

For Members Only

**THE CONNECTION - 9**  
January, 2009

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The new executive is in place. An exceptional enthusiasm among the engineers for the polling of votes was clearly visible. And the results expressed their unshakable faith in the governing body. The message was clear: Nothing else but the performance matters.

The last term of the executive saw our president making a thought-provoking presentation on power reforms before the state government. Even the hard-to-convince bureaucrats were forced to think twice. 'Are we really adopting the right model?' the question lingered on their minds. And another fact became evident to them PSEB EA was a body that not only protected the rights of the engineers but aimed at the well-being of the department as well.

Our body having its own code of ethics in place, more and more members have been following the edicts, putting them into practice and trying to improve their inner-selves, their work sphere and the organization as a whole. Concrete efforts have been made to reduce the T&D losses, check power thefts and increase energy conservation. We have to keep laying more efforts and work on Kaizen theory as there is always a scope for improvement. No doubt, when we are armed with the right information, facts and figures, it becomes easier to drive home the point. Today, India is on the threshold of power revolution. It has been well realized that abundant power is required to be generated and conserved to wheel the economy and to provide it speed. Efforts in this direction can succeed only if we keep ourselves abreast of latest developments in power sector through our studies, knowledge sharing and interactive sessions.

'The Connection' remains one such effort to connect the power engineers through its contents that encompass all facets of power sector and highlight key activities of the association as well. While the association website www.psebea.org launched during the last General Body Meeting brings to you all the day-to-day happenings in the Board, our in-house magazine promises a pack of high voltage information to you. Contribute to it and share your thoughts and ideas with others. Meanwhile, plug-in and recharge yourself.

**Wishing you all a Happy New Year**

**Er. Jagvir Goyal**  
Chairman,  
Publication Committee

## General Body Meeting - 2008

**A General Body Meeting of PSEB Engineers' Association was held at Guru Teg Bahadur Hall, Punjabi University, Patiala on 30.09.2008. This meeting was attended by over 1,200 PSEB Engineers coming from all nooks and corners of the state of Punjab. S. Parkash Singh Badal Chief Minister Punjab holding power portfolio was the Chief Guest. The meeting was also attended by S. H.S.Bains Media Advisor to the CM Punjab, Sh.Suresh Kumar Principal Secretary/Power, Sh.Y.S.Ratra Chairman PSEB, leaders of All India Power Engineers' Federation and Northern India Power Engineers' Federation.**

While addressing the gathering, the Chief Minister Punjab said that the engineers in general and power engineers in particular are responsible for developing the country and that the development of any society is measured by the electricity units it is consuming. He said that the State is presently facing 30% shortage in power but in coming four years, 'we shall be able to add



more than 100% of our existing capacity and bring it to more than 12,000 Mega Watt'. He added that the four thermal plants at Talwandi Sabo, Gidderbaha, Rajpura and Goindwal Sahib shall be commissioned in shortest possible time. He called for making a 50 to 100 years plan for Punjab and India like Japan. Regarding unbundling, the Chief Minister said that 'any decision in this regard shall be taken in consultation with PSEB Engineers Association. He also added that 'a small group meeting shall be called by him with PSEB Engineers' Association to lay down short term and long term plan through which the power sector of Punjab can be improved to match the needs of the people. The Chief Minister announced that 225 new Assistant Engineers, 225 new Junior Engineers and 125 SSAs shall be recruited purely on merit in PSEB to reduce the shortage of technical manpower in the organization. He assured the engineers that they shall be supported by Govt., in controlling theft of power and assured that 'the prestige of PSEB Engineers was the prestige of his Govt'. He gave a call for cleaning the public life and tackle corruption with an iron hand.

Er. Shailendra Dubey Secretary General All India

Power Engineers' Federation hailed the decision of keeping Kerala State Electricity Board as one public sector company and suggested to follow same Model in Punjab. "The unbundling of State Electricity shall lead to bankruptcy of the country and thus review of Electricity Act 2003 is in national interest", he concluded.

Er. M.S. Bajwa Patron PSEB Engineers' Association

welcoming the Chief Minister asked for making Trade Unions and Associations as Partners in the Management of PSEB and HRD and Manpower Planning should be made a focused areas in PSEB. He vouched for additional investment in power sector for development of industry and economy of the State and added that Power sector be treated as core sector for Punjab. Mr. Suresh Kumar Principal Secretary said that the Punjab Govt. had an open mind on the issue of unbundling of PSEB and that the future power sector model shall be Punjab centric and in the interest of the consumer. He exhorted that the process of innovations, reforms, cutting costs and delays should continue in PSEB without waiting for restructuring. There is no scope of being complacent in our working, he added. He exhorted that all of us should work hard to ensure efficient service deliveries to the citizens of the State. Mr. Suresh Kumar invited PSEB Engineers' Association to send him a 'Policy Paper' on the subject of Internal Reforms for implementation in PSEB.

Sh. Y.S. Ratra Chairman PSEB said that the PSEB Engineers were the biggest stake holders in the power sector of Punjab. He assured that all models of

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restructuring including Kerala model shall be studied to arrive out at a Punjab centric model. He said that the focus on three issues namely 'Reduction of losses, Consumer Service and improving PSEB Performance have to be kept by the engineers and employees of the Board.

Er. Padamjit Singh Chairman All India Power Engineers' Federation stressed that generation, transmission and distribution be held together in Punjab for optimum and efficient operation of power system. He warned that major reliance on private sector generation can lead to a bankrupt Punjab as Enron would have turned Maharashtra into a similar situation.

Earlier, Er. H. S. Bedi President PSEB Engineers' Association in his key note Presidential Address said that the PSEB Engineers' Association was committed to implement positive changes and reforms in the power sector and extend prompt, courteous, clean and corruption-free service to the power consumers. While narrating the achievements of PSEB, Er. Bedi said that the challenges before the power sector in Punjab were tough and required to be met with equal grit and determination. Welcoming the initiative taken by the present Govt. to enhance the power availability in Punjab by 12,244 MW through private investment of Rs 61,000 Cr by 2012, Er. Bedi cautioned the authorities that Punjab was taking a big risk in getting 100% of 6480 MW planned thermal plants executed through private sector players. He intimated that the private sector could never achieve more than 51% of its allotted generation capacity during any of the Five Year Plans and due to its poor performance, the Planning Commission has earmarked only 10,760 MW out of total generation capacity addition target of 78,577 MW i.e. 14% to private sector during the present 11th Plan (2007-12). "Most of the states in India are executing 60% to 100% additional generation projects through state funding" Er. Bedi added. He warned that while the power shortage up to 2012 shall be a permanent feature in Punjab ranging between 39% to 26%, any slippage by a private sector executor shall further deteriorate the situation.

As an alternative, Er. Bedi suggested that proposed thermal plants at Gidderbaha (2640 MW) and Rajpura (1320 MW) should be respectively executed in equity participation with NTPC and departmentally ensuring their 100% availability at the right time. He added that annual funding of Rs.660 crore required to execute these two projects during next 4 years can be provided by the Punjab Govt. and PSEB who are otherwise sustaining

payment of Rs.6,000 crore for power purchase and Rs.500 crore on subsidized power annually. He pleaded that Punjab should immediately press the Govt. of India for allocation of 2x2000 MW nuclear power plant to be executed by Nuclear Power Corporation of India Ltd in equity participation with PSEB ensuring its commissioning within next 6 to 8 years. Er. Bedi added that to ensure that generated power is available to the consumers adequate transmission and distribution network is a must for which investment plan costing Rs 40,000 Cr has to be made immediately. Giving an immediate solution to power shortage in Punjab, the President said that 1,500 MW demand of Punjab can be met by 'time bound implementation of low cost system improvement-cum-loss reduction plan, drive against theft of power, discouraging the sale of incandescent lamps by taxing them heavily, installation of shunt capacitors and execution of PSEB Energy Conservation Plan from October-2008 to May-2009'. Discussing the present bad financial health leading to bankruptcy of PSEB reeling under short term loans of Rs.5,800 crore, Er. Bedi said that the solution lies in execution of Financial Re-Structuring Plan by Punjab Govt. cleaning the balance sheet of PSEB, conversion of 100% of Punjab Govt. loans into equity and advance payment of subsidy in cash.

The President stated that unbundling of the State Electricity Boards has proved to be a big failure and has resulted into higher consumer tariff. He resented that while the private sector like Reliance Energy, Tata Power, Torrent Power and CESC have bundled generation, transmission and distribution, the State Electricity Boards are being forced to un-bundle by mis-interpreting the Electricity Act 2003 which actually aims at converting a State Electricity Board into a company by separating the trading of power under an independent company'. He informed the gathering that only recently Kerala Govt. has issued a notification to convert Kerala Electricity Board into one public sector company and exhorted to implement a similar structure for PSEB.

