

VARIOUS FACETS OF SARDAR SAROVAR PROJECT

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ABSTRACT

The Sardar Sarovar Project (SSP), originally proposed in the year 1946, is an inter-state multi-purpose project on the river Narmada in Gujarat. The project was inaugurated by the late Prime Minister, Shri Pandit Jawahar Lal Nehru, on the 5th April, 1961. The joint venture between the states of Gujarat, Madhya Pradesh, Maharashtra and Rajasthan is implemented as per the decisions of the Narmada Water Disputes Tribunal (NWDT) -1969, considering the development of the water resources of the basin as a whole as per its award in 1979. As per the award, Narmada Control Authority (NCA) is to monitor the water sharing in the basin and Sardar Sarovar Construction Advisory Committee (SSCAC) is to oversee the implementation of the Sardar Sarovar Dam & Power House works. The construction of the project has become a complex task especially because of Rehabilitation and Resettlement issues. The Unit-I component of the project involves main dam construction which started in April 1987 and was programmed to be completed by the end of January 1998. However, the construction work remained held up for long, due to litigation in the Supreme Court of India which was cleared in October 2000, accordingly the spillway portion could be raised above EL110.64m to EL 121.92m by December 2006. Further works to complete the dam with FRL at EL138.68 m. is yet to be resumed. However the benefits of the project have been visible since last few years especially in power generation, public water supply and partly in irrigation. The Unit-III of the project involving works related to power infrastructure in regard to the Canal Head Power House (CHPH), underground River Bed Power House (RBPH) and the Garudeshwar weir required for the reversible operation of the RBPH. All works of CHPH were completed in January 1998. The five units of CHPH and six Units of RBPH have been commissioned by 2006. The work of Garudeshwar weir is about to start. Substantial power generation has been started & so far about 23000 Million Units of energy has already been generated by both power houses. The benefits of power generated have almost paid back the expenditure incurred on the power component. The paper discusses various facets of the mega project and the benefits which have been envisaged.

Key words: Interstate, multipurpose, mega project, NWDT, SSP, SSCAC,

1.0 INTRODUCTION

The river Narmada, being one of the least tapped rivers in India, is the largest west flowing river in the country. It traverses Madhya Pradesh, Maharashtra, Gujarat and meets the Gulf of Cambay covering the total length of about 1312 km having catchment of about 97,410 sq. km. out of which 85,858 square kilometer in Madhya Pradesh, 1658 square kilometer in Maharashtra and 9894 square kilometer in Gujarat. The mean annual rainfall in the basin is 1120 mm. The annual yield is about 34.5 cu. km. Even now large portion of the water of the Narmada continues to flow to the sea unused. The maximum recorded flood in the river is about 70,847 cumecs. In spite of the huge potential, there was hardly any development in the basin prior to independence. Inter-State differences on sharing of waters of the river prevented any concrete action even after independence. The then Ministry of Irrigation & Power in 1969, constituted the Narmada Water Disputes Tribunal (NWDT) to adjudicate upon the water disputes. As per the decision of the Tribunal in 1979, out of the 34.5 cu.km. utilizable quantum of Narmada water, Madhya Pradesh is to share 22.5 cu.km, Gujarat 11.1cu km, Rajasthan and Maharashtra to share 0.6 & 0.3 cu km respectively. As per the award Narmada Control Authority (NCA) is to monitor the water sharing in the basin and Sardar Sarovar Construction Advisory Committee (SSCAC) is to oversee the implementation of the Sardar Sarovar Dam & Power House works.

