Integrated Water Resources Development in Andhra Pradesh – Problems faced in "Jalayagnam" & Solutions

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KEYNOTE ADDRESS

1. Introduction

Construction of irrigation projects is taken up on a massive scale in Andhra Pradesh. In the history of irrigation development, there is no such precedent in the State and this activity is going to boost the irrigation sector in a significant manner benefiting irrigated agriculture throughout the State. Twenty-six major and medium irrigation projects costing Rs. 46,000 crores (Revised to Rs. 67, 823 crores) are taken up for execution. Out of this, 8 projects are programmed to be completed within 2 years and the balance 18 projects within 5 years. The increase in cost, though happened within 1 year of taking up execution of works, is mainly due to increase in scope of the projects as well as the realistic costs of land acquisition, relief, and rehabilitation. In addition to these 26 projects, it is proposed to construct several other major irrigation projects like Polavaram, Pranahitha - Chevella and it is estimated that about Rs.1.00 lakh crores would be needed to complete all these projects. When such a massive programme of execution of works is taken up, it is bound to cause several problems mostly in the shape of displacing habitats and effecting people living in the submersion areas. In this context, an in depth analysis of all aspects relating to water resources development as well as the possible problems that would arise in the process of execution of works, would be needed. This is with a view to see that serious problems may not arise during the course of execution of works and also work out a methodology to solve various issues technically as well as sociologically to the satisfaction of the people affected.

The purpose of this paper is to analyse the problems faced in the water sector and suggest possible solutions for consideration. Though it may not be possible to find ready answers for various issues, yet a study and analysis would lead to working suitable solutions.

2. Allocation of Water within the 3 regions of Andhra Pradesh

Nine Major irrigation projects on Krishna river are taken up for utilizing the surplus flows available in the river, according to the conditions stipulated in the Bachavath award. In addition to this, 3 more projects on Krishna River, based on assured water at 75% dependability, have also been taken up for execution. The requirements of water in these 12 projects will have to stand as designed since financial commitments are already made. There is no scope for taking up any more schemes based on surplus water on Krishna River. With regard to Godavari River, the allocated water of 1480 TMC is not fully utilized. It is estimated that only 680 TMC of this, is under utilization now, and the balance 800 TMC will have to be fully utilized. In addition to this, there is a need to request for allocation of 300 TMC at 75% dependability (in addition to 1480 TMC already agreed to by the 4 States and mentioned in the Award). During the time of the award, AP felt that there may not be any need for more

than 1480 TMC, but the present situation of different. Also the upper States may not find it difficult to agree to this, since they would not be in a position to utilize this due to mountainous and forest terrains in their States, especially in Pranahitha, Indravathi & Sabari basins. Considering this, it is possible to plan utilization of 1100 TMC, in addition to the water presently being utilized in Godavari.

Projects like Polavaram Pranahitha - Chevella, Yellampally, Devadula, Dummagudem, Tadipudi, Pushkaram, Alisagar, Gutpa, Sriram Sagar 2nd stage, SRSP flood flow canal, Ichampalli and several other medium projects are proposed for utilization of Godavari water. Some of these are yet to be started; where as many of them have been grounded. With regard to allocation of water, these projects can be considered for all purposes as committed and further use of balance quantity can be planned. While planning in such a manner certain guidelines may have to be followed in order to have equitable distribution of water to the needy areas of the State and also to set right the regional imbalances. For example, 1100TMC quantity of water can be utilized for irrigating upland areas in Telangana, as well as diversion of water to Krishna River to take care of drought prone areas of Rayalaseema. The apportionment of water and the manner in which this has to be done cannot be spelt in detail at this stage in a paper like this. It is suggested that a Committee of Technical persons of all the 3 regions may be constituted to go into the details of the same and work out the best alternatives to satisfy the above guiding principle. This can be later reviewed by a Committee of party leaders of the 3 regions and draft proposals finalized. As this is a rigorous exercise, it may be take 3 – 6 months time to complete such a task. State Government can then take a view on these proposals of allocation of water and start formulating proposals for implementation after due completion of the projects now taken up for execution. The guiding principle is that when a project on Godavari is taken up for execution, it should be taken up with a firm commitment on water usage and finances.

3. Number of flood days in Krishna River and utilization of Surplus flows

Nine projects on Krishna River are contemplated to utilize surplus flows in the river. According to the Bachavath award, such flows going to the sea can be utilized by the Andhra Pradesh state. It is, therefore, needed to work out the number of days when such flows would occur. When once the upper riparian states start utilizing the allocated shares of water, there will be reduction of flow in the river at the state border and Andhra Pradesh has to accept this situation. Also when Andhra Pradesh fully utilizes, its allocated share of its 811 TMC of water, there will also be a certain reduction in flow of the river on the downstream side. As such, a simulation exercise of long term hydrological data considering these factors will have to be made and the number of days in which the water would go to the sea and the quantity of the same will have to be estimated. Such simulation exercise was roughly done by me about 15 years back, and it worked out to 25 days. When Telugu Ganga project was contemplated in 1983, it was then estimated that the number of such days would be 60 and then to be on the safe side, it was reduced to 45 days, while working out the project details. In the case of designing the Pothireddypadu Head Regulator, it is taken as 30 days. This appears to be fairly correct, however, there is a need to do a long-term simulation exercise, considering the later period flows in the river from 1976 - 2006. Viewed from this context, the provision of 44,000 cusecs discharge for Pothireddypadu Head Regulator and the main canal up to Banakacherla cross regulator appears to be in order. Though this may appear to be a sudden increase from the earlier 15000 cusecs, yet the same is inevitable for technical reasons. When it is contemplated to utilize 112 TMC for the requirements of Telugu Ganga project, Madras Water Supply, Galeru Nagari, SRBC, PABR and when it is required to draw these quantities of water in a period of 30 days, such a discharge becomes a technical necessity. When once these 5 projects are sanctioned and works are under execution, the quantity of

supply for the requirements of these projects through the Head Regulator and the Main Canal is only a Technical issue. However objections are being raised for this increased regulator capacity and no objections were raised for the 5 projects, which have already been started, and presently under execution. If at all, any objection is to be raised, it should have been for the utilization proposed under the 5 projects but not for the Head Regulator capacity. However the main reason of apprehension for Head Regulator capacity is that, at a later date, assured flows also may be drawn through this regulator, affecting the interests of the Nagarjuna Sagar project, Krishna delta and Hyderabad water supply. The Government has rightly given clarifications on this to clear such apprehensions. Though the intentions are good, applying the principles in practice would be a major issue in this case. There is a need to constitute an empowered authority representing the interests of the 3 regions of the State to regulate the flows in Pothireddypadu Head Regulator on a day to day basis, complying with the principles already laid down by the Government through various G.O's issued in this regard.

The principle of availability of flood flows in 30 days adopted for Pothireddypadu Head Regulator will have to be followed for all other schemes drawing surplus water from Krishna River. For example, in the case of Handrineva project, it is presently designed for drawing water for 120 days. This has to be reduced to 30 days and greater pumping and canal capacities will have to be provided to facilitate drawing the surplus flows available in 30 days. Similarly Srisailam left bank canal (Alimineti Madhava Reddy Canal) will have to be designed for drawing water for 30 days, as against the present 90 days contemplated. When water is to be supplied for 120 days during the crop period and, it has to be drawn in 30 days, there is no possibility to supply water to the crops in the balance 90 days unless storages are built up in the shape of balancing reservoirs. In the case of Telugu Ganga project, storages of 32 TMC balancing reservoirs were built at Veligallu and Brahmamgari Mattam. However, there are no such balancing reservoirs on SLBC. It is, therefore, necessary to construct suitable balancing reservoirs across Gudipallivagu, Saslervagu, Halia, etc; and investigation for the same will have to be done in detail to work out exact locations and capacities. Also, the tunnel of SLBC will have to be designed to draw water in 30 days. The same principle will have to be applied in the case of Kalvakurti lift irrigation scheme, Nettempadu lift Irrigation scheme and Koyalsagar Lift irrigation scheme, all based on drawing surplus flows from Krishna river. Any different type of technological treatment between Pothireddypadu Head Regulator and other similar schemes drawing surplus water from Krishna River, would lead to inter regional and even inter district conflicts. Also doubting and suspecting the intentions of Government, from any quarter should be avoided. Apart from these issues, it will be technically necessary to design all the schemes on the same principle if the same have to function successfully. In addition to drawing or pumping the required higher discharges, construction of balancing reservoirs would also become necessary, for all the schemes based on surplus water.