Er. H. S. Bedi further pointed out that while the failed experiments of unbundling and corporatization are being forced upon the power sector of various states in India for the last 16 years at a cost of lacs of crores of rupees, no real power sector internal reforms are being carried out and the matter has virtually ended after unbundling and appointing non technocrats as the heads of these entities. He laid down an Eleven-Point Reform Model for PSEB which is equally implementable in the existing or company

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structure of the Board and emphasizes using modern management techniques to improve employees productivity, professionalization of Board management, reward scheme for performance - initiative and innovation, implementation of Quality Improvement and Quality Circle plan and PSEB IT plan, forming profit centres and business units down up to the 11 KV feeder, re-organization of distribution set up on functional basis, strengthening of human resources development as a separate core function on the lines of NTPC by converting the post of Member/Administration to Member/HRD and implementing scientific manpower planning, ensuring commercial discipline, strengthening and professionalizing regulatory framework and insulating the power sector from political and bureaucratic inference. Er. Bedi resented that in the so called reforms programme being carried out in India, the power engineers have been marginalised and the leadership of the sector is being passed out from technical hands to the bureaucrats and added that 'out of 59 power companies formed after unbundling, 55 companies are being headed by non-technocrats'. He said that the while PSEB Engineers' Association was neither against changes in the power sector nor bureaucrats. "We demand our rightful place in the hierarchy of power sector on the pattern of developed and developing countries where these slots are

exclusively managed by power engineers" Er. Bedi concluded. Putting the demand of revision in pay scales and allowances in the end, of his address Er. Bedi said that the present differential between the pay structure of PSEB Engineers with Punjab and Central Govt. engineers be maintained, and added that as a fair play the PSEB Engineers should be given time bound pay scale of Senior Xen after 9 years, SE after 14 years, CE after 18 years and EIC after 27 years on the pattern of Central Services. He demanded fixed pay scale for actually promoted Chief Engineers and Engineers-in-Chief on the pattern of two last top scales for the IAS. He said that all PSEB technical employees should be given Power Sector Pay in view of their round the clock hazardous duty and the Electricity concession and facility of one tubewell connection on priority needs to be extended to the retired PSEB employees. He demanded that a cadre review of PSEB Engineers needs to be initiated immediately to achieve a cadre structure at par with the Central Engineering Service to end career stagnation in PSEB.

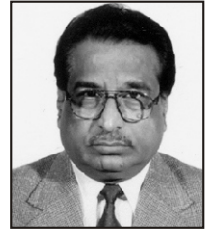
Er. Nirvair Singh was awarded for his life time achievements. Er. P. S. Satnam memorial award for Technical Excellence was given to Er. S. S. Josan of Jalandhar.

A Souvenir was released and website of PSEB Engineers' Association [www.psebea.org](http://www.psebea.org). was also launched on this occasion.



## **FINANCIAL CRISIS OF PSEB WHO IS RESPONSIBLE ?**

**Er. H.S. Bedi\***



**In terms of section 59 of Electricity (Supply) Act 1948, the SEBs were required to earn a minimum rate of return of 3% on their net fixed assets in service after providing for depreciation & interest charges. The State Government could prescribe a higher return if considered necessary. However no State Govt, allowed its SEB to fulfill this statutory provision. The combined Rate of Return (RoR) of all SEBs (without subsidy) during 1992-93 was (-) 12.7% which further deteriorated to (-) 43% in 1999-2000. Had the State Governments allowed its SEBs to earn 3% RoR, the additional revenue mobilization could have increased from Rs. 5642 Crore in 1992-93 to Rs. 28186 Crore 1999-2000, sufficient to fund capacity addition and system strengthening projects.**

### **ROLE OF STATE GOVERNMENT**

Punjab was no exception. The RoR recorded in the year 1996-97 was (-)22.17% which deteriorated to (-)55.53% in 1998-99 after the announcement of free power to agriculture sector in Feb.1997. Had Punjab Govt. allowed PSEB to earn 3% RoR, Rs. 688 Crore additional amount could have been mobilised in 1996-97 & Rs.1425 Crore in the year 1998-99. State Govt. while announcing free power promised in the Vidhan Sabha that PSEB would be compensated but it never happened. The loss of revenue in 5 years (1997-98 to 2001-02) due to free power to agriculture was over Rs. 6000 Crore considering total units supplied to agriculture (as per official data) to be 26657 MUs and average rate of sale to be Rs.2.25 per unit. The agriculture consumption may be disputed considering it being un-metered but fact remain that whereas PSEB's finances are concerned, 50% of the total units pumped into the system earned zero revenue. In the year 1998-99, out of 23000 MUs pumped in to the system, 7500 MUs was shown against agriculture sector whereas 4200 MUs were projected as T & D losses. Some of the units shown against AP may actually be T & D losses but in any case, 11700 MUs out of 23000 MUs earned zero revenue. Secondly the State govt. did not allow PSEB to raise tariff commensurate with the raise in cost of power. The difference between average tariff & average cost of power increased manifold.

As per section 67-A of Electricity (Supply) Act- 1948 , any interest payable on loans advanced by the State Govt.

to the Board may be paid only if there is surplus after deducting operating expenses, interest to institutional creditors & deprecation from the revenue receipt of that year. State Govt. continued paper transaction by adjusting interest on loan against subsidy payable to PSEB, although there was no surplus as defined in Section 67 of Electricity (Supply) Act- 1948.

Free power to agriculture sector without compensating PSEB, poor internal resource mobilization coupled with nominal tariff hike & withdrawal of budgetary support for capital works resulted into deterioration in the financial health of PSEB. The commercial losses of PSEB increased from Rs. 606 Cr. in 1996-97 to Rs. 1941 Cr. in 2001-02. PSEB started raising huge short term loans to bridge the gap. Working capital loans which were NIL upto 1997-98 increased from Rs. 125 Cr. in 1998-99 to Rs. 827 Cr. ending 2001-02.

The total loan amount outstanding increased from Rs. 4617 Crore in 1996-97 (out of which Rs. 3402 Cr. was govt. loan) to Rs. 9265 Cr. in 2001-02. All these policy decisions resulted in almost collapse of PSEB's finances with the Board finding it difficult to even pay salary to its employees in May 2002.

However, the situation improved temporarily after the constitution of State Electricity Regulatory Commission in 2001. Nominal tariff hike & regular payment of subsidy by the State Govt. as determined by PSERC resulted in profit of Rs. 175 Crore during 2003-04.

Year	Actual Tariff hike	Profit (+) Loss (-)	Subsidy paid/ to be paid by Govt. in Rs. Cr.
2002-03	7%	-436	950
2003-04	7%	175	838
2004-05	-6%	-591	924
2005-06	10%	12.89	1436
2006-07	NIL	-1629	1424
2007-08	NIL	-1380	2848
2008-09 (RE)	5.1%	-1600	2607

Even with reduction in tariff to the tune of 6% during 04-05, the losses were confined to Rs. 591 Crore. With 10% tariff hike (actual 4% over 2003-04 tariff), PSEB achieved a break even in 2005-06 although Punjab Govt. announced re-introduction of free power to AP w.e.f 1.9.05.

However, the financial position again started to deteriorate from 2006-07 mainly due faulty policies of the state government and the refusal of PSERC to allow any tariff hike for the year 2006-07. PSEB registered a loss of Rs. 1629 Crore during this year. Thereafter, in view of state Assembly elections in Feb. 2007, the State Government did not allow PSEB to file its tariff petition for the year 2007-08 before PSERC which was due to be filed in Nov. 2006. Board first got permission from PSERC for filing tariff petition by March 2007 but even with change of State Government, PSEB did not file tariff petition forcing the commission to start suo motto determination of tariff leading to award of tariff hike of only 4.9% in Sept. 2007 which was totally inadequate in view of the fact that Commission did not allow any tariff hike during the previous year. The situation was further made worse by refusal of the state government to pay subsidy of Rs. 2548 Crore which was payable in quarterly advance installments as per PSERC orders dated 13.9.07. Instead of paying the subsidy already due to PSEB, the State Government decided to roll back complete tariff hike announced by the regulator for all other categories including industry.

State Government approached PSERC for allowing this roll back & promised to compensate PSEB to the tune of Rs. 284 Crore in addition to Rs. 2548 Cr. PSEB Engineers' Association filed a petition under section 142 of the Electricity Act 2003 seeking PSERC's directions to GoP for clearing arrears of subsidy due to PSEB as per Commission's order dated 13.9.07. The Commission in its order dated 15.2.08, ordered the State Government to pay subsidy & also directed PSEB that in case the

Government failed to pay the subsidy, tariff be changed w.e.f. 1.3.08 from the subsidized consumers as per tariff determined by the Commission without taking into account the subsidy as indicated in tariff order for the year 2007-08. Out of Rs.2832 Cr. subsidy payable, the State Government made cash payment of only Rs.1095 Cr. and Rs.375 Cr. of Electricity Duty collected by PSEB was allowed to be retained. For remaining amount, State Government decided to recall an amount of Rs. 1362 Cr out of overdue loan of Rs.2342.8 Cr. and allow the Board to retain Rs. 1362 Cr. against outstanding subsidy. This was last straw on the back of the camel.

Instead of taking legal recourse to protect the financial interests of the organization, Board meekly surrendered before the State Government & accepted the paper adjustment pushing the finances of the Board into hopeless situation. Board even issued commercial circular for refund of amount charged from consumers on account of tariff hike without getting the permission of PSERC. Instead of taking serious note for this blatant violation of Commission's orders, both by the State Government and the PSEB, the PSERC regularized the whole issue just by imposing a fine of Rs. 10,000/- on the Board.

All these policy lapses resulted in a commercial loss of Rs. 1380 Cr. during 2007-08 & accumulated losses to cross Rs. 7000 Cr. With expenditure far exceeding revenue receipt, PSEB resorted to heavy borrowing to repay earlier loans pushing the organization into debt trap. The short term loans which were Rs. 2317 Crore ending March 2007 increased to Rs. 4500 Crore ending March 2008 i.e an increase of 94% in just one year.

#### LOAN POSITION (Rs. Cr.)

	2000-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08
Working Capital Loan	888	827	631	260	751	895	2317	4500
Total Loan	8974	9264	9388	8637	9287	8239	10588	14460

The situation is by and large the same in 2008-09. State Government promised a subsidy of Rs. 2601.73 Crore to PSEB on account of free power to AP & other categories. However Finance Department of the state Govt. continued to pay monthly installment of subsidy @ Rs. 166 Crore upto September- 2008 by taking into account Rs. 2000 Crore provided for subsidy in the budget. Total subsidy paid so far during this financial year is Rs. 1320 Crore whereas as per PSERC orders, Punjab

Govt. is required to pay full subsidy amount of Rs. 2601.73 Cr. by the end of December- 08. The short term loans have further increased to Rs. 6500 Cr. and accumulated losses are likely to touch Rs. 9000 Cr. at the end of this financial year. The financial crisis has further deepened due to turmoil in the financial markets with banks refusing loans to PSEB. Again PSEB is finding it difficult to pay salary to its employees. The state government stake in PSEB, government equity of Rs.2946 Cr. plus loans of Rs. 1712 Cr. i.e total government stake of Rs.4658 Cr. has already been wiped out by the accumulated losses. The State Government is making PSEB to bleed and with no respite expected in the near future, the financial collapse of PSEB is imminent unless or until some drastic corrective steps are taken.

### ROLE OF BOARD MANAGEMENT

However, State Government is not alone responsible for this mess. Board is equally responsible since it has failed to protect the financial interests of the organization. Board has been failing consistently to achieve performance parameters fixed by PSERC (many of them were achievable) resulting in huge financial loss. The first and foremost is the failure to achieve T&D loss reduction trajectory agreed by PSEB. Board promised to reduce T&D losses from a level of 25.35% in 2003-04 to 19.5% by 2007-08. However the target and the actual achievement was as under

Year	2002-03	03-04	04-05	05-06	06-07	07-08
Target %	25.52	24.5	23.25	22.00	20.75	19.50
Actual %	24.54	25.35	24.27	25.07	23.92	22.53

As per Abraham Committee report, which PSEB had referred in its Tariff Petition of 2008-09, Utility is supposed to reduce AT&C losses by 2% each year in case loss level is between 20% to 30% and by 1% for losses less than 20%. So as per this yard stick, PSEB was required to achieve the level of 18.35% ending 2007-08. (taking 25.35% as base) So PSERC target of 19.5% cannot be termed as unrealistic. Although above table shows that PSEB achieved a loss reduction of 2.01% in 5 years but the metered sale during this period fell by 2.62% whereas AP sale increased by 4.76% which is the lowest tariff category.

Year	2002-03	03-04	04-05	05-06	06-07	07-08
Metered sale (%)	54.42	53.76	54.23	52.54	52.56	51.80
AP sale (%)	20.91	20.89	21.50	22.40	23.53	25.67

### T & D LOSS TRAJECTORY AFFECTED PSEB'S FINANCES

Every year PSERC while analyzing Board's Annual Revenue Requirement (ARR), first calculate the energy requirement of PSEB for that particular year. Energy requirement is calculated by estimating metered sale on the basis Compounded Annual Growth Rate (CAGR) of the last 3 years, sale outside the state, AP consumption & also energy lost on accounted of targeted T & D loss. This energy requirement is then matched by calculating expected generation from own sources, share from BBMB, Central Sector allocations & remaining from short term power purchase. In case PSEB fail to achieve targeted T & D loss level then power purchase is reduced proportionally & Board's ARR is reduced by multiplying average cost of total power purchase with energy disallowed order T & D. For the year 2006-07, 1546 MUs power purchase amounting to Rs. 487 Crore was disallowed. Similarly for the year 2007-08, PSERC disallowed 1686 MUs of power purchase amounting to Rs. 1022 Crore.

In the last 5 years (2002-03 to 2007-08) about Rs. 2100 Crore of revenue requirement has been disallowed by PSERC for the failure of the Board to achieve T & D loss reduction trajectory.

Similarly PSERC has been disallowing interest payable on loans taken by the Board. The major cut has been usually on interest paid on working capital loans taken by Board in excess of that allowed by PSERC on normative basis. In the year 2006-07, PSERC allowed Rs.713 Cr. as working capital loans but PSEB raised Rs.2,316 Cr. and paid Rs.145.35 Cr. as interest. PSERC disallowed interest paid on excess working capital loans and reduced interest liability to Rs.55 Cr. PSERC also disallowed Rs. 100 Cr. of interest due to deficiencies in the working of Board. PSERC is also disallowing fuel expenditure due to non-achievement of 'Heat Rate' target. The disallowed expenditure on account of fuel, interest charges and loss reduction in the last five years is Rs.3083.38 Cr. which is a substantial amount.

Expenditure disallowed by PSERC on account of failure of PSEB to achieve performance parameters (Rs. Cr.):

Year	2003-04	04-05	05-06	06-07	07-08	Total
Fuel	5.88	50.02	60.41	93.08	117	326.39
Interest Charges	102.61	100	124.68	155.31	164	646.6
Loss Reduction	164.37	110.49	326.2	487.33	1022	2110.39

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The second major reason is the failure of the Board to manage or control its power procurement expenditure which constitutes more than half of its total expenditure bill. Power purchase bill which was Rs. 2432 Crore in 2005-06 has increased to Rs. 6030 Crore in 2007-08. The major component of power purchase bill (nearly 60%) is short term power purchase. Punjab has the distinction of buying not only maximum power under this category (17.8% of total traded power in the country) but also costliest chunk of traded power. Board is purchasing power @ Rs. 10/unit to supply it to consumers contributing Rs. 2.40/unit.

The third reason is the total failure of the Board Management to observe commercial discipline while taking investment decisions. No efforts have been made in the last few years to improve internal efficiency to reduce cost of power. The productivity of PSEB's vast manpower is very low. We are still persisting with the British era rules & working techniques. Workers still use obsolete and outdated tools and techniques for construction as well for maintenance works. Two to three workers still go out on bicycles to attend a minor supply complaint. The procurement procedure is totally centralized with cases of essential items of very low value going upto Board level. Grid Sub Stations are erected not on technical grounds but on political considerations. No efforts have been made in the last 2 years to execute 220KV works which cater to 66 KV transformation capacities. Only one new 220KV grid has been added in the system whereas about 30 out of 48 number 220KV grid sub-stations in Punjab are overloaded with 10 grids being critically overloaded. More and more funds are being diverted to 66 KV grid works many of which are being executed on top priority by ignoring more emergent works.

A bankrupt organization spends lacs on foundation laying ceremonies of Grid Sub Stations & full page advertisements in Newspapers to satisfy the false ego of politicians. Each year, PSEB seek the verbal approval of the State Govt. before filing ARR/tariff petition before PSERC delaying the tariff determination process each year. Connections of ordinary consumers are disconnected on non-payment of petty amount but big defaulting Government Departments are not touched. Commercial instructions are amended & twisted to give relief to big industrialists at the cost of PSEB's finances. Board is maintaining two corporate offices, one at Mohali & other at Patiala. In addition to financial burden, lot of time &

energy of senior officers is wasted in traveling from one place to other. PSERC is disallowing employees' expenses but Board is re-employing superannuated officers to carry out normal functions of the Board. Under such circumstances, how an organization which is supposed to perform as a commercial department can survive?

### **ROLE OF STATE REGULATORY COMMISSION**

The regulatory commissions were constituted primarily to insulate the power sector from the influence of state government in commercial matters and to ensure commercial viability of the power utilities. Although PSEB was taken out of red in 2003-04 just after two tariff orders but again allowed to slip in the red for which PSERC cannot be absolved of its responsibility. There was not justification for reduction in tariff during 2004-05 and zero tariff hike during 2006-07. Similarly, PSERC have been disallowing many genuine expenses incurred by the Board and there is no way out for the Board to curtail these expenses. For example, PSERC has so far disallowed an expenditure of over Rs. 1580 Cr. on account of employees expenses knowing fully well that no employee can be retrenched nor there can be any salary cut. Only way out is to offer VRS to employees for which again huge funds would be required and recent experience of such schemes in public sector banks is not encouraging for the organizations. Either the Commission should suggest some way out or allows such expenses. PSERC has also failed to ensure timely payment of subsidy and other arrears by State Government to PSEB and allowed government to circumvent or ignore commission's orders. Government's refusal to refund excess payment of Rs.411.14 Cr. made by PSEB on account of interest is one example. Without the proactive role of the PSERC, commercial viability of the power sector cannot be ensured.

### **RESPONSE OF STAKEHOLDERS**

Difficult situations warrant matching response from the stakeholders and policy makers. However, in Punjab, the response of the key stakeholders responsible for the survival of the power sector is totally naive and heedless. All over the world, huge financial bailout packages are being announced by Governments to prevent big private companies from going bankrupt. Instead of giving special bailout package to PSEB, Punjab Govt. is pushing the Board towards financial disaster by refusing to pay timely



subsidy (which it has promised in writing to PSERC), forcing PSEB to take commercially unviable decisions, interfering in day to day working of the Board etc. etc. The minimum we expect from the State Government is to atleast free PSEB from its stranglehold.

Board management on the other hand instead of taking decisions with sound commercial acumen, is adopting tokenism by withdrawing LTC or curtailing TA etc. or contemplating measures to reduce perks of employees etc. which may not save more than Rs. 2 Cr. to

Rs. 3 Cr. in the remaining part of the year. The finance wing headed by Member/F&A is responsible to maintain financial discipline in the Board and act as internal auditor for execution of various projects by the technical wing. However this role is marginalized in case projects are executed by the wings working directly under Member/F&A such as IT directorate or billing projects etc. The management should chalk out a comprehensive plan not only to scale down the loss of more than Rs. 1600 Crore loss likely to be incurred this year but to ensure break even in the next year.

### FINANCIAL POSITION OF PSEB

Sr. No.	Particulars	(Rs. in Crore)					
		2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
		Actual	Actuals	Actuals	Actual	Actual	Un-Audited
1	i. Sale of Power	5188.21	5934.92	5865.59	6462.16	6803	7671.99
	ii. Misc. Receipt	300.70	371.88	413.04	478.49	532.61	908.07
	iii. <b>Tariff Compensation from GOP for:</b>						
	a. Domestic consumers	50.00	50.00	50.00	50.00	-63.00	270.90
	b. Agriculture consumers	900.00	787.69	873.61	1385.92	1486.8	2284.37
	c. Bal Subsidy of 2003-04/2004-05					8	292.77
	Total	6438.91	7144.49	7202.24	8376.57	8759.81	11428.10
2	<b>Rev. Expenditure</b>						
	Fuel	2007.41	2025.21	2137.81	2417.81	2436.19	2831.53
	Power Purchase	1508.48	1594.99	2229.92	2432.5	4250.64	6029.41
	O&M Exp.	204.28	199.26	225.14	239.57	285.3	294.01
	Estt. & Admn.	1320.5	1431.30	1619.61	1694.17	1818.2	2112.37
	Other Finance charges	28.26	12.81	3257.94	21.22	22.04	16.89
	Total	5068.93	5263.57	9470.42	6805.27	8812.37	11290.20
3	Gross Operating surplus/loss	1369.98	1880.92	-2268.18	1571.3	-52.56	137.9
4	Depreciation	573.56	603.78	583.00	618.14	703.90	666.38
5	Interest: a) Instl. loans	739.93	675.42	563.10	559.38	667.63	987.41
	b) Govt. loans	551.52	483.09	480.73	480.73	375.91	85.99
	Total:	1291.45	1158.51	1043.83	1040.11	1043.53	1073.4
	Less Capitalized	59.04	56.29	61.43	99.84	173.6	222.24
	Net	1232.41	1102.22	982.40	940.27	869.93	851.16
6	<b>Retained surplus (+) /Loss (-)</b>	<b>-435.99</b>	<b>174.92</b>	<b>-3833.58</b>	<b>12.89</b>	<b>-1626.39</b>	<b>-1380.14</b>
7	<b>Impact of R.E. Subsidy written off.</b>			<b>3242.40</b>			
8	<b>Balance surplus (+)/Loss(-)</b>	<b>-435.99</b>	<b>174.92</b>	<b>-591.18</b>	<b>12.89</b>	<b>-1626.39</b>	<b>-1380.14</b>

#### Sources:

- 1) Estimate of Financial Resources
- 2) Tariff orders of PSERC
- 3) Information collected under RTI
- 4) PSEB and PSERC websites
- 5) Annual report of Planning Commission

\* President, PSEB EA

## NOMINATIONS AND COMMITTEES

**The following committees were constituted and nominations were made in the first meeting of newly elected Executive Committee of PSEB Engineers' Association on 6.12.2008**

**Permanent Invitees**

- Er. Baldev Singh
- Er. J. S. Thakur
- Er. N. K. Arora
- Er. S. S. Sarna
- Er. Harjit Singh Gill
- Er. P. K. Jain
- Er. B. B. Pandhi
- Er. Harjit Singh



**Benevolent Fund Committee**

- |               |  |
|---------------|--|
| Chairman      | President (Er. H. S. Bedi)                                   |
| Vice Chairman | Er. Jagvir Goyal   |
| Secretary     | Er. S. P. Singh  |
| Members       | General Secretary<br>(Er. Bhupinder Singh)<br>Er. S. K. Sood |

**Senior Advisory Council**

- |                  |                    |
|------------------|--------------------|
| Er. I. S. Anand  | EIC/Planning       |
| Er. G. S. Chabra | GM/GHTP            |
| Er. Shashi Dixit | CE/MM              |
| Er. S. K. Jain   | CE/S&D             |
| Er. Suresh Arora | Director/Billing   |
| Er. Gurpal Singh | SE/Open Access     |
| Er. P. K. Jain   | Dy. CE/Civil       |
| Er. V. K. Gupta  | Dy. CE/OP, Patiala |

**Building Committee**

- |   |          |
|---|----------|
| Er. P. K. Jain                                      | Chairman |
| Er. M. L. Singla                                    | Member   |
| Er. Anil Vij  | Member   |
| Er. Harjinder Singh                                 | Member   |
| Er. G. D. Sharma                                    | Convenor |
| (Er. G. D. Sharma will do Engineers' Home booking.) |          |

**Publication Committee**

- |                         |          |
|-------------------------|----------|
| Er. Jagvir Goyal        | Chairman |
| Er. Harjit Singh Gill   | Member   |
| Er. S. S. Josan         | Member   |
| Er. J. S. Thakur        | Member   |
| Er. Anil Vij            | Member   |
| Er. Jaswant Singh Zafar | Convenor |

**Website Committee**

- |                         |          |
|-------------------------|----------|
| Er. Sanjeev Sood        | Chairman |
| Er. S. P. Singh         | Member   |
| Er. Jaswant Singh Zafar | Member   |
| Er. Rakesh Gupta        | Member   |
| Er. Gagandeep Singh     | Member   |
| Er. Ajaypal Singh Atwal | Convenor |

**Disciplinary Committee**

President, General Secretary and Organizing Secretary are ex-officio members. Two other members nominated are Er. R. S. Sarao and Er. Baldev Singh.

**Pay Revision Committee**

Each thermal plant & distribution zone will recommend at least one engineer. From the Head office, the names of Er. S. K. Sood and Er. Rakesh Gupta have been finalized.

## FUTURE POWER SCENARIO

Er. Rakesh Gupta\*



**As on 1.4.2008, PSEB has got total generating capacity of 6306 MW, out of this 3185 MW is own generation, 1258 MW is from BBMB and 1863 MW is PSEBs share from Central projects. PSEB has commissioned two units of 250 MW each at Lehra Mohabat since then. Out of these two units only one unit has achieved the commercial operation and the other is stabilizing. With the commercial operation of these units PSEB will be having 6806 MW of capacity.**

In addition to these two units PSEB, during the remaining period of 2008-09 PSEB will be getting 75 MWs from Central sector and is likely to get 100 MW from Baglihar-I HEP, Doda (J&K) through PTC. These Projects are under advance stages of commissioning. Thus in all the likely addition during 2008-09 will be 675 MW. The situation will be dismissal next year. There will addition of only 39 MW through center sector and 173 MW of IPP power for which long term PPAs has been signed by PSEB. Thus 213 MWs will be added during 2009-10. During 2010-11 the addition in power will be 928 MWs. The addition from own generation will be only 93 MWs ( 18 MW of Mukerian stage II and 75 MW of UBDC Stage III). 275 MW will come from central sector projects and remaining through IPPS. 1883 MWs are likely to be added during 2011-12. Central sector will add 127 MW and remaining will be added through IPPS. All these capacity additions are as per the latest CEA estimates. This is the maximum possible generation that can be added and there is always a chance of slippage. Thus by the end of 11th Plan PSEB shall be having 10120 Mws of installed capacity at its disposal. Maximum 80 % of this can be assumed to available during peak. Thus peak availability during 2011-12 will be 8100 MW. Similarly peak availability during 2008-09 will be 5580 MW, during 2009-10 peak availability is estimated to be 5584 MW and during 2010 it will be 6580 MW.

Thus during the next three years PSEB own generation will increase by only 593 MW out which 500



MW are from Lehra Mohabat, which is already has slipped project. Whole of the capacity will be added either through central sector or through IPPS.

According to 17th EPS, the peak requirement during 2008-09 will be 9391 MW, during 2009-10 it shall be 9899 MW , during 2010-11 it will be 10435 MW and by the end of 11th Plan shall be 11000MW. Thus the peaking shortage during 2008-09 and 2009-10 will remain 40 % and will reduce 38 % during 2010-11 and further reduce to 29 % by 2011-12. Similarly as per 17th EPS the energy requirement will

increase from 48347 MUs during 2008-09 to 60627 MUs during 2011-12. The energy shortage thus will remain around 22 % till 2010-11 and may reduce to 12 % by 2011-12.

Thus we see that the shortage both on energy basis as well as peak basis are huge and are increasing till 2010-11. The shortage during 2011-12 will only reduce in case all the central sector and IPPS are commissioned on schedule. In case of any delay the relief will be accordingly reduced.

Thus PSEB will be compelled to purchase costly short term powers and also impose huge power cuts. Both of these actions are financially suicidal for the organization. Due to zero addition in power generation PSEBs dependence of short term power purchases have increased many folds during the last 5 years. The short term power purchases (trading + banking +UI) have increased from 690 MUs to 6455 Mus i.e a increase of 10

folds in energy terms. It was only 2.3 % of the total energy input and has increased to 16 % of total energy input during 2007-08. The cost wise position is very alarming. PSEB had spend 153 crore on these short term power purchases during 2002. The expenditure increased to 3500 crore during 2007-08. The expenditure on short term power purchases was only 2.25 % (153/6796) of the total expenditure in 2002 and it increased to 33% (3500/10501). This is totally alarming and unsustainable. The short power is totally unreliable and is dependent upon the surplus available with other states. In case of any shortage in these states the first casualty is short term power. For a reliable power to consumers the dependence on short term power shall not be more than 5 %. The dependence of more than 16 % power requirement basis means that the consumers of Punjab are being given very unreliable power.

PSEBs dependence on short term power purchase is maximum amongst all the states in the country. During 2007-08 17.8 % of the total traded power in the country was purchased by PSEB. Next to PSEB, WBSEB purchased 1785 MUs, APPCC purchased 1392 MUs, MPPTCL purchased 1357 MUS MSEDCL purchased 1214 MUs. All these states are three to four times bigger than Punjab but are purchasing not even half the power through short term trading.

Whereas the cost of the traded power upto 2005-06 was less than the maximum tariff, it increased dramatically from 2006-07 onwards. The maximum domestic tariff during 2004-05 was Rs. 3.84 per unit and industrial tariff was Rs. 3.37 per unit The corresponding tariff during 2007-08 was Rs. 4.16 per unit and Rs. 3.98 per unit. Thus the average cost of traded power is much more than the maximum tariff applicable. Last year the costliest power purchase was HPSEB which at 730 paise / unit and this year the costliest power is again from HPSEB at 750 paise/unit. This power is at HPSEB bus. Some quantum of liquid fired power was also purchased this year at around Rs. 10 per unit.

During 2007-08 PSEB purchased 1584 MUs at an average cost of Rs. 5.40 per unit from traders. In case the T&D losses (22%) are taken into consideration the average cost of the power at the consumer end is Rs. 7.0 per unit. In case it is assumed that whole of this power is supplied to the highest tariff consumers then even PSEB is losing Rs.2.84per unit. This means PSEB has lost Rs 1850

crore on account of supplying short term power to its consumers during 2007-08. Actually the loss is much more as PSEB is restricting the supply on the paying sector and giving supply to the non paying sectors like agriculture and rural areas where the losses are much more. PSEB is supplying power to these areas with minimum power cuts even at the cost of paying segments which having negligible losses. It can be safely concluded that the loss to PSEB is much more than Rs. 1850 crore.