2.0 SARDAR SAROVAR PROJECT

The rainfall in most parts of Gujarat and Rajasthan is not only scanty, but very erratic with large spatial variations. Lack of adequate recharge has resulted into over-exploitation of the ground water in major water deficit regions of Suarashtra and Kachchh resulting in salinity ingress. The advancement of desert in many parts of Kachchh and north Gujarat as well as general shortage of power resulting in lack of development in these regions. To address these issues, the Sardar Sarovar Project (SSP), one of the largest interstate water resources projects is being implemented by the participating states of Maharashtra, Madhya Pradesh, Gujarat and Rajasthan under monitoring by Narmada Control Authority (NCA) and Sardar Sarovar Construction Advisory Committee (SSCAC) established under NWDT award. The project comprises a concrete gravity dam to impound a reservoir with gross storage of 9.5 cu.km, for utilizing 11.1 cu km of Gujarat share of Narmada waters. The irrigation infrastructure having Narmada Main Canal transferring water to Mahi, Sabarmati basins as well as reaching to river basins of Luni, Banas, Saraswati, Vatrak, Som etc. to irrigate over 2 M Ha of drought prone CCA in Gujarat and Rajasthan, apart from providing public water supply to over 8 thousand villages and 135 urban centers. As a major contributor in country's hydropower share, the SSP has installed capacity of 1450 MW in its two power stations. The controlled outflow from the reservoir provides flood protection to the lower reaches of the river. In addition, there will be benefits of fisheries development, recreational facilities, water supply for industries, agro industrial development, conserved forest, employment generation etc. Because of availability of water & power, effect on agricultural & industrial production is already visible. With adequate and quality water available throughout the year, improvement in conditions of health, hygiene and sanitation, improved standard of living in the region is not distant dream. In addition, navigation & recreation infrastructure if properly planned and implemented may convert the project area to be one of the biggest tourist attractions.

3.0 WATER AVAILABILITY

The utilizable quantum of waters of Narmada at Sardar Sarovar dam site on the basis of 75% dependability is assessed at 34.5cu.km. being shared in the proportion as 73% by M.P. 36% by Gujarat, 1% by Maharashtra and 2% by Rajasthan. The requirements of SSP have to be met from the releases by Madhya Pradesh and by inflows from the intermediate catchment, surplus to the requirements of Madhya Pradesh below Narmada Sagar and Maharashtra. Assuming the uniform releases, the amount of water to be released by Madhya Pradesh per month would be 0. 835 cu km. for the SSP reservoir. For the purpose of computing power generation, NWDT has estimated the utilization of waters in various stages Viz. Stage-I, Stage-II and Stage-III starting after 10 years, 30 years and 45 years respectively from the commencement of construction of dam. Although the construction work of dam was started in 1987, the project has been delayed due to various reasons. The Stage-I may likely to end after full completion of dam height of 138.68 m (FRL). Utilization of water at various stages of development considered by NWDT is given in following Table:1

Table1: UTILIZATION OF WATER AS PER NWDT

State	Utilization in cu km		
	Stage-I (10 yrs from start of construction)	Stage-II (30 yrs from start of construction)	Stage-III (45 yrs from start of construction)
M.P	7.4	16.0	22.5
Maharashtra	0.3	0.3	0.3
Gujarat	3.1	11.1	11.1
Rajasthan	0.6	0.6	0.6
Total	11.5	28.1	34.5*

* The utilizable waters at Sardar Sarovar Dam site at 75% dependability is 34.5cu km

4.0 STORAGE

The SSP reservoir is one of the unique storages in the country. The drainage area up to dam site is 88,000 sq km. The gross storage capacity of the reservoir is 9.5 cu km with submergence of about 370 sq. km. (which is only 0.4 % of the total catchment) having submergence per unit storage of about 39 sq km /cu. km which is about half of the same for the upstream Indira Sagar Project. The live storage capacity is 5.8 cu km. The

reservoir is elongated with total length of about 214 km and average width of 1.77 km. The storage being more or less confined to the valley, the evaporation and infiltration losses are comparatively low. The maximum recorded flood in the river is about 70,847 cumecs. The dam is designed for passing the peak flood of 87000 cumecs. The chute spillway has 30 radial gates, 7 number in auxiliary spillway having size 18.30mx18.30m (60' x 60') and 23 numbers radial gates for service spillway having size 18.30mx16.76m (60' x 55') being provided to negotiate the above design flood. While designing water resources projects, provision for accumulation of silt is made in working out economic life of projects by providing dead storage pocket so that the live storage does not get affected. For SSP, the design sedimentation rate of 0.54 mm/year has been adopted which is much less than the normal rate of about 1 mm/year adopted for many reservoirs. This is because of the cascade of upstream reservoirs resulting in increase trap efficiency and also due to elongated as well as forested catchment of the river.