There is an impression in some quarters, that because, off-take levels of some schemes are kept much lower than the sill level (841 ft.) of Pothireddypadu Head Regulator, water can be drawn in more than 30 days and hence there is no need to increase the discharges. This is not correct. If any water is drawn from a level below 841 ft, it would amount to utilizing the assured 75% dependable flows or depleting the stored water in Srisailam. Since it is contemplated to draw only surplus flows, such a method shouldn't be resorted to. For example it is reported that the pumping level for Kalwakurthi lift scheme is 811 ft. In such a case, irrigation water shouldn't be pumped when the water level in the reservoir drops below 841 ft. However drinking water requirements can be pumped even when the water level goes down, similar to the case of Hyderabad city water supply from Nagarjuna Sagar reservoir. In the case of SLBC tunnel, though the sill level is provided at 825 ft. level, it

requires an FSL of 850 ft. in the canal to draw 4000 cusecs, and hence this is in order for the purpose of drawing surplus flows.

4. Preparation of Detailed Project Reports (DPR) & execution of works

Most of the irrigation projects taken up by the Government are of the type of excavation of canals. Head works (Dam) are involved only in the case of some medium irrigation projects and Polavaram dam. The State has got technical skills to prepare the detailed reports for all these works. It would not be prudent to call for technical bids following EPC (Engineering, Procurement and Construction), since there is no need to procure Engineering from any bidder. The Central Designs Organization of the State as well as the Investigation wing are having skills to prepare estimates for tunnels also. However, the State had chosen EPC system for the reasons stated by them as timely completion of work without any extra costs for any reason of change in design, as the responsibility of designing is also with the tenderer. The disadvantage of the system as presently being flowed would become evident and clearer during the later period of execution, since the EPC system is not followed in toto. The case in point is that the tenderers are not giving the designs and drawings at the time of evaluation of the technical and financial bids. They were given a time of 1 week to 3 weeks to submit their technical, bids involving investigation, designs and drawings where as it require 3 to 6 months for the same. However the tenderers were made to agree for any changes in design that the Government would make later on while approving the designs of the contractors. In order to ensure this, Government is safeguarding its interests by taking an agreement from the contractor that he will abide by the changed designs made by the Government given later on, and that he will not claim any extra towards the same even though it may cost more amount than the design given by the contractor. When such compliance would entail in losses to the contractor, he would not be encouraged to complete the works and would prefer taking up this case for redressed through a Court of Law. As per law of Contract, any agreement on unknown factors would be null and void and even if the contractor signs for complying with an unknown factor, it would not stand before Law, as valid. On the other hand, if there is a design suggested by the Contractor, that would meet the technological requirements and if such a design costs significantly less, the benefit of the same would go to the contractor and not to the Government. There are several instances recently reported in the media that when a contractor suggested replacement of 30% of cement by fly ash and submitted the designs fully complying with the various technical requirements, the entire benefit would go to the contractor, if the same is approved by the Central Designs Organization of the Government. Another example is regarding different grades of cement concrete. A dense design concrete mix would reduce the use of cement and yet meet the design requirements of strength. The contractor would then stand to gain by using less cement than originally contemplated. Also such savings running to several hundreds of crores of rupees would not be available to the Government. Thus a situation may develop later on where a contractor is likely to be benefited by an economical design and when a costlier design is given by the Government, he would seek a remedy through a Court of Law. All these problems would not be felt in the earlier stages of construction, but will be faced during the middle and later stages only. FIDIC System of procurement of works (tendering) adopted by World Bank and other International Organizations is a well-tested method throughout the World. It would be prudent to adopt this method for the future contracts duly safeguarding the aspects regarding timely execution of works and no claims for extra compensation or payments for whatever reasons it may be.

Certain procedural irregularities have occurred while pre-qualifying category -1 contractors. This has resulted in court cases, mudslinging, accusations and counter accusations

between political parties. An irregularity committed to save time and quickly start execution of works, had actually resulted in a delay of several months. All this could have been avoided by issuing a fresh short notice (1 week) notification for pre-qualification bids, incorporating the relaxations of qualifications. A procedural error was committed in relaxing the norms only to the 9 bidders who tendered, shutting off the others who would satisfy the relaxed qualifications and yet have not tendered earlier (as they felt that they were not eligible). It is a recognized fact that errors are possible only when something is being done and not otherwise. In all such cases in future the Government can take full advantage of the skills and expertise available in its Law and Finance Departments in order to avoid errors and complications later on.

5. Lift Irrigation Schemes

Most of the lift irrigation projects contemplate pumping to high heads ranging from 100 - 300 meters. Power consumption charges at Rs. 2 per unit for I.D crops would work out to Rs. 2000 - 6000 per acre, depending upon the season of the crop (Kharif or Rabi) and the actual head of pumping. Since all the projects are designed to irrigate one crop and that too by supplementation during Kharif season, it can be estimated that the power charges may be about Rs. 3000 per acre on an average. However, the farmer would not be able to bear this burden if past experience in the case of lift irrigation schemes where the head of pumping is not more than 30m (functioning in the Irrigation Development Corporation), is any guide. It is therefore necessary to supply free power to the lift irrigation schemes through especially dedicated hydroelectric power stations constructed under the irrigation budget. The farmers can, however bear the expenditure of operation and maintenance of canals of the pumping schemes (excluding power charges). In the case of lift ' schemes, operation of the same will have to be done by the Government, and water delivered into the canals. The canal distribution system can be maintained, in the same manner as the surface water distribution system and the farmers, associations can be made responsible for operation and maintenance of the same. However, the Government will have to bear the burden of ordinary repairs, special repairs and renewal of pump sets and also maintain the pumping mains.

It is estimated that 2800 MW of hydropower will have to be generated for meeting the power requirements of all the lift irrigation projects taken up by the Government. Most of this will have to be met through the future hydroelectric projects on Godavary River. It is, therefore, necessary to plan and construct these hydropower projects and complete the same along with the irrigation projects. Also HT lines along with transformer yards will have to be built to supply power over long distances to the lift schemes on Krishna (Handrineva, Kalwakurthi, Nettempadu, Koyalsagar) and stage pump houses for lift schemes on Godavari river. These activities are very much lagging behind and hence they have to be speeded up. This is a formidable task, but this would turn out to be a key factor in achieving results under the whole "Jalayagnam" programme, and hence this should not be relegated to the back burner.

6. Design, Discharges for Kharif season, I.D Crops

Irrigation for Kharif season I.D crops would be mostly of the type of supplemental irrigation to rainfed crops. This can also be called as life irrigation. Depending upon the agro climatic conditions of the area, incidence of rainfall and duration of droughts, the need for such irrigations would arise. This can vary from 2 to 6 wettings during a crop period. It is not the total rainfall that is important in calculating the number of irrigations. The numbers of drought spells or periods when the rainfall does not occur will have to be evaluated statistically. Such a methodology for 75% dependability was worked out by me and was given in the case of minor irrigation. Since the numbers of irrigations vary from year to year

depending upon the distribution of rainfall in a given year, the statistical method to work out 75% dependability would be needed. It is reported in the media that the quantity of water required from project to project is varying drastically from 14,000 acres per TMC to 25,000 acres per TMC. Though this may appear as a contradiction in irrigating ID crops, it need not be so. It has to be actually worked out based on the above principles. More important than this, is the design of canals to provide such supplemental irrigation or life irrigation. These design principles are given by me in the guidelines published by the Government for minor irrigation schemes and Lift irrigation schemes. In essence, the design discharge of irrigating Kharif I.D crops would be significantly more than that of the Rabi I.D. crops. This is because Rabi season crops can be irrigated for an irrigation depth of 50 mm in a rotation period of 8 - 10 days, where as the same amount of water will have to be supplied to the crops during drought periods in Kharif season, in a rotation period of 3 – 4 days. When there are no rains for nearly 8 - 10 days, all the farmers would need water at the same time, and a shorter rotation period will have to be selected. This is because no farmer will be prepared to wait for rotation period of 10 days, when once there is need for water to the crop and the crop is already showing signs of wilting. It may sound paradoxical that the design discharge of Kharif *I.D* would be almost double than that of Rabi I.D though the total quantity of irrigation water for Kharif season crop may be 1/2 to 1/3 of that of Rabi season crop. This aspect was not properly understood and the canals, which were designed, based on "duty norms" in the earlier days, have failed to supply water for the full command area. The reasons for such non supply of water were wrongly attributed to wastage and excess usage of water by farmers, non-cooperation by the farmers, absentee landlordism, in-appropriate selection of crops, etc. However, there were years when the full command area would be irrigated, even though the design discharges are based on 'duty concept'. This is because in such years, there were timely rains and the need for irrigation was very less and was almost nil. I had the occasion to hear from farmers that water comes to their fields through canals, only when it rains! Realistic design of distribution system is therefore needed in the case of Kharif I.D crops. Similarly the discharge capacity of pumps would be more. However this design can be streamlined and moderated by introducing balancing reservoirs and pumping for the entire period of flood days. Realistic designs of canals and pump sets should be done though the same would increase the cost of the project. This is needed to meet the requirements of command areas.