Even now the position of short term power purchases is still very alarming. For the year PSERC has allowed 898 MUs for 505 crore( 564 p/unit) under short term trading for the whole year. Against this PSEB till end Oct, has already purchased 1890 MUs through traders for Rs. 1175 crore( 623 p/unit) plus 342 MUs under UI for 235 crore(687 paise/unit) i.e in total 2232 MUs for Rs. 1413 crore ( 633 p/unit).

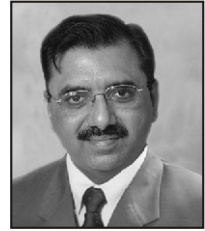
For this history we can very well imagine the fate during the next three years. The dependence of short term power will increase exponentially. The availability of short term power in the country is limited. PSEB is already getting the maximum quantum of short term power and this is not going to increase much. The other alternative will be the increase in power cuts. During the winter of 2007-08, Punjab for the first time witnessed regular power cuts of more than 6 hrs per day. These cuts continued during summer also and are still continuing. The situation is most likely to worsen in the coming months.

*\*Addl SE/Hydel Design, Secretary Finance, PSEB EA*



## DWINDLING COAL STOCKS AND POWER SECTOR

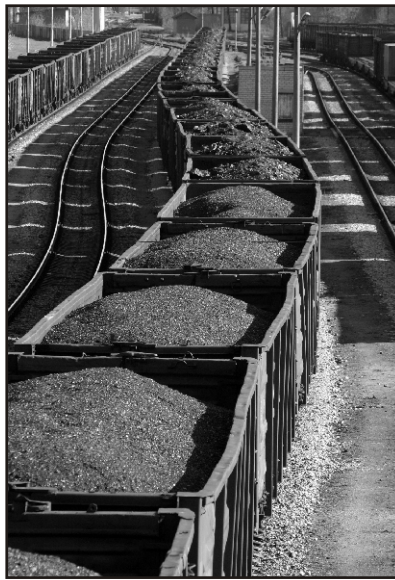
Er. Jagvir Goyal\*



India's resolve to make power available to its cent percent population by the year 2012, to raise the per capita consumption to 1000 units per year from the present 631 units coupled with a consistent rise in demand of power at a rate of about 10 % per annum are a few reasons that are forcing our country to take all possible long-term and short-term steps towards capacity addition. While the hydel potential is already being tapped in view of it providing pollution free and cheap energy, nuclear power sector is yet to invent itself on a major scale after India's signing of agreement with USA. Solar energy still remains untapped, as no cost-effective technology for its use on a mass scale is so far available. This situation has virtually forced our country to choose thermal projects on a large scale.

### THERMAL POWER IN INDIA

A look at the power proportions tells that thermal power percentage is already on a higher side in India. About 62% of India's power comes from coal fired power projects. And there is no stopping. Many more thermal plants are coming up. In a way, thermals have been holding the life line of Indian power sector. There is a growing resentment among people against thermals in many parts of the country, mainly due to the fly ash problem and the air pollution caused by these units. People's concern is genuine. Ask the people living in the vicinity of thermal power stations. They'll show you the exterior surfaces of their houses laden with fly ash, the parapets gone grey and the washed clothes hung outside for drying having black streaks. But we have no alternative. Setting up of thermal projects is important to meet essential power demand. Parallel handling of wastes by looking into the ways and methods for tackling the pollutants and to make the thermal plants environment friendly is equally important. Keeping in view India's geographical situation and fuel resources, power-future will be dark for India if thermals are dispensed with though fuel shortages and capital investments remain the major constraints even in setting up of thermal projects.



### INDIAN COAL

Indian coal contains 38 to 40% ash. And the ash is highly resistive. To run our thermal plants, we have no alternative but to use this coal and at the same time, tackle its byproducts. Government of India is thinking upon taking a national technology initiative to develop coal technology for eco-friendly energy generation. This initiative proves that government circles are fully aware of the pollution problems related to thermal generation. India is third largest producer of coal in the world and its power sector is banking upon coal-based projects at the moment. Indian Institute of Chemical Technology, Hyderabad, is likely to be involved in the research work along-with other major power giants like NTPC and BHEL.

### WORKING OUT COAL REQUIREMENTS

Coal requirements of a thermal project depend upon the Gross calorific value and heat rate of the coal being supplied. Obviously, more is the Gross Calorific value (GCV) and lesser is the heat rate, lesser is the quantity of coal required per MW of power. Coal requirement for a project can be worked out as under:

Let generation capacity of a thermal power project = A MW.  
 Let the Plant Load Factor (PLF) to be maintained = 80%  
 Let the Gross calorific value of coal available = C Kcal/kg.  
 Let the heat rate of coal = B Kcal/KWH.  
 Then coal consumption per hour shall be =  $0.8AB/C$  tonne per hour.

Coal consumption per year =  $0.8AB/C \times 24 \times 365$  tonne.

While working out coal requirements of a project, the units of various items involved should be kept in view. As explained above, generation capacity has to be in Megawatts, PLF in %age, GCV in Kcal/kg and heat rate in Kcal/KWH.

Let GCV of coal available is 3900 Kcal/kg and the heat rate of coal is 2450 Kcal/KWH. For a 2000 MW capacity thermal project, the coal requirement per hour at an PLF of 80% shall be:

$$0.8 \times 2000 \times 2450 / 3900 = 1005 \text{ tonne.}$$

Daily coal requirement shall be :

$$1005 \times 24 = 24120 \text{ tonne}$$

And yearly requirement of coal for this project shall be =  $1005 \times 24 \times 365 = 8.80$  million tonne. Converting it into coal rakes, 1 wagon generally carries 60 tonne of coal and one rake carries 60 wagons. Thus one rake normally carries 3600 tonne of coal. Daily requirement of coal works out to be 24120 tonne. Therefore, 7 rakes of coal should reach this project of 2000 MW every day. In general practice, 20% additional quantity of coal is added to the requirement to take care of losses during transportation and handling of coal. Numbers of rakes of coal therefore work out as 8.5 per day.

## INDIAN COAL REQUIREMENTS

As per the latest figures available from CEA, of India's total generation capacity of 1,43,061 MW in June 2008, 91,907 MW comes from thermal power stations. If all of this generation capacity operates at an PLF of 80%, total coal requirement per year will work out to be 405 million tones. Many thermal projects in India are operating even at a higher PLF and winning national awards. By the year 2012, another 78577 MW of power is planned to be added. Of it, 58664 MW shall be from thermal power projects. Out of 58664 MW, about 45000 MW shall be from coal-based plants and balance from gas based plants. That would mean an additional coal requirement of 200 million tonne per year. By the year 2012, the coal requirement of thermal projects shall therefore be 605 million tonne. Adding a normal wastage and loss of 20%,

actual requirements of thermal plants shall be 726 million tones. It would also mean that leaving apart the thermal projects located on coal pits, 550 trains carrying coal shall be running across the length and breadth of our country every day.

## COAL SHORTAGES

News of the danger looming large over many thermal plants of different states due to shortage of coal are heard by us every other day. Ideally, a thermal project is supposed to maintain a coal stock of 45 days and coal handling plants of thermal projects are designed and established by keeping that much stock in view. In actual, thermal plants are sometimes forced to under-perform due to dwindling coal stocks with them. As per rules of Central Electricity Authority (CEA), a thermal project is said to be in critical position if its coal stock falls below 7 days requirement and in super critical position if the coal stock is less than 4 day's requirement. To have an idea of actual position of coal stocks that prevails at thermal plants, a survey of various thermal projects in Punjab was done on October 27, 2008. The figures and data that became available looked horrible. Here is a slice of the information:

### Punjab TPS : Coal position as on October 27, 2008

Sr. No.	Thermal Project	Capacity	Coal stocks available for
1	GGS Super Thermal Ropar	1260 MW	One day
2	GND Thermal Bathinda	440 MW	Two days
3	GHTP Thermal Lehra Mohabat	630 MW	Four days

The table shows the extent to which the coal stocks get reduced sometimes at various thermal projects. The coal shortage problem that Indian thermal projects are likely to face after addition of another 58664 MW of thermal power by 2012 can be well imagined.

## INDIAN COAL RESERVES

During a recent conference held in New Delhi, Mr. Parth S. Bhattacharya, Chairman, Coal India Limited estimated that the demand for coal will touch 2000 million tonne by the year 2016-17. As calculated above, only the power sector will need 800 million tonne of coal in the year 2012. This demand is likely to rise further to 1200 million tones by 2016. Clearly, it is the power sector that is consuming major percentage of our coal reserves. It has been estimated that the rate at which the demand for coal

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is increasing, our coal reserves are likely to be exhausted by the year 2041. To avoid a deadlock in 2041, coal mining needs to be intensified by involving private sector in this area. Private sector can contribute in coal mining only if the area allocation policies are framed in a manner that wins the confidence of private sector. On its part, the private sector needs to acquire the best expertise for coal mining.

### **COAL SUPPLY AGREEMENTS**

As per the coal distribution policy of Government of India, the power utilities and companies requiring more than 4200 MT of coal per annum need to enter into a Fuel Supply Agreement (FSA) with Coal India Limited. Main sectors that consume coal as a fuel are Power, Steel, Cement and Sponge Iron sectors. About 1500 companies and utilities belonging to these sectors exist in India. However these companies are not coming forward to sign the FSA with coal India limited. Their main grouse is that after signing of FSA, they must get the coal supply committed by coal India limited in the agreement. Their further demand is that a 'trigger level' for coal supply should be fixed in the agreement and if Coal India Limited supplies coal quantities below trigger level, it should be penalized. On the other hand, CIL says that unless the companies sign the FSA, their exact requirements will not become known. CIL has also refrained from signing the trigger level clause. Overall, CIL carries a good image in India and the problem between the CIL and companies should be solved by the government intervention.