5.0 STRUCTURAL FEATURES

The project comprises a 1.21 km long and 163m high concrete gravity dam with total volume of concrete of 6.82 MCM. The top of dam is at EL 146.50m and the crest level at EL121.92 m whereas the Full Reservoir Level (FRL) and Maximum Water Level (MWL) being at 138.68 m. and 140.21m. respectively. The Min. Draw Down Level (MDDL) is at 110.64m and the Normal Tail Water Level (NTWL) being at EL 25.91m. The design of the dam allows for a horizontal seismic coefficient of 0.125g and it also covers an additional risk due to so called reservoir induced seismicity. Seismological instruments network and other geotechnical instrumentation network required for monitoring the dam as well as the effect on the periphery of the reservoir is established.

6.0 IRRIGATION

The Narmada Main Canal having length of 458 km and 1133 cumecs capacity of water discharge at the head which tapered down to 71 cumecs at the tail (i.e. Gujarat – Rajasthan border) is the largest irrigation canal in the world. The SSP is to provide record irrigation facilities to over 2 M Ha. of land in Gujarat & Rajasthan and to about 37.5 Th. Ha. in the tribal hilly tracts of Maharashtra through lift. The irrigation system is being developed with detailed elaborate and micro level planning. As per the GOG, the command area is divided into 13 agro climatic zones and each zone is further subdivided into irrigation and drainage blocks ranging from 4000 to 10,000 Ha. Involvement of farmers in the construction activities and thereafter for irrigation management is aimed at to ensure efficient user friendly managed by the Water Users' Associations (WUAs) based on Participatory Irrigation Management (PIM). As per the NWDT award, the cost of Unit-I (Dam and appurtenant works) is shared by Gujarat and Rajasthan in the ratio of 18:1. as well as the cost of canal as per the guidelines. As per GOG, one of the unique features in the command area of SSP is to deliver the irrigation water to WUAs. These WUAs are to manage distribution within their block called Village Service Area (VSA). Thus the management of the minors, sub minors and field channels to be owned and looked after by the WUAs. Rotational Water Supply (RWS) – Varabandhi, the volumetric supply of water, the micro level canal systems with appropriate structures, the evaluation based on delta basis, discouraging water intensive crops are some of the features being adopted by GOG to make the sustainable irrigation system. However to increase the application irrigation efficiency substantially, large scale use of piped distribution system and use of pressure/micro irrigation system like drip will go a long way in saving the precious water as well as considerable increase in the area under the command.

7.0 PUBLIC WATER SUPPLY

GOG has made a special allocation of 1.05cu km (0.86 MAF) of water to provide public water to 135 urban centers and 8215 villages (45% of total 18144 villages of Gujarat) within and out-side command in Gujarat for present population of 18 million and prospective population of over 40 million by the year 2021. As per GOG, all the villages and urban centers of arid region of Saurashtra and Kachchh and all "no source" villages and the villages affected by salinity and fluoride in North Gujarat will be benefited. Water supply requirements of several industries will also be met from the project giving a boost to all-round development. It is to point out that the public water supply system for rural as well as urban centers needs to be integrated with proper sanitation schemes as well including the O&M of the entire system to make it sustainable to ensure better health & hygiene of the community.

8.0 HYDROPOWER

There are two power houses namely River Bed Power House (RBPH) and Canal Head Power House (CHPH) with an installed capacity of 1200 MW and 250 MW respectively. The power is shared by three states - Madhya Pradesh - 57%, Maharashtra - 27% and Gujarat 16%. SSP provides a useful peaking power to western grid of the country which has limited hydel power production at present. The RBPH is an underground power house stationed on the right bank of the river located about 165 meters downstream of the dam. It has six number of Francis type reversible turbine generators each of 200 MW installed capacity each operating under a head range of 116.6 m. to 75 m. The T.G. Sets are supplied by M/S Sumitomo Corporation, