then I think the fault will substantially reduce and the OLTC will require minimum maintenance. If some advance has been made in this line, then same can be expedited with necessary amendment in standard. If not some serious thought may be given in this line. Experts are requested to offer their views please.

Answer :

1. By Vedanta Nigam: Vacuum type oltc is available.
2. By Er. Surya Prakask, Aptransco:

   Very good information. Upto what voltage Vaccum OLTC is available .Is there any adverse effect on Main tank.
3. By Er. Tripathy The manufacturers should come forward with the design.
4. By Er. Chinathambi Seimens: As transformer manufacture SIEMENS India have already exported transformers fitted with vacuum type OLTC. MR Germany Website contains more technical details of such vacuum type OLTC.
5. By Er. Chinathambi, Seimens: Many other transformer OEMs also had supplied transformers fitted with vacuum type OLTC already.
6. Tripathy PC Sir: With vacuum type OLTC there may be voltage limitations, as in the case of circuit breaker. So for higher voltage class SF6 gas may be more suitable.

Experience TALK by Er. Venkateswarulu, Aptransco: CT polarity most important in REF relay for transformer protection: we commissioned a 400/220 kV 315 MVA t/f with an Ref relay on 220 kV side. The summated phase currents and the neutral ct current are so connected that as long as there is no ground fault in the t/f the relay will not operate. For external earth fault, the current will circulate in the loop and relay will not get any current and will be stable. On once incident, there was an earth fault on one of the 220kv feeders fed from this t/f . Along with the feedr distance relay ion, the 400/220 kV t/f also tripped on REF rest. On detailed check up, it was found that the Polarity of neutral ct is reversed. After correcting it, the relay is ok now.

Supplements by Dr Dineshbabu Nagalingam the polarity of CT is very important as rightly pointed out. In case of wrong polarity, the issue can be identified during the transformer stability test. We need to do single phase injection and verify the stability of REF relay. The calculated 3I0 and the measured ground current will nullify each other and the relay should read zero current. If it reads twice the current, then the CT polarity in the neutral is reversed. This issue would not be identified on balance three phase injection. This is one common issue happening everywhere since single phase injection testing is not a routine relay testing procedure followed by many.

Question : By Er. Jena Sittal : Now OPTCL System is adopting Substation Automation System.For proliferation of knowledge let somebody explain about integration of e terracontrol SCADA and HMI at Grid substation end.

Question : By Jayanta Dutta, DVC : we are on the process of procurement of 80 MVA 132 kV/34.5 kV star - Delta

power transformer for our organisation. We are thinking of installing RIP bushings in both 34.5 kV and 132 kV side. Kindly provide your valuable comments if we would go for RIP bushing or stay with the Conventional bushings

Sir I would like to add here that our consumers are mostly at 33kV level and many of them have arc furnaces. Request the experienced group members to kindly comment.

Answer :

1. By Er. Ramachandran, ABB: 80 MVA - suggest that 34.5 kV can be plain bushings as per IS 3347 to save money. - It is true many times Ct polarity of neutral ct creates so much problem . It is very difficult to detect it when it is a bushing ct as single phase injection is not easy. Solution for this is to provide a test winding for the bct so thT polarity etc can be checked very easily. It is a single turn winding on ct core which acts as primary winding. For details see the annexure in latest CBIP. Transformer Manual where self had authored a chapter on this subject.
2. By Er. Mamtora Tr : I agree with Mr. Ramchandran to use porcelain bushings instead of Rip as it saves cost and not any disadvantage.
3. By Er. Surya Prakask, Aptransco:

   I am very happy to follow the discussion on a very very important topic "CT polarities and reversal of polarities, its effect in case of neutral CT polarity reversal on REF relay".

   It is also very happy to know that you have given a solution to overcome this problem.

   I got a small doubt. Generally we do short circuit test on PTRS at site as one of the precommissioning tests.