### **IMPORTED COAL**

While the Indian coal has high ash content, imported coal has been noted to be having much lesser ash content. In some cases, it has been noted to be a mere 6%. Private sector should therefore try to buy stake in coalmines across the world. This step will decrease the load on Indian coal reserves and these may last longer than anticipated. L&T, a major Indian company is contemplating to buy coalmines in Australia and Indonesia. As Indonesian coal has low ash content, the company may ultimately be benefited if it succeeds in buying these coalmines. L&T may then think of setting up its own power plants and utilized the imported coal there.

### **IMPROVED TECHNOLOGY**

More and more plants in India need to be set up by

adopting improved technology that demands lesser supply of coal. IGCC, Integrated Gasification Combined Cycle, is said to be among the most efficient and cleanest clean coal technologies. It has not yet arrived in India. Fluidized Bed Combustion (FBC) technology is also fuel efficient. Most of Indian thermal projects work on sub-critical pulverized coal technology. India should now look for super-critical technology for its new projects. L&T has recently tied up with Mitsubishi Heavy Industries, Japan (MHI) for manufacturing super-critical boilers, turbines and generators. It has also signed up with MHI to form two joint venture companies for manufacturing boilers, turbines and generators in India itself. The manufacturing plants are likely to come up in Hazira, Gujarat. Some companies are signing up with Chinese firms for supply of turbines, boilers and generators for super-critical technology plants. Keeping in view the general impression of poor quality of Chinese products, the companies may now buy these three crucial components within India from the L&T-MHI joint venture.

### **SOME IMPORTANT STEPS**

While the focus shall remain on Thermal power projects during the next two decades, following steps if taken may help in easing the coal demands from Coal India Limited:

1. Adopt new and improved technology like Super critical technology and if possible, IGCC for the newly coming up thermal plants.
2. Sign up agreements with foreign companies with technical know-how to produce boilers, turbines and generators in India for improved technology thermal plants.
3. Exploit non-conventional energy sources on a mass scale so that number of thermal plants to be set up may be reduced.
4. Import coal or acquire coal-mines abroad wherever feasible. Here, it should be checked whether the boilers are compatible to receive the imported coal. Not all boilers are capable of using imported coal.
5. Signing up of Fuel Supply Agreements (FSA) by the industrial and power sector companies with the Coal India Limited.

*\*Dy. C.E. Civil PSEB, Author: Technical books & Technical Journals*

# INSTRUMENT TRANSFORMERS



Er. J.S. Thakar

In Power System to measure high voltage and large currents Instrument Transformers are used. These transformers step down the voltage or current to measurable level of measuring instruments and protection relays.

i) **Current Transformer (CT)** is for measuring large currents.

ii) **Voltage transformer** is for measuring high voltage.

The main advantages of providing instrument transformer in Power System are :-

- i) These transformers save the overall cost, otherwise for high voltage and large currents the measuring instruments would be so bulky the measurement would have been expensive and very difficult.
- ii) The metering and protection instruments installed in the control room panels are isolated from high voltage power circuits in the switch yard. Hence insulation is no problem and safety to operating personnel is ensured.

## DIFFERENCE BETWEEN A CT AND PT

Potential Transformer	Current Transformer
1. PT is a parallel T/F with its secondary with its secondary winding operating under near open circuit conditions.	1. CT is a series T/F with its secondary winding operating under virtual short circuit conditions.
2. Primary winding current in PT depends upon secondary winding VA burden.	2. Primary winding current of CT is independent of secondary winding conditions.
3. In PT full line voltage is impressed on the terminals.	3. In CT only a small potential exist across its terminals but its primary carries the full line current.

## RATIOS RELATING TO INSTRUMENT TRANSFORMERS

1. **Transformers Ratio** :- This is the Primary winding current to secondary winding current Ratio in case of CT and Primary winding voltage to secondary winding voltage ratio in case of PT
2. **Nominal Ratio** :- This is the Rated Primary current to rated secondary current Ratio in case of CT and Rated Primary voltage to rated secondary voltage Ratio in case of PT
3. **Ratio Correction factor** :- It is the Transformation ration divided by nominal Ratio.

## ERRORS IN INSTRUMENT TRANSFORMER

There are two types of errors in Instrument Transformer

(a) Ratio Error (b) Phase angle Error

(a) **Ratio Error** :- Ratio Error in a current T/F is ratio of difference between nominal Ratio and Actual Ratio to Actual Ratio  
 Ratio Error =  $\frac{\text{Nominal Ratio} - \text{Actual Ratio}}{\text{Actual Ratio}} \times 100$  as usually it is expressed in percentage.

(b) **Phase angle Error** :- Phase angle Error of a CT is defined as the angle by which the secondary current phasor, when reversed, differs in phase from primary current phasor.

Similarly errors in PT are calculated with nominal Ratio and Actual Ratio and voltage phasor.

## CAUSES OF ERRORS

Ideal CT and PT can not be manufactured because there are physical limitations inherent in electric and magnetic



circuits causing departures from ideal values of ratios and phase angles.

Age of the instrument transformer is also factor responsible for ratio and phase angle error as with the no. of years in service the cores undergo stress due to fault currents, magnetizing currents and magnetic leakage currents causing in crease in errors.

## CLASSIFICATION OF INSTRUMENT TRANSFORMERS

### (a) Voltage Transformers (PT)

The voltage or Potential T/F (PT) are classified as (i) Magnetic Type (ii) Capacitive Type

**Magnetic Type :-** This type of PT works on the same principle as the Power Transformer. The design is however different because of different requirement in two cases. The load to be transmitted by a PT is to be used with limited to few hundred VA burden only. The main object in the design of Magnetic Type PT is to minimize the ratio and phase angle error.

**Capacitive Type PT :-** For voltage above 100 kV. (Phase) the conventional Magnetic. Type PT are not used due to its high insulation requirements. Capacitive Potential Transformer (CVT) is less expensive alternative for very high voltages measurements.

**(b) Current Transformer CT :-** The CTs are classified as (i) Bar Type CT (ii) Wound Type CT

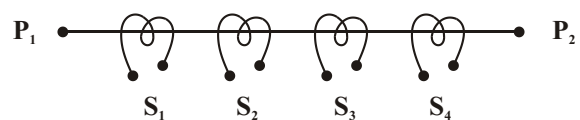
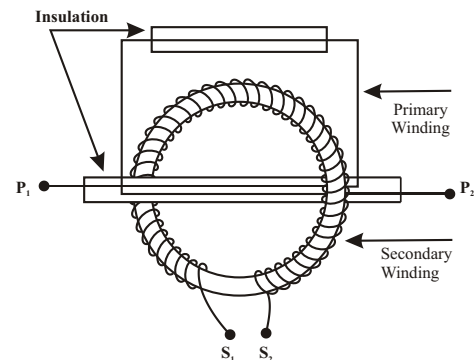
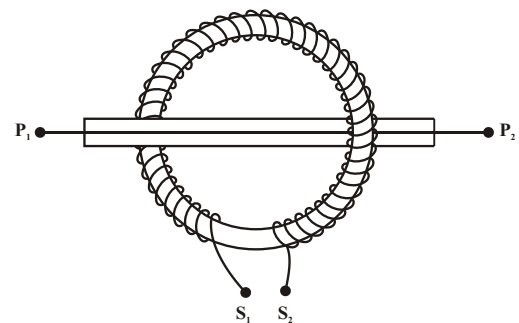
**Bar Type CT :-** This Type of CT is suitable for large primary currents because it can meet with the burden and accuracy requirements and at the same time can have high thermal and dynamic short time factors. Primary is bar only without winding.

**Wound Type CT :-** This type of CT is suitable where the primary current are low and the burden and accuracy requirement are high. The primary has some no. of turns which depends upon the primary current. The greater no. of primary turns will lower the thermal and dynamic short term current factors so it is usual to aim at approximately 1200 AT.

**Multi core CTs :-** As in Power System the requirements for metering and protection are different. This needs separate design considerations for metering and protection. It will be very uneconomical to build and install separate metering and protection CT's. The CT's can there fore be provided with two or more cores. Each core carries its own secondary current with primary winding common to all of them.

An CT with more than one cores operates in exactly the same way as two or more independent transformers with the same primary current. If ratio change toppings are on primary side then with the change in ratio of primary winding the ratio of all secondary cores changes. Now a days the CTs are manufactured with center tapped secondary windings to change the ratio of individual secondary as per requirement.

Combined CT/PT unit is manufactured for purely metering purpose in large industrial units. For protection purpose differential or distance protection should be provided from separate core other than the one used for over current and earth fault protection.



## ACCURACY CLASS OF CURRENT TRANSFORMERS

Accuracy class of CT is the indication of the limit of ratio error and phase angle error. For relaying purpose, the ratio error is important factor because the currents are very high during short circuit conditions. In general percentage ratio error increases with increase in primary current. The phase angle error in CT is negligible as load on secondary side of CT is at such a lagging power factor that secondary current phasor is in phase opposition with magnetizing current phasor. The Accuracy Limit Factor (A.L.F.) of CT is closely related to the VA burden of the core as at half the burden of the same CT will have its A.L.F. approximately doubled. This factor is seldom less than 10 and quite commonly as high as 20.

The table below will give an idea of permissible error.