7. Inland Water Navigation

World Water Forum (WWF) in its meeting held at Kyoto during March 2003 (Attended by 82 Nations, including India) has made an important recommendation that all future water resources development projects in the World should have inland water navigation facilities built in as a component of the project. When such facilities are provided, it is possible for flat bottom sea going vessels upto 2000 tonnes capacity, requiring a draft (depth of water) of 1.5 meter to ply in the rivers upto the sea mouth. The same vessels can also travel in the sea and transport goods to any port. Such facilities were already achieved in developed countries during the 19th and 20th centuries. (eg. Saint Lawrence Seaway connecting the Great lakes to Atlantic ocean in USA, Mississippi, Missouri, Ohio rivers in USA, Rhine Danube linkage and Rhone, Volga systems in Europe). The same is now being developed in the projects now under construction in China (eg. 3 Gorges dam). Inland water navigation would not only provide cheap transport of bulk goods but also provides employment throughout the year for rural, non-land holding population. Also, this as an eco - friendly transport when compared to the high levels of pollution in road and rail transport systems. When cheap transport and water is available, mineral based bulk industries would come up in the hinterland of the river basin. All these activities would lead to economic growth of the area and also livelihood

support of the landless rural population. It is therefore suggested that all the future projects like storage reservoirs at Polavaram, Ichampalli, Pulichintala, and barrages at Yellampally, Dummagudem, etc., should have navigation facilities and locks to enable plying of flat bottom sea going vessels.

8. Projects on Godavari

In order to utilize flood flows of about 800 TMC (ultimate 1100 TMC) in Godavari river, it would be necessary to construct 3 reservoirs across Godavari – one near Suraram in between the confluence of Pranahitha and confluence of Indravathi river, the second one near Kantalapalli upstream of Yeturunagaram and the third at Polavaram (as originally agreed between the 3 States). It would be necessary to construct two reservoirs instead of one at Ichampalli in order to generate the required hydro power as well as fully store the flood flows of the order of 10 - 15 lakhs cusecs flowing for about 10 - 15 days in a year. The earlier contemplated Ichampalli project has some basic disadvantages to Andhra Pradesh, since only 27% of the power can be utilized by the State though 78.1% of expenditure of the project has to be borne by Andhra Pradesh. Also only 85 TMC of water can be utilized for irrigation. It would be preferable to construct two reservoirs (instead of Ichampalli), one near Suraram and another near Kantalapalli to generate about 1500 Mw power and utilize 500 TMC exclusively for Andhra Pradesh. In addition to the three reservoirs, four barrages can be constructed one each near Yellampally, Chennur, Edira and Dummagudem. Investigation for these barrages as well as the two reservoirs will have to be done to exactly locate the same, and work out the details. It is possible to develop 3600 Mws of power from the three reservoirs and four barrages. This power can be utilized to pump water from Godavari River to irrigate uplands in Telangana as well as divert water to Krishna basin. It is also possible to supply this power to the four major lift projects proposed on Krishna River.

9. Alternatives for Polavaram Dam

The present proposals of the Government to retain the Full Reservoir Level (FRL) of the Polavaram project at 150 ft level was already agreed by the three Sates and also the same was mentioned in the Bachavath award. The design for this proposal is quite sound and hydraulic model studies conducted have confirmed the suitability of the spillway and the changed river course on right flank. This is a terminal reservoir on the river and should therefore have as much bigger capacity as possible. However, in order to reduce the submersion area, the FRL was already reduced about 3 decades back from 185 ft. to 150 ft. and hence any further reduction in FRL would not be in the interest of the project. This was clearly mentioned by me earlier in various meetings and relevant publications. However, I have examined the technical issues if the height is reduced from FRL 150 to 130 ft. (the minimum draw down level of earlier design) and concluded that it is preferable to keep the original design without reducing the height. This was not properly understood in some quarters though correctly reported in the media, and they thought that my proposal was to reduce the FRL to 135 ft. This alternative of FRL 135 ft. would become a solution only when the Government is not in a position to construct the dam for FRL 150 ft. and it wants to reduce the submersion area (villages, lands and forests). When the canals are already under construction it becomes a waste when the dam is not constructed. There were certain alternatives suggested by others for avoiding Polavaram dam altogether by constructing barrages across Sabari river and diverting the flows through a tunnel to Polavaram Left bank canal. It was also proposed to utilize the barrage at Dummagudem to feed the Polavaram Right bank canal. Though the proposals may appear to be sound and attractive, it requires a detailed hydrological study, in order to examine whether the required quantity of water can be supplied during the non-flood period for various uses contemplated under the Polavaram

project. Prima-facie it appears that there is a need to store the floodwater occurring in Sabari River and Godavari River. A few lakh cusecs would be flowing in Sabari River during the floods. The same will have to be either stored in Sabari or Godavari after its confluence. Even if it has to be diverted through a barrage and stored elsewhere it is not possible to utilize the full flood flows in the river. Similarly the storage at Dummagudem would be nominal and will not be able to impound any flood flow. The crux of the problem is how to store the flood flow of 10 lakhs cusecs to 15 lakhs cusecs flowing for 10 - 15 days and supplies the same during the non-flood period for the requirements of Polavaram project. Even with storage at Polavaram dam, there is a shortage of nearly 72 TMC for meeting the requirements of the project during the period from November to May. It is therefore, necessary to examine the hydrological feasibility and work out with daily working tables of inflow, outflow and storage in order to evaluate the feasibility of the alternatives.

There is a criticism that construction of Polavaram canal works were started much earlier and the works on dam are not yet started (Feb 2006), and that the construction of dam ought to have been taken up first, and canals later on. But there is another argument that canals would take longer time to construct than the dam, and the example of Nagarjuna Sagar project is cited, for taking up canal construction in the first instance. The ground reality and technical aspect is that construction of dam will take not less than 5 years and the canals would take only 3 years if the needed funds are kept at disposal. This is because the entire length of canal can be tackled simultaneously, where as in the case of dam, it involves distinct stages, one after the other, such as excavation of foundations, foundation treatment, construction of dam lift by lift, gates erection, head sluices, power house equipment etc. Nagarjuna Sagar canals took more time than the dam because of inadequate flow of funds. Projects like High Aswan Dam, Egypt (almost same size as Polavaram) took 8 years for construction of dam and 4 years for canals. It is therefore, necessary to obtain all clearances and consent of submersion people and commence construction of dam as early as possible.

9a. Pulichintala Project

In the case of this project, on the request of the then Minister, (for utilizing the flows in Krishna river), I have sent proposals (during September 2003) for five barrages to be investigated, in lieu of the dam proposal. If found feasible and attractive, this can be taken up instead of a dam proposal, which involved submersion of villages, forest lands, lime quarries, Nagarjuna Sagar ayacut etc. The then Government has not investigated the barrage proposals and the successive Government, as reported in the media had examined the same and opted for construction of the dam. In the wisdom of Government when it decided to opt for the dam and started executing the same, the issue of alternatives or examination of the same may not be relevant. All the alternatives are appropriate, upto a point of time, and that is before execution of any proposal, and they may not be relevant after the works are started and are in various stages of progress.

10. Designs to be approved by Central Water Commission

In the Bachavath award, it was mentioned that the designs of the Polavaram project will have to be approved by the "Central Water Commission". It is contended by the Andhra Pradesh State Government that Central Water Commission had already taken a view with regard to various major and medium irrigation projects, that there is no need to send the designs of the same, for their approval, since the State Government is having a fully competent Central Designs Organization capable of doing this work. Though such a contention would be relevant in the case of other projects, this has to be examined in the context of the Bachavath award on Polavaram Dam and the spirit behind the award. Apart form meeting the specific requirements of the award, for several reasons it will be necessary for the Andhra Pradesh

State Government to send the designs to Central Water Commission for their approval. This is required since submersion is involved in upstream States of Chattisgarh and Orissa. Calculations pertaining to back water curve, and the extent of submersion occurring when the reservoir is under FRL conditions with peak flood occurring in Sabari river will have to be examined in detail by the Central Water Commission as well as by the upstream States. In these computations, certain technical assumptions are made, while 'routing' the peak flood when the reservoir level is at 150 ft at the dam site. These assumptions mainly relate to field conditions such as values of coefficients of rougocity, vegetative cover along the flanks of the stream, topographic conditions including the types of soils of the river and its margins. The assumptions made in the calculations by one State, need not necessarily be agreed to by the other State, where submersion is involved, and also an organization like Central Water Commission will have a fair and neutral role to play on all such matters. It would be therefore in the interests of Andhra Pradesh, that these designs of the project are sent to Central Water Commission as well as to the upstream States for their perusal as well as confirmation on submersion areas in other States. Recently it is reported in the media that though Andhra Pradesh Government is contending that there is no submersion in other States, Orissa Government had submitted to the Central Water Commission that 588 hectares of land in Malkangiri Taluk in that State will get submerged effecting 6316 families. Also Chattisgarh has contested that 2398 hectares of land (17 Villages in Kunta block) will get submerged in their State. Transparency In designs will therefore facilitate thrashing out certain initial minor issues, which may pose bottlenecks later on. If experience is any guide, such issues have become bottlenecks and delayed construction of projects like Janjhavathi and Vamsadhara stage II for nearly two decades. Another example is that during heavy floods in 2005, Maharashtra Government had contested against Karnataka Government regarding the excess submersion caused in their State by keeping water level at Almatti dam at FRL conditions. They blamed the Karnataka Government for the havoc caused in their State on account of backwaters of the Almatti dam, and demanded depletion of water level in the dam for which Karnataka Government did not agree. Such problems can be sorted out during the beginning stage of the project, than when they become major issues, later on.

11. Quality Control

The departmental staff will have to do the Quality Control of works, executed in the irrigation projects. In the present system of execution of works, the contractors are doing the work of investigation, design and execution and as such the Departmental staff is not having any role either to mark out the works, organize the material, labour and machinery for execution of works or stepping up the tempo of works. Even for preparation of bills the contractor has to take measurements and submit the bills. Also the contractor will have to ensure good quality on works. Thus the Department staff has no other work except to make some checks of the bills of quantities and satisfy regarding quality of works and arrange payments for the same. The only technical work that they have to perform would be Quality Control. There is no point in allocating this work also to a private agency by inviting bids for the same. In the case of execution of major works in the Department like Nagarjuna Sagar dam, Srisailam dam and Pochampadu dam the Quality Control and laboratory tests were entirely done by the department with exclusive staff allocated for this, in addition to the usual field staff in-charge of works. The same concept was adopted for all the irrigation projects in India. In the case of industries also (public sector as well as private sector) Quality control is very much within the domain of the particular industry. Only when certain quality control tests had to be conducted outside the country like U.S, U.K etc, private reputed agencies like Lyods were engaged for this purpose. This is more of the type of a cost effective reliable method and resorted to, only when it would become cumbersome and too costly for the staff of the industry to make frequent visits abroad for such Quality Control inspections

and tests. When the works are executed within the State and the departmental staff are available at site, there is no reason why the Quality control has to be delegated to any private agency. Payments made to such agencies would be an additional burden on the State. Apart from this, somebody has to take the responsibility and be accountable for the quality. It has to be appreciated that in the long run it would turn out to be disastrous to entrust such important functions of safety and stability of structures to a private agency. Quality control is always best done through departmental officials rather than by contracted private individuals. The concept of privatizing quality control and making payments for the same will have to be viewed from the above context and it is worthwhile for the Government to reexamine this issue and take proper decisions.

12. Krishna Water Disputes 2nd Tribunal

There are several issues to be raised before the 2nd Krishna Water Dispute Tribunal. The State Govt. is already having a list of these issues and they are very much in order. In addition to the points already raised by the State Govt. a few more aspects can be considered. In the catchment area of river Krishna, there is an extensive drought prone area. Ground water is being pumped to such an extent that it resulted lowering of water table levels significantly. Data (1969-70 to 1999-2000) in the three States show lowering of water table below bed of rivers by 20m in some places. On account of this the river is now recharging water table during the dry periods instead of ground water draining into the river, as happened earlier to 1970s. The loss in flow of the river due to this is estimated as 1.85 BCM (65 TMC) at Karnataka - Andhra Pradesh border. The base flows occurring through ground water draining into the river and its tributaries also got reduced drastically. As per figures quoted in the 5th International R&D Conference on Water Resources (Feb 2005), the reduction in base (ground water) flows in Bhima river at Andhra Pradesh-Karnataka border is 250 MCM (9 TMC) and that of Tungabhadra river at Andhra Pradesh border is 700 MCM (25 TMC), during the period 1970 to 2000 (between January & May). Thus, the total reduction of base flows to Andhra Pradesh is 34 TMC (9+25). The first tribunal considered that there will be re-generated flow in Krishna River due to irrigated commands to an extent of 70 TMC. There is also no regeneration of flows in the river (due to irrigation), in view of the improved water management practices and I.D. Cropping pattern now being followed in the command areas of Krishna Basin. Thus, the entire assumption of availability of 70 TMC regenerated flows in the river has got to be reassessed. It is felt that there will be no contribution of regenerated flows in the future also due to efforts being taken by the 3 State Governments to improve irrigation efficiency. In view of the above the 75% dependable yield of Krishna river will have to be reduced by 169 TMC (65+34+70) due to losses in river bed, reduced base flows and absence of regenerated flows. An estimation of reduction in surface flows in 20 years from 1976 to 1996 was indicated as 7 BCM (247 TMC) during the same R&D Conference. Thus, the total reduction in flow in the river is 416 TMC (169 + 247). However, the aspect of reduction on surface flow (247 TMC) in 20 years needs hydrological statistical refinement and therefore may get altered. The reduction of 169 TMC of base flows etc. is actually felt and hence is realistic. One important argument to be advocated by Andhra Pradesh would be to insist that 2060TMC, 75% dependable flow is no more available in the river and that this has to be reduced by 416 TMC. This would result in not sanctioning any more new projects in all the 3 states based on 75% dependable yield. Andhra Pradesh is having a provision for utilizing surplus water of the river during good rain fall years and hence this reduction of 75% dependable yield will have no impact on the new projects, taken up by the A.P. Government, which are all based on utilization of surplus flows. Though Andhra Pradesh has no right on this water, yet it can utilize the same going to the sea. In order to utilize this surplus flows, the State Govt. will have to organize construction of structures like dams, canals, storage reservoirs, etc. Though such a measure is not an

economically attractive one, since the utilization of the same will only be in "surplus years", yet the State Govt. has to resort to this method in order to meet the requirement of drought prone areas of Rayalaseema and Telangana Regions. In an earlier judgement the Supreme Court has viewed that though this is permissible, the State Govt. should not construct permanent structures for using surplus water. It has to be convincingly argued that it is not technically feasible to utilize surplus water without the constructions of structures like dam, canals etc. If necessary the Tribunal and Courts may be requested to take technical opinion on this, through a committee appointed by them and later make the award. It has to be impressed that mearly giving a facility for utilizing surplus water in the shape of writing (award) on paper; it cannot be practically implemented, unless structures to utilize the same are constructed on the field.

13. Continuing Education for Engineers

It is a recognized fact that Science & Technology is doubling in a very short period in recent times. It is estimated that the doubling period of knowledge in this area got reduced from 1000 years during the 18th century to a few decades now. This means to say that knowledge in Science and Technology has more than doubled from 1970 till date. When this is the situation, continuing education and training on specialized disciplines would be very much needed for engineering personal in the State. Though to some extent, this is being done for bureaucrats, management personal etc, this is totally absent in the case of engineers. As a result, it has become a routine to hear that our engineers are not knowledgeable and experienced and therefore we have to obtain skills from outside. It has to be remembered that the strength of the engineering department would be entirely resting with the staff of the dept. and not by temporarily borrowing or depending from other sources. It is, therefore, necessary to formulate a programme of continuing education and practical training for the engineers engaged on irrigation projects as well as other works. This should be a continuous phase and should not end abruptly. It is seen that several retired engineers are re-employed are taken on contract in order to meet the technical requirements. This is not a desirable method since the strength of the dept. should not be the strength of retired persons. Though as a rule retired employees should not be reemployed, it is still happing in practice. Another anomaly is that the same retired persons when they were working while in service were not considered as experts, but yet were termed as experts after their retirement. If a committee has to be constituted to examine specific issues it is advisable to constitute the same by inviting working persons from Central Water Commission rather than constituting the same with retired persons. The State Government working Chief Engineer could be the convener of the Committee. This is necessary to get suitable technical expertise in the interest of works. One more aspect to be considered in this context is that skills and talents are not available in the private sector, for irrigation projects, since, this activity was totally a governmental monopoly right from the beginning. The so-called experts from private sector are either not really experts in project design and execution, or the very same retired persons joining the private sector. The situation in structural engineering is totally different from major irrigation projects, since there are several structural works in the private sector where adequate skills and talents are available. The difference between these two disciplines of engineering is not properly noticed while taking policy decisions.

14. Answering Technical Questions in Meetings

During several discussions organized by the State Government on irrigation projects, various technical questions raised by the participants are being answered by other than Chief Engineers. Replies by concerned Chief Engineers are conspicuously absent in the meetings. This is not a good development, and does not lead to strengthening the technical institutions.

Also wrong technical information is being given. For example, when there was a question regarding the discharge through SLBC, replies were given, that with a sill level of the tunnel at 825 ft (FSL 850 ft.) by increasing the head of flow (when the water level in the reservoir is above FSL and upto FRL 885 ft.), It is possible to increase the velocity from 2 mts. per second to 6 mts. per second, thus increasing the discharge from 4,000 Cusecs to 12000 Cusecs. It was also further explained that velocity is equal to √2GH (a well known hydraulics formula applicable for orifices & sluices) and hence higher discharge of 12000 Cusecs is possible. A technical scrutiny would suggest that both these replies are totally wrong. The tunnel of 43.5 Km long with a diameter of 9.2 mts. would technically function as a gravity pressure pipeline when subjected to hydraulic heads upto 885 ft. level. Adopting a co-efficient of rougocity of 0.018 for the tunnel and applying 'hydraulic gradient' method, the velocity of flow in tunnel works out to 2.37 mps., when water level is at FRL 885 ft. as against 1.951 mps., without such a pressure head. Thus, the increase in discharge would be only from 4,000 Cusecs to 5,566 Cusecs and not 12,000 cusecs as replied in the meeting. The orifice formula of velocity equal to √2GH is not applicable to this situation (when worked out in this manner it gives an absurd velocity of 22 mts. per second). It has to be recognized that any wrong replies given by Govt. would also lead to doubts in the minds of others and complicate the situation, which can be totally avoided.

Political Leaders in the Government will have to take the best advantage of the persons available in the Govt. in the form of administrators and technical personnel. This aspect has also been considered while formulating the "business rules and Secretariat instructions", with regard to leaving the option to the Chief Engineer to discuss the matter with the minister and (or) Chief Minister, when his proposal is being negatived. The objective is that Government may get the best advantage of skills and expertise of Chief Engineer as well as the Secretariat.

15. Kolleru Lake

The State Govt. is taking commendable steps for restoring Kolleru Lake to its original condition obtained about 40 years back. Measures are being taken up by Govt. to protect the lake upto 5 feet contour level and also construct 2 regulators (one at the entrance to Upputeru and another at the end of Upputeru). The aspect of compensating the private lands upto 14,407 acres lying within 5 feet contour will have to be done speedily in order that an extent of 75,613 acres of fish tank is available through out the year. This would be several folds more than the huge number of small fish tanks extending to a total year of about 15,000 acres. The entire 75,613 acres of a huge fish tank can be exploited, as intensively as that of a small fish tank and economic gains can be obtained. The procedures and management methods adopted in the case of Lake Laguna, Philippine would be of interest in this regard. Some problems have arisen in this lake, and the same were solved technically and managerially about 1 1/2 decades back. A visit to this area by a multi disciplinary team would be of some advantage for planning activities in Kolleru Lake. In addition to this, I suggest that the following measures are taken up in order to get best results.

a) All roads within the 5 feet contour constructed earlier will have to be removed and in their place cart track stilt bridges erected. These bridges will be similar to those constructed for jetties with column supports through piles driven in the soil in the bed of the Lake. Decking for the bridge would be of a light type to facilitate movement of carts, lightweight vehicles, motor cycles etc. These roads were constructed early under the presumption that the villages will have to be connected to each other. Such connection and communications in an environment of a lake should be through the medium of water and should never be a conventional road; since such a conventional construction has to be technically prohibited within a lake area. Even though a bridge

is provided for passage of water from one side to the other, such a passage would be limited in length and this causes afflux i.e. rise of water level on the upstream side of the lake when compared to the down stream side of the lake. Such a phenomenon was noticed at Peda Yedlagadi when the road was constructed between Eluru and Kaikaluru. There was a water level difference of 2.5 feet between one side of the road and the other side of the road. Such affluxes (rise of water level) would create heavy submersion in agricultural lands surroundings the lake, during the monsoon periods. This is due to prevention of sheet flow of water within the lake. Providing one more bridge would still be not a solution for the existing Peda Yedlagadi bridges.

b) During the monsoon rains in 2005, it is seen that a water level of 13.5 ft. is obtained as against the earlier ever maximum of 9.5 ft. in the lake. This is due to obstruction of sheet flow of water in the lake, as well as reduced area of the lake due to encroachment of fish tanks in levels higher than 5 ft. contour. It is, therefore, necessary to remove all the fish tanks encroaching into lake and lying below 9.5 ft. contour. The hydraulic features of the lake will have to be recognized to appreciate the need for this. When the peak flood inflow into the lake is 1,20,000 cusecs and the maximum outflow possible through Upputeru, is 15,000 Cusecs, it would result in inundation and storage would be build up within the Lake. If the lake area is reduced, higher water levels (higher than 9.5 ft. upto 13.5 ft.) would result inundating villages and agricultural lands surroundings the lake. Thus, the absence of sufficient area for the lake would create havoc in the neighboring villages as happened in the year 2005. It is, therefore, essential that all the fish tank existing upto 9.5. Ft. contour will have to be removed and the lands used for agricultural purposes as done earlier. In order to facilitate this, the landowners of such lands can be made to share the benefits of pesciculture in the big Lake of 75,613 acres.

c) ***Channelisation:*** Crores of rupees were spent earlier for Channelisation within the lake to facilitate the water flow through Upputeru during the times of floods. Such a step is not technically necessary. It has been proved through 3D model studies, that Channelisation is not technically required. It has to be appreciated that the lake hydraulics is different from channel hydraulics. Sheet flows occurs in a lake, whereas channel flows occur in a drainage system. Applying principles of channel hydraulics to lake hydraulics is totally wrong. As such this activity of Channelisation can be totally avoided. The important aspect to be understood here is that sheet flow of water in the lake, should not be obstructed for any reason. It is reported recently in the media that some people's representatives have requested to take up Channelisation works within the lake and requested funds to be allotted for this purpose. Sensitising and educating the public on these technical aspects will therefore become a necessity.

d) All along the 5 ft. contour, a shelterbelt 200 to 300 mts. wide with mangrove tree species will have to be developed. These trees growing upto 20 to 30 feet height will survive inundation as well as dry conditions and support bird life. Migrating birds require trees for them to nest thrive and breed. The food requirement for these birds would be met through the fish in the lake. When these birds arrive in huge numbers, tourism can be developed through out the year. Apart from bird watching, water sports activities would create a boom in tourism as is happing now in the backwater of Alleppy in Kerala.

e) ***Navigation:*** locks will have to be constructed at the two regulators to facilitate flat bottom sea going Vessels upto 500 tonnes capacity (50 lorry loads of fish) to ply within the lake as well as in the Upputeru channel. These flat bottom vessels need a draft (depth of water) of 1m and would be capable of plying in Inland waters as well as in

the sea. Thus, a shipload of fish can be taken from the lake to Calcutta or any other port in a period of 4 days directly, without any transshipment enroute. Such Inland water navigation would result in fetching higher prices for the fish catch in the lake and establish good commercial contacts for the fishermen to the attractive outlets all along the coast upto Calcutta. This will not only result in higher income but would also provide livelihoods for the local people through out the year (through navigation).

16. Cropping pattern

The choice of crops will have to be left to the farmers. Under the new projects, now under construction, it is expected that 15 lakh acres would be given irrigation facility during the Kharif season of 2006. This is a significant area and cropping pattern will have to be planned appropriately to suit the types of soils and the agro climatic zones. For example, when supplementation to rainfed crops is planned during the Kharif season, farmer's choice will have to be preferred especially in the black soil areas. Though project design may specify that ID Crops will have to be grown during Kharif season, the farmers of black clayey soil areas would not favour it. They feel that any irrigation activity in black soils would result in damage to the ID crops during the times of heavy rains and they would therefore like to raise wet crops (paddy). This is the experience of black soil area farmers in the various projects, which were already completed. Project design in such cases will have to be modified for supplying irrigation water to raise wet crops in Kharif season. In order to minimize the water requirements for paddy crop SRI method will have to be insisted since this requires only 50% of the conventional water supplies. However, in the case of red soils, supplementary irrigation (life irrigation) can be followed and Kharif ID crops can be raised.

17. Farmers Wells

Technology pertaining to electrical and mechanical engineering aspects are not properly disseminated in the private sector of pumping ground water for irrigation purposes. There is a lack of technical understanding among the village mechanics, electricians, dealers and the farmers in this regard. Replacement of existing foot valves with frictionless foot valves (ISI mark) is a recommendation suggested several decades back and it required a lot of pressure from the Govt. side to implement the same. Again for better power (voltage) regulation, higher power factor has to be achieved through installation of capacitors, and this aspect also is not appreciated in the villages. Often high head pumps are being utilized for low head pumping applications. This results in lower efficiency of the pump and thus there would be greater consumption of power. Selection of pump has to be done on Q-H curve basis and not on HP basis. This means that the head of pumping has to be correctly assessed with regard to lowest water level conditions in the well, fiction losses through pipes and pump selected should have capability to pump to this maximum head. However, the maximum efficiency of the pump will have to be achieved during the most probable water level conditions in the well. This has to be estimated based on average depth of water table level in the well (dug well or bore well). The discharge can match the yield in the case of bore well and the number of hours of pumping required in the case of dug well. The HP requirement of motor has to be calculated based on discharge and head and next higher size motor can be selected for coupling with the pump. For example, if 3 HP is required as per the pump requirement, a 5 HP motor can be used and the increased power consumption in such a case will be about 1 or 2% and not 66% as commonly understood in the villages. There is an advantage of using a higher rated HP motor, since the same will not get burnt under low voltage conditions. The diameter of windings for a high rated motor will be more and any increase in amperage flows of current due to low voltage can safely pass through the motor windings without getting heated up. Thus, a slightly higher HP motor would be working

satisfactorily even under low voltage conditions prevailing in the rural areas. In order to compensate for the resulting low power factor, an appropriate capacitor can be installed. The overload relay (tripping adjustment) in the starter can be suitably adjusted for higher amperage, which would still be within the permissible limit of the motor.

18. Power for Pumping Irrigation water

The farmer in the surface water irrigation project gets water to his field without paying any contribution towards cost of the project. Also, he gets water to his land, without making any effort. The farmer having irrigation through ground water source will have to incur the capital expenditure as well as maintenance expenditure to get water to his field. This maintenance expenditure, not only includes ordinary repairs and special repairs for the equipment but also periodical replacement of equipment due to various causes. In order to maintain equity between the farmer using surface water and the other using ground water, it may be necessary that some relief is provided to the farmer using ground water in some shape or another. One method is to provide free supply of power to the farmer since he had already incurred expenditure on the capital cost. However, this becomes economically untenable to maintain good quality power and it also results in wasteful usage of power as well as excessive pumping of ground water. Hence such free power will have to be restricted for the really needed low-income economic groups. One method is to supply power for the weaker sections who are classified as small and marginal farmers. This would not be a simple technical process, but involves several other issues like socio economic, policies of different political parties, quality of power (voltage) supplied, including number of hours of supply. Since it is not possible to give a simple and straight-line recommendation on this, it is usual to decide such matters on administrative and economic grounds.

It was recently announced by the Government that in order to make farmers eligible for free supply of power, they should install capacitors and frictionless foot valves for their pump sets. With regard to foot valve, it is necessary that the farmers should comply with this in order to reduce, the power consumed. When a frictionless foot valve is introduced in place of the existing high friction foot valve, the head of pumping gets reduced (due to reduction in frictional head). When a kilowatt-hour meter (energy meter) is fixed in the switchboard, it would record lesser power consumption. It is, therefore, justifiable that the farmer should contribute his bit of effort to reduce the burden on the State TRANSCO (Electricity), when he is utilizing free power given to him. However, in the case of capacitor, the picture is somewhat different. On account of introducing a capacitor, the power factor gets improved which in turn would reduce the "wattless current" (pulsating current). In other words, if the energy meter is fixed in the switch board, the number of units consumed would be the same for a given installation whether the capacitor is installed or not. When the "wattless current" component reduces, the benefit entirely goes to the TRANSCO (Electricity) and the benefit to the farmer is only indirect in the shape of better regulation of power due to higher voltages being obtained. This is because voltage drop due to "wattless current" is significantly reduced. Thus, introducing a capacitor would help the Electricity Authorities directly, but not the farmer. It is suggested that this component may be done by the Electricity Department as the benefit is entirely derived by them, though indirectly, the farmers would be happy to have better voltage than earlier. Again from operational and technical reasons it is easy for the concerned Electricity wing to install this as a part of the item of the switchboard. Apart from first time installation, it is equally important to maintain and replace the capacitor when needed. It is somewhat similar to the energy meter being fixed by the Electricity wing and maintained by them. It would be therefore appropriate that frictionless foot valve is taken care of by the farmers and installation of capacitor taken care by the TRANSCO

(Electricity Wing). This would be appropriate from technical, logical, administrative and maintenance points of view.

Some persons hold a view that if a capacitor is provided, it would save energy for the farmer and also facilitates tripping of motor when it gets overloaded.

Both these contortions are not correct. The tripping of an electric induction motor depends upon the amperage setting of the overload relay in the starter, but not on the factor whether a capacitor is installed or not. With regard to saving of energy, it would entirely benefit TRANSCO, since 'watt less current' gets reduced and to this extent 'useful current' gets increased. With regard to voltage improvement at the farmers end, it would not be that significant as to improve from 330 volts to 400 volts. For example if the power factor is improved from 0.8 to 0.9, 'watt less current' gets reduced from 20% to 10%. For a given conductor size and length, when a certain amperage current is flowing, the voltage drop will be less, when the 'watt less current' is less. The voltage drop due to 'useful current' will be the same with or without a capacitor, since this useful current is the same in both the conditions. A sample calculation for a given field situation (size of conductor, length, amperage current), the improvement in voltage due to a capacitor (by improving the power factor from 0.8 to 0.9) may work out to about 6 volts. This is very desirable and since the entire benefit of reduction in 'watt less current' and increase in 'useful current' goes to TRANSCO, it is appropriate that they should install the same and maintain it. it would be of interest to note in this context that the power factor of a fluorescent tube (used for lighting) is about 0.5 (much lesser than an agricultural motor of 0.85) and TRANSCO is not insisting the city dwellers to install capacitors.

Some political leaders had mentioned that the capacitor fitted to an electric motor, would give benefits of improved voltage similar to that of a voltage stabiliser. This is not a correct description and care should be taken to see that farmers are not taken for a ride with wrong information's. A voltage stabiliser has a function to improve the low voltage, by as much as 50 volts, whereas the voltage improvement due to a capacitor may be as low as 6v. Also the voltage stabiliser has an additional function, to reduce the voltage to the desired level, when excessive voltage flows in the lines, which function is absent in the case of the capacitor.

Let us now examine the extent of power that can be saved by 'Transco', when capacitors are installed for agricultural pump sets. The annual power consumption in AP is reported as 50 Giga (thousand million) units. Out of this, 15 G.V is said to be utilized for agricultural pump sets and the cost of it works out to Rs. 3600 cr.; at an average rate of Rs. 2.40 per unit. When the power factor (cos Ö) is improved from 0.75 or 0.8 to 0.9 (by installing capacitors), the 'wattless current' or 'pulsating power' reduction would lead to saving of power. The cost of installing capacitors for 22 lakh pump sets would be Rs. 55 cr. at the rate of Rs. 250 each. With an one time capital outlay of Rs. 55 cr. (a comparatively meager amount), a recurring annual saving of about several times more than this can be obtained through reduction in power losses called I^2R losses. This, by itself is a very good economic proposal for the 'Transco' and it would have given a great financial benefit, had this been implemented by them long ago. Thus there is no need to insist farmers to fix capacitors all these years. When there is such a financial gain to Transco. It is also not worthwhile to wait till the farmers fix the capacitors. Any savings in power is of utmost importance to Transco, especially during times of power scarcity and shut down of feeders due to overload. Wrath of the unwilling farmers, or any unpopularity on this account, could have been easily avoided by the Government. Another important point is that a mere installation of capacitors by farmers, without their proper maintenance (or repair) would not give any benefit to Transco. If past experience is any guide, these capacitors would go out of order, after some time and the farmer will not be able to maintain or replace the same. The farmer cannot be blamed for

this, since there is no way he can know whether the capacitor is working or not. The pumpset would continue to run in a normal way, whether the capacitor is working or not. It is therefore appropriate that Transco maintains the capacitors, similar to the power meters, in order to achieve lasting results.