   Since the PTRs have got bushing CTs in phase bushings and neutral bushing to feed REF relay, can't we do short circuit test for one phase winding, by applying voltage from a suitable variac to one phase and neutral on HV side of PTR duly shorting corresponding phase and neutral on LV side. If apply about 450 Volts on primary for one phase and neutral for a 315 MVA PTR, we may get about 10 milli amps each at the secondaries of both the CTs, we can measure the current at REF relay by connecting a milliammeter in series with the relay. The short circuit current will come out from LV phase bushing and enter the neutral from top and complets the circuit. It amounts to as if it is external single phase to ground fault. If secondaries of CTs are properly connected the milliammeter will indicate Zero at REF relay. Otherwise about 20 milli amps.

   Sir, is there any limitations for such test to ensure correct connections to REF relay.

   If I am wrong please correct me.
4. By Er. B.S. Palki, ABB: Another way to make sure that the CT connections to REF relay is done properly is to carry out polarity test on CT. This can be easily done by a small battery and a DC milliammeter. I have done this in my younger days in few sites with good results. This is particularly for neutral CT.
5. By Doble Watwe: A separate CT in neutral for REF can also be provided.
6. By Jayanta Dutta Dvc: When we commission transformers during checking of Zero Sequence stability at low voltage, the REF stability is also checked. The current in the REF relay is checked and if the polarity is ok then the current is zero. Again the secondary wires of the neutral CT at the transformer marshalling kiosk is changed intentionally to check if the current is doubled or not during this stability. By this way normally we carry out our REF connection. Sorry to add initially polarity of the CT, S are checked through battery and a DC multimeter through flick test. Kindly correct if we are wrong.
7. By Dr Dineshbabu Nagalingam With the availability of numerical relays we can identify the polarity easily. The relay should be configured for waveform trigger using breaker status. On charging the transformer, the inrush current provides uneven current in all the phases and the relay will record the current along with ref differential current. If the polarity is correct, the ref current will be zero else it will be twice the In, which also can be recorded.
8. By Dr Dineshbabu Nagalingam from this graph we can confirm the CT polarity.
9. By Er. Ramachandran Abb: Bushing CT polarity- all previous comments- let me confess, I don't have any hands on experience on testing or protection. A few years back, I had a problem with a 315 MVA auto- after commissioning REF was tripping continually. Customer had to suffer this for few months. No one could give a solution. Finally primary injection was arranged and the mistake was in neutral BCT polarity. On my search for a permanent solution I found that European manufacturers provide this test winding in protection BCTs. This is a 10 A one turn in addition to secondary winding on CT core.

This test winding will be kept in open condition during service and when test winding is energised, transformer winding (i.e. primary of BCT) shall be kept open. Are experts are of view that this test turn is not required with modern relays? Is it easy to apply dc to a 400 kV Trf winding and test polarity? BS 3938 - 1973 covered this test winding. Many transformer manufacturers are now providing this so that CTs can be fully tested anytime without much hassles. If experts feel otherwise we should delete this from CBIP transformer manual.

Experience TALK By Er. Surya Prakask Aptransco:

I would like to write about my experience with one 8MVA, 33/11 kV power transformer at 33/11 kV Chilakalaguda Substation, Secunderabad operation circle.

I joined as DE /MRT in this circle during 1993.

One day evening I got a complaint that the HV and LV breakers of one 8 MVA power transformer at Chilakalaguda SS, tripped on Bucholtz relay indication. We have gone there and checked the Bucholtz relay. There was no gas or air in the relay.All the tests were conducted on the power transformer. Results were alright. The PTR was charged and found alright. The PTR was also put on load. It was alright.when we have seen the log sheet,we noticed that one 11 kV feeder tripped on earth fault and along with that the Bucholtz relay acted. Next day we have checked the cable connections to the Bucholtz relay and tested the Bucholtz relay. It was alright.

After one week again Bucholtz relay of the PTR acted along with tripping of 11 kV feeder on fault. The PTR was alright. It has become a regular feature. Whenever any11 kV feeder connected to that PTR was tripping on fault Bucholtz relay was also acting.