Accuracy class	Current Error at rated Primary current in Percent	Composite Error Rated A.L.F. Primary current in Percent	Phase Displacement at Rated current in Minutes
5 P	$\pm 1$	5	$\pm 60$
10 P	$\pm 3$	10	-
15 P	$\pm 5$	15	-

For example if a CT is marked as 30/5 P 10 this indicates the following :

First Number (30) denotes the VA burden

Second Number (5 P) denotes accuracy class

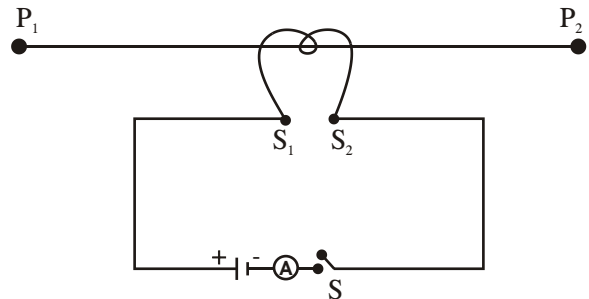
Last Number (10) denotes composite error

For IDMT (Inverse definite minimum time) relays class 10 P CT is preferred. As discrimination of faults is done normally by grading of relays in network, so 10 P is sufficient but 5 P CTs are preferred where accurate time grading and stability are desired as in differential and REF core of the CTs.

## POLARITY OF CT AND CONNECTIONS

Polarity gives the relative instantaneous direction of currents in the primary and secondary leads of the CT. It is essential for the manufacturer to mark primary and secondary polarities of the CT to error the polarity the simple circuit is self explanatory.

For right polarity of  $P_1$ - $P_2$  and  $S_1$ - $S_2$  the Ammeter needle will indicate forward deflection when switch S is closed.



## CT CAN NEVER BE OPEN CIRCUITED

In secondary short circuit condition the voltage across the secondary winding is very small i.e few volts only. However if it is open circuited by mistake the voltage rises to very high value. It may rise to some kilovolts. When secondary is open circuited the secondary current is zero and hence back e.m.f. will be reduced to zero. The working flux will increase manifolds and the core gets saturated. The secondary e.m.f. increases due to increased flux.

The primary gets heated up and the core also gets over heated resulting in damage to CT The wave form of the dangerous to persons working near the CT

For more detail of specifications engineers may refer following Indian standard for Instrument Transformer :-

Is : 2705 Specifications for current Transformer

Part I 1964 General Requirements

Part II 1964 Measuring Current Transformers.

Part III 1964 Protective Current Transformer.

In addition the Indian Standard : 5201 - 1967 "Application Guide for current Transformer" has also been issued.

\* Sr. Xen. P & M, Kapurthala

## DO WE HAVE TO GET ANGRY?

Er. J. Kharbanda\*



**We live in a fast-moving competitive world. One-up-manship gets built into our psyche right from the childhood. Many of our desires remain unfulfilled for no rhyme or reason. Whenever our good and righteous desires do not get fulfilled, we are filled with righteous anger. When our evil desires remain unfulfilled, we tend to become destructive and un-reasonable. But, wrath of either kind causes equal measure of harm to our body and soul.**

When we get angry, sometimes, for trivial or undeserving causes, we undergo physiological as well as psychological changes. It is we, who have to decide whether the anger has to be allowed into our lives or not. To help in deciding, we must first understand the mechanism and consequences of anger.

### PHYSIOLOGICAL EFFECTS

- The heart beats faster.
- The heat of blood rises.
- The blood rushes to the head.
- The brain-tissues get tensed.
- The whole body burns.
- The electric circuits of the nerves get overloaded.
- Toxic chemicals are secreted and spread throughout the body.
- Digestive mechanism is disturbed.
- Extreme anger could give you a heart attack or a stroke and may even kill you.
- Our faces become contorted and ugly and we would be ashamed to see our faces in the mirror when we are in anger.



### PSYCHOLOGICAL EFFECTS

- Anger stuns us and our mind loses its functioning power.
- Normal psychological state gives way to irrational behaviour.
- Anger impulses lead to irresponsible acts.
- When angry, a perfectly sane person becomes abusive

and violent and may even injure others.

- Heinous acts during a fit of rage can not be undone after your mind realizes the gravity of the act.
- Psychological blindness is born out of anger and all reasonable faculties are impaired.
- The mind over-clouds and you move aimlessly without knowing what ought to be done.
- In an attack of anger, the light of reason extinguishes and you are left in darkness without a guide or direction.

A high stress and high risk lifestyle is seeing us walking a tight-rope-all the time-tense, worried and challenged. Everybody seems to be on run. We are paying the price for professional and financial successes and lifestyle diseases like the high-blood pressure, anxiety, stress and sleeplessness are making us angrier by the day. Impatience, inability to relax, aggressiveness and jealousies are prompting anger in us.

Next time when unreasonable targets are thrown at you, the boss makes unjust demands, jealousy over-takes you, the system frustrates you, people don't co-operate and don't think like you do and when plain and simple luck deserts you-pause to think. Do you have to be angry? Is it worth it? No, it is not. Turn away, take a long breath, look into the mirror and smile.

*\*Chief Engineer, Civil Design & Construction,*

## ਸ਼ਹੀਦ

### ਜਸਵੰਤ ਜ਼ਫ਼ਰ

#### ਕਰਾਮਾਤ

ਕੱਲ੍ਹ ਦੇ ਦਿਨ ਸ਼ਹੀਦ ਹੋਇਆ ਰਹਿਬਰ  
ਛੁੱਟੀ ਛੁੱਟੀ ਛੁੱਟੀ ਛੁੱਟੀ

ਅੱਜ ਆਮ ਕੰਮ ਕਾਜੀ ਦਿਨ  
ਸਵੇਰੇ ਸਵੇਰੇ ਪਹਿਲਾਂ ਚੱਪਲ  
ਫਿਰ ਕੰਘੀ ਨਾ ਲੱਭੇ  
ਚੁੱਕੀ ਰੱਖੀ ਕਿਨ?  
ਮੈਂ ਰਿੱਝਦਾ ਖਿੜਦਾ  
ਲੇਟ ਤਿਆਰ ਹੋਇਆ  
ਠੰਡੀ ਕਾਰ ਤੇ ਸਵਾਰ ਹੋਇਆ  
ਦਫ਼ਤਰ ਚੱਲਿਆ  
ਆਟੋ ਰਿਕਸ਼ਿਆਂ ਸਾਰਾ ਰਾਹ ਮੱਲਿਆ  
ਦੁਖੀ ਹੋਇਆ  
ਜਵਾਲਾਮੁਖੀ ਹੋਇਆ

ਪਹੁੰਚਾ ਦਫ਼ਤਰ  
ਕਹਿਣ ਲੱਗਾ ਅਫ਼ਸਰ  
ਲੇਟ ਆਉਂਦੇ ਹੋ  
ਮੈਂ ਕਿਹਾ ਜਨਾਬ  
ਸਵੇਰੇ ਸਵੇਰੇ ਕਿਉਂ ਗਰਮੀ ਚੜ੍ਹਾਉਂਦੇ ਹੋ

ਮਾਰਨ ਤੇ ਟੱਲੀ  
ਆਵੇ ਨਾ ਤੁਰੰਤ ਪੀਅਨ ਬੱਲੀ  
ਮੈਂ ਅੱਗ ਉਗਲਦਾ  
ਕਮਰਾ ਠੰਡਾ ਖੂਨ ਉਬਲਦਾ

ਸ਼ਾਮੀਂ ਘਰ ਨੂੰ ਆਂਵਦਾ  
ਹੋਰ ਗਰਮੀ ਖਾਂਵਦਾ  
ਜਦ ਬੱਤੀ ਵਾਲੀ ਕਾਰ ਦੀ  
ਐਸਕੋਰਟ ਹੂਟਰ ਮਾਰਦੀ

ਗਲੀ ਦਾ ਮੋੜ ਮੁੜਦਾ  
ਗੁਆਂਢੋਂ ਹਾਸਾ ਸੁਣ ਜਲਦਾ ਕੁੜਦਾ

ਘਰ ਵੜਦਾ  
ਰਿਪੋਰਟ ਕਾਰਡ ਫੜਦਾ

ਸਕੂਲ ਜਾਂਦੇ ਆਪਣੇ ਬੱਚੇ ਦਾ  
ਇਮਤਿਹਾਨ ਕੱਚੇ ਦਾ  
ਪ੍ਰਾਪਤ ਬਟਾ ਕੁੱਲ ਅੰਕ ਪੜ੍ਹਦਾ  
ਪਾਰਾ ਅਸਮਾਨ ਚੜ੍ਹਦਾ

ਇੰਜ ਤਪਦਾ ਤਪਾਉਂਦਾ  
ਅੰਦਰ ਬਾਹਰ ਦਾ ਤਾਪਮਾਨ ਵਧਾਉਂਦਾ  
ਅੱਜ ਦਾ ਕੰਮ ਕਾਜੀ ਦਿਨ ਮੁਕਾਉਂਦਾ

ਕੱਲ੍ਹ ਤਾਂ ਗੁਰੂ ਦਾ ਸ਼ਹੀਦੀ ਦਿਹਾੜਾ ਸੀ  
ਜਿਸ ਦਾ ਸ਼ਬਦ ਕਰਮ ਧਰਮ ਕਾਰਜ  
ਹਕੂਮਤ ਭਾਣੇ ਪੁਆੜਾ ਸੀ  
ਤਿੱਖੜ ਧੁੱਪ ਸਿਰ ਤਪਦੀ ਰੇਤ  
ਤੱਤੀ ਤਵੀ ਦਾ ਆਸਣ ਰੇਤ  
ਸੜਦੇ ਚਮੜੀ ਚਰਬੀ ਮਾਸ  
ਮਨ ਅੰਤਰ ਸੀਤਲਤਾ ਖਾਸ  
ਮੁਸਕਾਉਂਦੇ  
ਮੀਠਾ ਭਾਣਾ ਗਾਉਂਦੇ