19. Minor Irrigation Tanks

There are nearly 84,000 minor irrigation tanks in the State. About 85% of these tanks need restoration and rehabilitation. During good rainfall conditions thousands of these tanks are getting breached every year. Some of the breached tanks also cause havoc in damaging railway tracks leading to disruption of traffic and railway accidents resulting in loss of life. It is necessary to restore these tanks to the design standards and provide spillway (surplus) capacity following the hydrological guidelines given by the Chief Engineer, Minor Irrigation in 1986. All tanks designed and executed according to these guidelines have not breached at any time even under heavy rainfall conditions. This is because, the earthen dams were built according to standards and the surplus arrangements are made to suit the maximum daily rainfall occurring in the given area in a return period of 25 years (as per norms of India Meteorological Dept.). When all the tanks are restored and function satisfactorily, it would be possible to bring an additional area of about 20 lakh acres under irrigation. This activity is, therefore, of great importance in obtaining irrigation benefits within a short time and also such benefits are distributed through out the State. Though the exact cost of such restoration works cannot be estimated without investigation, yet it is likely to be around Rs.5000 crores. It would be pertinent to observe that major and medium projects head works are not breaching during the times of heavy rainfall (eg. Year 2005), whereas thousands of Minor Irrigation Tanks are breaching in such years. This is due to substandard design in the first instance. This has to be set right as early as possible, in order to safeguard the existing tanks in the State, and add irrigation potential of 20 lakh acres, which was lost all these years.

20. Watershed Management

Technology required for watershed development will have to be of low cost type and mostly obtained through vegetative activities. Earlier technology implemented during the past two decades did not result in drought proofing, according to the studies conducted by several international and national organizations. A new technology under the name "Four Waters Concept" was developed and implemented in some States of India including Andhra Pradesh since a few years. This technology has an advantage of 100% participation of beneficiary, equity of benefits between the ridge area farmers and valley area farmers. When this technology was implemented, it resulted in base flows (springs) occurring in the mainstream and drought proofing the area with enough of ground water being available during successive drought years. All the dug wells in the watershed would get additional recharge making them functional even during the summer periods. Also, there is no need to drill bore wells for irrigation purposes, since adequate ground water would be available through dug wells. The recharge measures comprise of 11 structural activities (no work costing more than Rs.6,000 each) and eight vegetative activities. It is found that modified PERON principle is applicable in this case. 30% of increase in recharge will be happening though structural works costing 70% of the programme, whereas 70% of increase in recharge will be happening with 30% cost of the programme. Cement based check dams across 3rd and 4th order streams are totally avoided in this concept. Mini-Percolation Tanks are proposed near ridge and sub-ridge valleys. A technology for raising successful rainfed crops even during drought years is contemplated. This is made possible by improving the soils structure within the root zone of crop to hold 35% moisture content (field capacity) as against the 10% in red soils existing now. This is achieved by raising green manure crop, before main Kharif season

crop and raising cover crops during the post Kharif period and summer periods. The green manure and mulch will be ploughed into the soil at the appropriate times. This will not only improve the moisture holding capacity of soil, but also the fertility status, through organic manure. The increased moisture storage can support the crop during a drought spell of 30-35 days in Kharif season. Thus a successful rainfed crop can be grown even during long spells of drought. It is observed that in several districts, the rainfall was about 600 mm. even during the drought years. With such a rainfall, it is possible to raise successfully rainfed crops even during drought years, if the enhanced soil moisture can support the crop during the drought spells.

21. Water Management under Minor Irrigation Tanks

A majority of Irrigation tanks were constructed in red soil areas. The ayacut under these tanks, though they may appear black in colour, are actually red soils, turned black, over a period of-intensive paddy cultivation with green manure and farm yard manure added to the soils. In most of these tanks, soils in the ayacut will be of light textured type amenable for cultivation, with dry land implements. When these soils are not puddled, cultivation can be done using ordinary ploughs and other rainfed crop implements like seed drill, harrow etc. In the present practice, irrigation under the tanks would be commencing from the middle or end of August by which time some storage will get accumulated in the tank. Thus, there may be no crop in the tank ayacut during the rainy months of June and July. It is a paradox that in the surrounding rainfed areas, crops would be growing in a lush manner, where as there will be no crops in the ayacut area though there is enough soil moisture available, to support a crop. The farmers will have to wait till some inflow occurs in -the-tank, and a sizeable storage is built up. One method to make use of the soil moisture for raising paddy will be to sow the seed into the soil through a seed drill like any other rainfed crop. With the soil moisture available, paddy comes up like any other rainfed crop and this crop can be irrigated from August onwards. Since there is no standing depth of water, the weed growth that occurs, will have to be removed by operating a four tyne or six tyne cultivator (called Guntaka) and by manually removing the weeds growing along the row of crops. In this practice of water management, tank water is conserved and it is possible to irrigate a second crop for the entire area. Usually groundnut crop will be grown during the period November to end of February, when crop water requirements during this period would be minimum in a year. It is found that when such practice were adopted in Kurnool district, there was no reductions in crop yield for paddy when weedicides are applied and there was a reduction of 10% yield when weedicides are not applied. The farmers would get double the income than what they were getting earlier, (when the lands were puddled in the month of August). I suggest that this water management practices may be adopted for all minor irrigation tanks in red soil areas. It may be possible to adopt this practice in about 50% of the existing 84,000 nos. minor irrigation tanks in the State (42 lakh Ac). This would create an additional irrigation potential of about 21 lakh acres (2nd crop) with negligible costs. The only cost to Government would be in the shape of extension and demonstration trials. Video tapes (in Telugu and English) and relevant literature (where it is extensively practiced in 18,000 Ac under tanks) are also available.

22. Relief and Rehabilitation of Project Displaced People

The State Government had stated that the package of relief and rehabilitation now being implemented in projects is most liberal when compared to the existing package elsewhere in the country. However, it was contended by some social activists, that in certain respects the relief measures of other State Governments are more liberal. For example displaced persons who were residing in the villages for a minimum of 1-year period before

notification (is issued for acquisition), are eligible for compensation in other States, where as in Andhra Pradesh it is fixed as 3 years (instead of 1 year). Further it was contended that in States like Gujarat and Rajasthan, widows and handicapped without any age limit, were treated as separate families where as there is no such mention in the package of Andhra Pradesh. It was also contended that a higher compensation of lands for house sites upto 502 sq mts is being given in other States (Gujarat, Maharashtra & Madhya Pradesh), where as it is only 150 sq mts in rural areas and 75 sq.mts, in urban areas in A.P. Several other issues like money required for building a house, land required for allotment under cultivation etc, are stated to be much better in other States than in A.P. I suggest that these aspects may be reviewed and appropriate decisions taken in order to translate the commitment of the Government into action. Though these are relatively minor in nature, yet they are vital and important for the displaced persons.

World Water Forum (attended by 82 countries including India) in its meeting held at Kyoto - Japan during March 2003 had resolved that the displaced persons should be the 'first beneficiary' of any water resources project. The terminology of 'first beneficiary' amounts to that benefits due to the project for the displaced persons should be more than the economic gain of the command area farmer on an average. So far, relief and rehabilitation packages are oriented towards liberal compensation of assets and creation of amenities including, giving the economic benefit, which are all of the type of one-time activities. In order to operationalise the recommendations of World Water Forum (WWF), it requires a far more effort on the rehabilitation side. This amounts to creating new livelihood opportunities, training in these new livelihoods, including retraining in the same field or a different one. Monitoring the economic growth of the displaced persons will have to be done every year and corrective steps taken, in order to achieve the economic growth programmed. Thus these activities would continue even after the project is completed till such time the displaced persons achieve the economic growth programmed earlier. Wherever such economic growths were achieved in the rehabilitated areas of the 3 Gorges dam, China, the responses from displaced persons were interesting. The young generation upto age groups of 35 years were totally positive for the Water Resources Project. The middle age groups of 35 to 60 years were happy that they were able to earn better economic returns than earlier, and were highly hopeful of the future of their children. The age group above 60 years were however not happy with the project since they are displaced from their traditional homes and thrown out 500 kms away. Thus the general situation is that majority of the displaced persons are favorably inclined to this project. It is also mentioned in the World Water Forum that the displaced persons should "request for the project", and in order to facilitate this, economic growth package will have to be implemented. Also free education for the children of displaced people in professional colleges like medical and engineering will have to be provided when they get seats for the same. It was also recommended by WWF that the R & R packages should be started 2 years before the commencement of construction of the project.