We have taken the PTR to departmental repairing shed at Shapoornagar EHT SS, and opened the PTR and lifted core and winding checked found to be alright.

We noticed that the Vent pipe was provided with two diaphragms one at bottom and the other at the end. The bottom one was found to have punctuated completely in to pieces. We have provided A new diaphragm at the bottom. The transformer was assembled, New transformer oil filled and filtered. The PTR tested and erected at Kandukur 33/11 kV SS, charged and taken in to service. Later We did not had the old problem of Bucholtz relay tripping along with feeder tripping on fault.

Supplements

1. By Er. Ramachandran, ABB: Question comes why the gas relay operated with feeder trip? It cannot be due to rupture of lower diaphragm. If anything it could have acted as a gas collector preventing pick up by relay. It may be as below: In the first station LG fault was severe, meaning high current. Windings were moving violently in axial direction resulting in a surge flow in relay pipe or excessive vibration of the relay pipe

Any other view?

2. By Er. B.S. Palki, ABB: I have read in a CIGRE report that electromechanical forces acting on transformer tank can cause operation of Buchholz relay. If it persists one way to prevent is to provide over current element to block operation.
3. By Er. Guru Mishra, OPTCL: The inclination angle and right positioning of the buchholtz relay i.e 3 : 5 ratio w.r.t to conservator may also aid in maloperation due to centrifugal force of oil surge when there is a fault phenomenon ocuured in o/g feeders.
4. By Er. Watwe Doble: Such maloperation of buchholtz relay has been observed when the inclination angle is not proper.
5. By Er. Venkareswarulu, Reliance: We should eliminate mercury contacts forany transformer trip. After Gujarat Earthquake in 2001, at Reliance we have revised the specs and specified reed relay (magnetic actuated contacts). Mercury elimination is environmental friendly also.
6. By Dr. Debabrat Guha: I remember. But I still feel it was a blessing in disguise. Power was cut off through such 'maloperation' which was a good thing to do in such severe earthquake.
7. Er. Ramachandran, ABB: Most of the transformer manufacturers are now avoiding mercury contacts in all their accessories. Japanese were using only reed relays from the beginning as earth tremors are frequent there. I remember TELK importing such Buchholz relays nearly half a century back.
8. By Dr Sridhar: T V Sridhar Clear explanation of Buchholz tripping due to transient Tank bulging, and

undesired vibrations in slender pipes. I think this problem will go now that most Relays eschew use of Mercury Switches.

9. By Er. Venkareswarulu, Reliance: Transformer failures due to bushings is attributable is 17%. PowerGrid presented last Trafotech conference that bushings exploded 3 months after Tan Delta Capacitance measured in AM.

   They started variable low frequency 20 Hz and 400 Hz Tan Delta measurement.

10. By Er. Vikash Saxena, PGCIL: It would be interesting to know whether those bushings were of a particular make. I recall when in Power grid we were writing 765 kV specification for first time for Sipat system, ESKOM the South African utility were our Consultants. And their advice was - if one ensures good Bushings, OLTC and oil there is really no need for any fancy on line monitoring devices. And we did specify these three items by make in that project.

11. By Er. Bhowmick, PGCIL : It is true that failure rate for some particular manufacturer is high. But quite a few of bushings of other makes also fail.

12. By Er. Vikash Saxena, PGCIL: I understand Power grid is now specifying RIP bushings for 400 kV. How is the experience? How about 765 kV? Are these OIP or RIP.

13. By Er. Jayanta Dutta, DVC: We in DVC are using Omicron set as you referred CPC100 with CPTD 1 and results of Tan Delta Capacitance is measured with this set. In some cases this result have guided us in connection to the future coarse of action.