ਗੁਰ ਸੱਚੇ ਦੀ ਵੰਡ ਕਰਾਮਾਤ  
ਸਮਝ ਸਕਾਂ ਨਾ  
ਝੂਠੀ ਹਸਤੀ ਛੋਟੀ ਜਾਤ

#### ਜੈਤਾ ਜੀਵਨ ਸਿੰਘ

ਸਿੱਖ ਸੀ ਜੈਤਾ  
ਗੁਰੂ ਦੇ ਧੜੋਂ ਲੱਥੇ ਸੋਚ-ਸਰੋਤ  
ਸੀਸ ਨੂੰ  
ਰਾਜਧਾਨੀ ਵਿੱਚ ਰੁਲਣ ਨਾ ਦਿੱਤਾ  
ਮੋਹ ਪੁਗਾਇਆ  
ਗੁਰਧਾਨੀ ਵੱਲ ਧਾਇਆ  
ਨੇਰੀ ਨੇਰੀ ਤੇ ਹਕੂਮਤੀ ਪਹਿਰੇ ਚੀਰ ਕੇ ਦੱਸਿਆ  
ਜੇਤੂ ਹੋਣਾ ਕੀ ਹੁੰਦਾ

ਸਿੰਘ ਬਣ ਕੇ ਜੈਤਾ  
ਜੀਵਨ ਸਿੰਘ ਹੋਇਆ  
ਗੁਰੂ ਦਾ ਲਾਡਲਾ  
ਗੁਰੂ ਦੇ ਲਾਡਲਿਆਂ ਸੰਗ ਨਿੱਤਰਿਆ

ਕਹਿੰਦਾ-ਗੁਰੂ ਦਾ ਆਦੇਸ਼ ਹੈ  
ਬੇਦਿਲੀ ਕੂੜ ਜਬਰ ਅਨਿਆਂ ਨੂੰ  
ਮਾਰਨ ਲਈ ਲੜਾਂਗਾ  
ਇਹ ਰਹਿਣਗੇ ਜਾਂ ਮੈਂ ਰਹਾਂਗਾ

ਮੌਤ ਦੀ ਬਾਂਹ 'ਚ ਬਾਂਹ ਪਾ ਨੱਚਿਆ  
ਅੱਖਾਂ 'ਚ ਅੱਖਾਂ ਪਾ ਤੱਕਿਆ  
ਓਸਨੂੰ ਦੱਸਿਆ  
ਸਿੰਘ ਲਈ ਜੀਵਨ ਦਾ ਅਰਥ ਕੀ ਹੁੰਦਾ  
ਸ਼ਰਮ ਦੀ ਮਾਰੀ  
ਕਹੇ ਮੌਤ ਵਿਚਾਰੀ-  
ਜੇ ਤੈਨੂੰ ਪਸੰਦ ਨਹੀਂ ਤਾਂ  
ਆਪਣਾ ਨਾਂ  
ਬਦਲ ਕੇ ਸ਼ਹੀਦੀ ਰੱਖਾਂ?

ਪਰ ਮੈਂ  
ਨਾ ਜੈਤਾ ਨਾ ਜੀਵਨ ਸਿੰਘ  
ਨਾ ਪ੍ਰੇਮੀ ਨਾ ਜੇਤੂ  
ਨਾ ਲਾਡਲਾ ਨਾ ਲੜਾਕੂ  
ਚੜ੍ਹਦੀ ਕਲਾ ਤੋਂ ਦੂਰ ਨਾਖੁਸ਼  
ਨਾਂਮਾਤਰ ਖੁਸ਼  
ਜਾਂ ਬਨਾਉਣੀ ਖੁਸ਼ ਹਾਂ  
ਸੋਚਦਾ ਕੁਛ ਕਹਿੰਦਾ ਕੁਛ  
ਤੇ ਕਰਦਾ ਕੁਛ ਹਾਂ  
ਬੱਸ ਪੀਂਦਾ ਖਾਂਦਾ  
ਤੱਕਦਾ ਰਹਿੰਦਾ  
ਸਹਿਣ ਕਰੀ ਜਾਂਦਾ  
ਨਾਂ ਕੀ ਏ  
ਨਾਂ ਨਾਲ ਸਿੰਘ ਲਿਖਿਆ ਕਿ ਨਹੀਂ  
ਕੀ ਫਰਕ ਪੈਂਦਾ

## ਊਧਮ ਸਿੰਘ

ਮੈਂ ਅਕਸਰ ਵਿਸਾਰ ਦਿੰਦਾ  
ਸੌਣ ਵੇਲੇ ਕੀਤਾ  
ਸਵੇਰੇ ਜਲਦੀ ਜਾਗਣ ਦਾ  
ਸੈਰ ਕਰਨ ਦਾ ਪ੍ਰਣ  
ਤੇ ਹੋਰ ਕਿੰਨਾ ਕੁਝ

ਇਕ ਰਾਤ ਦੀ ਨੀਂਦ ਕਾਫੀ ਹੁੰਦੀ  
ਬੰਦੇ ਨੂੰ ਕਸਮ ਤੋੜਨ ਲਈ  
ਸਹੁੰ ਸੁਗੰਧ ਭੁੱਲਣ ਲਈ

ਪਰ ਇੱਕੀ ਸਾਲਾਂ ਦੀਆਂ  
ਸਾਢੇ ਸੱਤ ਹਜ਼ਾਰ ਤੋਂ ਵੱਧ  
ਰਾਤਾਂ ਦੀ ਨੀਂਦ ਵੀ  
ਭੁਲਾ ਨਾ ਸਕੀ  
ਤੈਨੂੰ ਤੇਰਾ ਪ੍ਰਣ

ਸਮਾਂ ਭਰ ਦਿੰਦਾ ਜਣੇ ਖਣੇ ਦੇ ਜ਼ਖਮ  
ਪਰ ਤੈਂ ਆਪਣੇ ਜ਼ਖਮੀ ਦਿਲ ਅਤੇ ਰੂਹ ਦੇ ਦਰਦ ਨੂੰ  
ਚਾਲੀ ਕਰੋੜ ਨਾਲ ਐਸੀ ਯਰਬ ਦਿੱਤੀ  
ਕਿ ਜ਼ਖਮ ਸੁੱਕਣ ਲਈ  
ਚਾਲੀ ਕਰੋੜ ਦਿਨਾਂ-ਰਾਤਾਂ ਦਾ ਸਮਾਂ ਚਾਹੀਦਾ ਸੀ  
ਪਰ ਤੂੰ ਦਿਨਾਂ-ਰਾਤਾਂ ਨੂੰ ਵਕਤ ਨੂੰ  
ਆਪਣੇ ਜ਼ਖਮ ਨੂੰ ਛੂਹਣ ਦੀ ਇਜਾਜ਼ਤ ਨਾ ਦਿੱਤੀ  
ਦਰਦ ਦਾ ਇਲਾਜ  
ਪ੍ਰਣ ਪੂਰਤੀ ਨਾਲ ਕੀਤਾ

ਤੇਰੇ ਵਲੋਂ ਵਿਹਲੇ ਹੋਏ  
ਕਰੋੜਾਂ ਦਿਨਾਂ-ਰਾਤਾਂ ਦੇ ਜੋੜਿਆਂ ਕੋਲ  
ਤੇਰੀ ਅਮਰਤਾ ਨੂੰ ਗਾਉਣ ਤੋਂ ਬਿਨਾਂ  
ਕੋਈ ਚਾਰਾ ਨਾ ਰਿਹਾ



Jaswant Zafar participating in International Festival of Poetry at Chandigarh organized by Kryta on 14 to 16 November 2008. Others sitting on the stage (from left): Ajmer Rode (Canada), Chandra Prakash Deval (Rajasthan), Dilip Jhaveri (Gujarat), John Siddique (Scotland) and Peter Waugh (Austria)

## THROUGH A JOURNEY OF COLORS

Er. Harjit Singh Gill\*



Jaswant Zafar's journey of images began with cartoons, then on to poetry, prose and now to photographs add paintings -somewhere in between. Jaswant Zafar through his photographs, which were on display in New Multipurpose Hall in PSEB complex Ludhiana from 27 to 29 September then in gallery Atmosphere from 30 September to 13 October, took the viewers through a journey of colors, images and self. The exhibition was inaugurated by S. Charanjit Singh Atwal, Deputy Speaker, Lok Sabha. Er. B. S. Bath, Engineer in Chief, Central Zone presided over the inaugural function and Prof. Hari Singh retired principal of Guru Nanak Engineering College was the Guest of Honor.

On this occasion the engineer artist said,



“These pictures are my journey which is spread over four years. In this journey, I have tried to break the boxes, the small compartments that we all have chosen for ourselves and prefer to live in them. My call is that let us all break out of these boxes and think with each other.” He added, “It would be too simple to say that all these are pictures of beautiful places for we all know how beautiful the Niagara Falls are or how magnificent our temples are. But then, my take is different. Let us try and see the unseen, hear the unheard, and feel what we all have not felt for so very long.” The Engineers & staff of PSEB, College & University teachers, writers & scholars, artists & art critiques, print & electronic media persons viewed these photos and absorbed the vibrations coming from them.

It was not for the first time that Zafar is so vocal about what he feels so closely. While he takes a dig at the system and politicians around us through the cartoons that he has been drawing for so many years for various newspapers and magazines, his book on poetry, ‘Assin Nanak De Ki Lagde Haan,’ which was released in the year 2001 not only brought a genre of poetry to the fore but also made people sit up and think. His latest work, “Sikh So Khoj Lahai,” which is a collection of essays on Gurbani and Sikh Society is again a well-received book, which is presently a talking point of Sikh and the intelligentsia world over.

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31	Er. G.D. Sharma	96461-12819	41-A, Khalsa College Colony, Patiala	gdsharma@psebea.org
32	Er. Malkiat Singh	96461-10782	264, Majoraja Yadwindra Enclave, Nabha Road, Patiala	bhangal_ms@psebea.org
33	Er. Sunil Kumar Sarwal	94172-02046	H.No.2, Eastern Avenue, Nangal Township	sunilkumarsarwal@psebea.org
34	Er. S.P. Singh	96461-18022	70, Power Colony 1, Model Town, Patiala	

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