23. Modernization of Irrigation Systems

The State Government has formulated proposals for modernizing several irrigation projects in the State. It was reported in the media that in addition to the Nagarjuna Sagar Canals and distribution system (costing Rs. 2500 crores), Krishna delta, Rajolibanda ayacut, Ghanapur ayacut, Nizamabad Ayacut, Kadam Ayacut are all included in these modernization proposals. It is a good management principle to maintain the irrigation systems out of income earned to supply Water to the ayacut. If the income is very low, it will hardly be sufficient to operate the system. If the income is moderate, it can take care of ordinary annual repairs and special repairs, needed once in a few years. If the water rate structure is adequate enough to undertake major repairs, then there would be no need to spend capital funds for such

maintenance. A sound management principle is therefore to utilize capital funds only for creating new irrigation potential and not for maintenance. As such it has to be ensured that repairs to damaged structures and proper upkeep of the system should all be done through the water rates collected. It is preferable that the modernization proposals of any existing project is not done unless there is a need for saving water or for increasing the command area under the project through water thus saved. The ordinary repairs and special repairs should not be carried out, as a principle under the modernization proposals but should be done only through income earned from the ayacut. It would be in the interest of funding new projects, that the expenditure on modernization of existing projects should be limited only to saving water and bringing additional area under irrigation. It is also sensible that capital expenditure should not be incurred unless new irrigation potential is created through water saved.

24. Reveriene Riparian Rights

After the construction of Godavari and Krishna anicuts, about 150 years back, flows in the river downstream of the structures got very much reduced especially during the summer months. In certain months, the entire flows of the rivers were exclusively utilized in the delta ayacuts and hence there was no flow into the sea. When this happened, consecutively for over a century, it resulted in environmental damage. This damage got intensified during the past 3 decades, after the construction of barrages in place of anicuts. There was no possibility of allowing any water into the sea during summer months, since the available flows in the river are hardly sufficient to meet the rising demand in the delta. When new dams are proposed across Godavari River, it has to be ensured that certain minimum flows go to the sea even during summer months. This is necessary for preserving the mangroves along the coastline, fisheries activities related to special species, which live in the sea and breed in fresh water. Also such a flow would prevent salt-water intrusion in the ground water aquifers of coastal areas. Presently several villages in the coast line had to be supplied with drinking water from elsewhere, since the ground water in their areas had become saline. This trend has to be arrested and by such continuous release of water into the sea, the ground water in the coastal areas can be made potable over a period of time. In any new irrigation project taken up on Godavari, it is usual to consider the riparian rights of existing ayacut on the downstream side. Similarly the riparian rights of the river itself will have to be considered for utilization of water in future dams across the Godavari. This can be termed as the "reveriene riparian right" and the quantity of water that has to be allowed to flow to the sea will have to be calculated in each river system. As a rough guide (thumb rule) 10% of flow diverted to canals should be allowed to flow to the downstream of the structure into the river. This amounts to utilizing 90% of the yield for the ayacut area, and 10% of the yield for reveriene riparian rights to flow into the sea.

25. Irrigation Efficiency

Considerable effort is being exercised on the financial monitoring of irrigation projects. Also in the modernization (rehabilitation) of existing projects financial monitoring is being done. It is equally important to monitor the irrigation efficiency of any project taken up for modernization. It is stated that the irrigation efficiency is about 30% in the existing projects in the State. In the process of modernization, this irrigation efficiency will have to be improved to 45%. When this is done, it is possible to irrigate 50% more area than now by utilizing the same quantity of water. However, it is not possible to achieve such increase in efficiency all of a sudden even though money may be spent on modernization aspects. This requires continuous activity and intense monitoring every year. The increase in efficiency can be achieved gradually in small steps every year, over a period of 5 years. For example, if the

irrigation efficiency increased to 35% in one year, it has to be increased to 40% during the next year. Periodic measurements of flow of water, implementation of better water management practices (ex. SRI cultivation), prevention of deep percolation losses as well as seepage losses etc. and improved agronomic practices will have to be introduced in the fields, in order to achieve results. These measures include improving the structure of the soil through green manure and farmyard manure, intermittent irrigation as against inundation irrigation, keeping mulch on the field during summer months etc. Though this activity would increase the irrigated area by 50% no separate funding is required. The funds available under modernization of projects would be adequate for this purpose.

In the case of paddy crops 'SRI' method of water management practices may be introduced in all the privately owned wells, minor irrigation tanks and selected pockets of major and medium projects where there will be no water logging. It was reported that in various 'SRI' trials conducted on the farmer's lands, the usage of water got reduced to less than half than the earlier practice. Hence this method can be adopted and water saved wherever the farmer has control on water application to his field. In the case of I.D crops (irrigated dry) sprinkler and drip irrigation may be followed in all places where ground water is being pumped. This will improve the irrigation efficiency to 75% and 95% respectively.

26. Gaps in Irrigation Sector

There are 4 major gaps in irrigation sector, which require bridging. The first gap is between irrigation potential created and actually utilized. This aspect is sufficiently taken care, through the existing monitoring system of interdepartmental type in the districts. As this is a well-identified gap talked about in various meetings and discussed in detail, there is no further need to reemphasize this. The second gap is fertility status of soils, as it should be according to the project report versus the actual in the field. There is lot of improvement needed to build the fertility status of soils in the command areas, in order to comply with those recommended in the Project Report (before sanction to the same is given). For example, when the Project Report would stipulate that the organic carbon content would have to be built up to a level of 0.9% from the existing 0.15%, the soils would still have only 0.2% even after irrigating the land for over a decade. This fertility gap in the soils will have to be bridged and brought to the 'levels specified in the Project Report, in order that higher production levels as envisaged in the Report are achieved. The third gap is with regard to productivity aimed in the Project Report while calculating the benefit cost ratio (justifying the project) and the actual productivity. It is seen that in the case of paddy crop productivity remains at 2.5 tonnes of rice per hectare, even though the project is completed about 10 years back, as against the productivity of 4 tonnes rice per hectare envisaged in the Report. This gap will have to be bridged as early as possible, in order to achieve the results of the project. The fourth gap is pertaining to irrigation efficiency. When irrigation efficiency of 40% is planned and in practice it is only 25% then it amounts to certain areas in the project not getting water. This irrigation efficiency gap will have to be bridged by better agronomic practices as already mentioned and when this is achieved, it is possible to supply water to the tail end areas also. In some cases, improper maintenance and inadequate designs may be responsible for not getting water to the tail end. However in most cases, it is seen that more utilization of water in the upper reaches is responsible for making the tail end ayacut suffer.

27. Finances for Projects

Finance is a major constraint in achieving Jalayagnam and this is well recognized. In fact, lack of adequate finances was the main reason for the limping progress on irrigation projects during the past 2 decades. However, the present Government had taken certain

bold steps to launch a massive programme requiring nearly one lakh crores. This may be quite formidable at the outset and may perhaps result in despair at a later date when things do not develop in the desired manner. Though there are limitations for expenditure on the irrigation projects, from the State resources, it is not incorrect to depend heavily on grants from Central and other sources. The financial experts had already cautioned regarding the extent to which loans can be taken to avoid debt trap. However this appears to be the only easy way to bridge the gap since there is also a limitation to the extent of grants that can be obtained from the Central Government. Special financial plans with a mix line of raising bonds, deferred payment of loans, people's contributions, introduction of water cess will have to be thought of. In other words, persons already getting benefited through irrigation water would form an important source for gathering funds. This would be a rightful choice, since it is not equitable to unduly charge the non-land holding population any more to benefit the land holding population. Though the people who are not directly benefited by irrigation activities will have to be charged to some extent to contribution to the finances (State funds, Central Government funds etc), there is a limit to which such contributions can be made. It is necessary to formulate new methods for gathering the finances. One method is collections from the beneficiaries as a periodical levy spread over the period of construction of the project. In other words, this amounts to the beneficiaries contributing to the capital cost of the project. There is also limitation to this since about 50% of the land holding population may be small and marginal farmers. In such cases a special device will have to be worked out to see that they get bank loans on the surety of their lands and contribute to this capital participation. This is similar to a farmer getting his capital for digging well and installation of a pump through the bank loan mortgaging his landed property. This method was adopted for financing the Mahatma Gandhi Lift Irrigation Scheme on N.S left canal, about 3 decades back. All innovative measures with regard to mobilizing finances for the projects will have to be thought of. One such method is to tap the share market, as recently done in the case of the 3 Gorges Dam, China. I suggest that a team of experts may be constituted representing bankers, SEBI, share market and recognized economists to suggest innovative ideas to mobilize finances. If adequate steps are not taken, there is a risk of stopping the projects in the midstream, as happened elsewhere in the developing countries. *(Eg., Africa & Latin America).*

THE END