14. By Er. Bhowmick, PGCIL: POWERGRID is yet to specify RIP for 765 kV. But trying to bring all the bushingmanufactures on board towards development of 765 kV RIP bushings and type test them. You may be knowing that our 1200kv bushings are RIP developed by HSP, Germany. How we landed up in 1200 kV RIP, that's another story, which cannot be shared in public

15. By Er. Pramod Rao Yash : As for monitoring Bushing, if the Capacitance & Tab Delta measurements are carried out at 50 Hz, at a predefined periodicity; the trend analysis definitely indicates onset of a failure & thus preventive actions can be taken in time. I am yet to come across a case study where 50 Hz results did not indicate onset of failure , but measurements at variable frequency indicated it.

Question : By Er. Guru Mishra, OPTCL: to B.S. Palki : An LG fault was simulated in 4th quadrant under zone 1.The distance shown was 0 km. What is its physical interpretation others may please also share their experience if any the relay was micom p444.

Answer: By Er. B.S. Palki, ABB: An extension is given to the distance relay characteristic in the 4th quadrant to give directional security for very close in faults.

How the fault locator in MICOM or any other relay I will not be able to comment.

Experience TALK By Er. Surya Prakask, Aptransco:

Today I would like to write about my experience with 33 kV feeder CTs at 132/33 kV Er. Surya pet SS.

During 1987-88 or so the Er. Surya pet 132 /33 kV SS with 2nos 16 MVA Power transformers was commissioned. Four nos 33 kV feeders were also commissioned. At that time I was ADE /MRT.

After about four months, I got a complaint that 33 kV Er. Surya pet town feeder breaker is not standing and tripping frequently on E/F relay indication. We went there and discussed with Asst.Engineer, Substation. It was understood that the feeder tripped 3 times on earth fault. The lines staff checked the line, located the fault and rectified it. Then when they have closed the breaker it was standing for few minutes and tripping on E/F relay indication.

We have checked the cable connections at control panel,at breaker and relays. All were alright. Then we have carried out primary injection test on CTs.Two CTs were O.K. For them when we have injected 20%current of adopted ct ratio to the primary, E.L.relay acted and ammeter also indicated correct value. But for the third CT, when we have injected current to primary ammeter was showing reading but E.L. relay did not pick up.

In these CTs, secondary leads from the CTs are terminated at bottom. The bottom terminals to front studs, (to which we connect cables to CT junction box),the manufacturer provided single copper wire of 22 gauge one for each terminal. One of the wire connected to protection core terminal in the third CT was found to have fused and CT secondary (protection core) got open circuited .when they have charged the line after line rectification only two CT secondary currents were available to protective relays. After attaining a load

of 20%, E.L. relay was acting and breaker was getting tripped.

Now the question was why the secondary connecting wire fused. The CTs were 1 amp secondary. The 33 kV town feeder was hardly 5 km length. The fault, which was single line to ground, also was very close to 132 kV SS .The secondary current on fault was much, than the sustaining capacity of undersized wire used.

We use 2.5 Sq.mm (3 leads of 20 gauge) Wires for CT Secondary.

The CT Manufacturer used under Sized Wires. They could not Stand to Fault Current.

So we have replaced the secondary connecting leads of all CTs at that SS with 2.5 sqmm stranded copper leads.Primary injection test on individual CTs and Z test on three CTs carried out and results found alright.

The 33 kV Er. Surya pet town feeder put in to service, stood OK. Thorough stage inspection of the equipment at manufacturer end is necessary.

Question : By Er. Patra pk: Pl. any one can clarify What is the purpose of auxiliary earth mat above the normal earth mat inside any switchyard near breakers and isolators. If it is there than whether that auxiliary mat will connect to normal mat.

Answer : 1. By P.K. Pattanaik OPTCL:

(1) Used aux mat is provided above the main earth mat layer. Say if main is at 600-700 mm, then this provided at 300 mm below. The reason of such to be discussed.

(2) Whether this mat has to connected to main mat or not.

All the members pl light upon in this angle.

2. By Er. Nihar Raj, ABB:

(1) Aux earth mat laid at shallow depth helps in reducing the potential difference between the touch point and feet. There by enhancing safety. We generally lay this at 300 mm depth.

(2) Aux earth mat laid at shallow depth of 300 mm is to be connected to the main earthmat so that they are equipotential. The entire trick is to have the maximum equipotential surface in the yard.

At the 5th National Conference on Earthing at CBIP there was a technical paper presented on parametric analysis of earthing system part 1. It will explain in more detail on the variation of step and touch potentials with variation on depth of laying main earthmat. Will try to send the pdf version of the study paper.

3. By P.K. Pattanaik, OPTCL: Nice explanation.

I want to supplement few on this.

1. The area as described of operation is near isolators and breakers, where operators do the manual operation in case of any problems in remote/ during testing.
2. As on fundamental any metal structure buried inside ground for earthing purpose must be interconnected to maintain equipotential surface.
3. In this situation also the aux mat should be connected to main mat.
4. Practice of using aux mat in present days is not taken due to use of main mat with proper spreading of electrodes and other design to attain required S.p and t.p.

Others pl comment.

1. By Er. D.K. Chaudhury : I think the aux mat is required below each operating handles in side the switch yard & to be connected with main earth grid.
2. By Er. Raman Narayanswami PRDC: Aux. mat is required to provide a metallic path to high fault currents.
3. By Er. Nihar Raj, ABB: Metallic paths are provided by risers which connect metallic structures to the earthmat laid below ground. These risers need to be of adequate capacity to carry the fault currents.

Question : Er. Pramod Rao Yash: Can you clarify the benefits of measuring Tan Delta at Different specified frequencies? Does it indicate a particular technical phenomenon? Has there been any research on this aspect? Above data specific to Bushings is desired as there are several articles related to transformers.

Answer : 1. By Er. Guru Mishra, OPTCL: In the variable freq. Tan delta, it is seen that the presence of moisture

becomes prominent during application of lower frequency.....why is it so????? Ne technical justifications for it.....

2. By Er. Venkareswarulu Reliance: When moisture increases resistance reduces. Low R can be measured by lowering the frequency to 20 Hz. Other determination in capacitance can be measured at 400 Hz. and typical values for the dissipation factor are shown for 50/60Hz. The measurement of the dissipation factor at other mits and typical values for the dissipation factor are shown for 50/60 Hz. The measurement of the dissipation factor at other short frequencies should become a standard. Low frequency results (e.g. 15 Hz) allow for a very sensitive moisture assessment, measurements at high frequencies (e.g. 400 Hz) allow a very sensitive detection of contact problems at the measuring tap or at the innermost layer connection or of high resistive partial break downs between grading layers.

   Experience TALK By Dr. Shreedhar Madichetty Bits Pilani

   I would like to share one of my strange experiance, when I was working as a Manager (Electrical) at Airtel. This case was happend in the year of 2014. Initially, we had several plans to set up a 35 MW Solar Power Plant. After several discussions with technical gaints, we have initiated the plant. It's took around 1 year 6 months to complete the project. Finally, one fine day we have connected to the grid. We had several inverters, which were connected to multi winding transformer.

   Inverter rating was DC I/P: 525-900V; AC O/V- 350+/- 10%, DC I/P: 750kW, AC O/P: 630kW AC.

   Which is then connected to 0.350/11kV 2520 kVA Dyn11 yn11 yn11 yn11 Multi winding transformer

   The inverter is IGBT based 3 Level Sinusoidal Pulse Width Modulated Inverter operating with 10000 Hz carrier frequency and chosen filters.

   Once system is running at 20 MW load, all of sudden inverters are getting failed one by one.

   As and when loads are increasing, the inverters are getting failed. This was happend very frequently.

   We had several discussions with many consultants across the countries and some parts of the world as well.

   We have tested the inverters individually for long time with 110% loading capacity and found ok.

   It took almost a month of time to figure out a problem for us. The problem lies with the Multi Winding Transformer.The Multi Winding transformer consists four primary three phase star connected. Due to which all the harmonics are passing through legs of the inverter. When we changed the transformer to Delta-Deltawe found working satisfactorily and up even now. So my experiance says, Delta-Delta connected transformer works fine with the inverter system.

Supplement

1. By P.K.Pattanaik, OPTCL: Delta winding might have solved the issue related to the harmonics but the earth faults if developed in the system how it shall be taken care.
   1. Because delta winding can not provide fault loop to trace this fault. So kindly provide the detail SLD (single line diagram) to study.
2. Multiwinding transformers and it's load distribution to be explained please.

   T1 Pradeep Modi:

   In the initial day's when it is dYn11, where was neutral formed

   (A) at inverter end

   (B) inside transformer

And how was neutral treated

   (A) floating

   (B) grounded

3. By Er. Ramachandran ABB to Dr Madichetty- I think the reason for inverter failure was not due to transformer connections. Did you earth the LV neutral ? If so this can be the reason. As per study is the correct one. Ie unearthed star on LV. For those involved with solar power plants, there is a good guide published by IEEE. C57.159 -2016 Guide for transformers for photovoltaic power plants. This guide written by a committee chaired by an Indian (he was earlier working at Mumbai) Hemachandra

Sherkude contains lot of information .

4. By Er. Shreedhar, Bits Pilani : Sir, Many Thanks for suggestion. We have earthed LV neutral. Further to ensure safety and balancing, mid point DC link capacitor was also earthed.
5. By Er. Ramachandran, ABB: As per that guide, LV neutral shall not be earthed. You can also get guidance from the inverter manufacturer. Another point is these multi LV transformers are very special type- with decoupled LV windings. Otherwise LVs will not share load properly.
6. By T1 Pradeep Modi to Patnaik

   From the drawing and based on correction applied thereafter regarding neutral (not grounded) can we say that it becomes isolated network and would it not be similar situation as we discussed for ungrounded loaded/ unloaded tertiary.
7. By P.K. Pattanaik, OPTCL to Modi

   You are absolutely right and need to be addressed very seriously. May the case of normal loading or associated with inverters, the fault identifications for such delta network has to be thought up. Kind attention once again to Dr Rajamani sir your intervention is highly solicited.
8. By Er. Vikash Saxena, PGCIL: In my opinion transformers with so many windings on LV side will be weak points. Of course it is all related to cost considerations but it may be better to use larger rating inverters with lesser number of transformer windings.
9. By Er. Ramachandran, ABB: As per current technology inverter rating maximum possible is 630 kw. Some have developed 1 MVA inverter and probably 2 MVA inverter also may be developed. Since these are converter transformers, two LVs are must. 4 LVs are provided to combine two inverters so as to save space and cost.
10. By Er. Vikash Saxena, PGCIL: I used 1 MVA inverters in 2011 itself with transformers having two LV windings for a 15 MW solar PV project I designed. Ours was first order received by ABB in India.
11. By Er. Ramachandran, ABB: Thanks for the info. Sure 4 LV transformer is a complex one requiring special knowledge and attention.
12. By Er. Vikash Saxena, PGCIL: And concern becomes bigger because these smaller rating transformers might be getting sourced from not so reputed manufacturer.
13. By T1 Pradeep Modi to Saxena Ji and sridhar Ji

    Since both of you have operated these solar plants can you help us to understand if there are any limits defined by grid operator (where solar park are injecting) regarding 2 khz to 9 kHz frequency spectrum and it's limiting values
14. By Er. Mamtora Tr : This is in response to Dr. Medichetty's experience with Multiwinding Transformer, all the input windings are star connected. I have never come across any specifications calling the delta windings for the input from the inverters and have supplied more than 500 Transformers and as Mr. Ramchandran suggested the windings are not earthed. The neutral terminal even is not taken out.
15. By Er. Vikash Saxena, PGCIL: Modi sahib I do not have information in this regard.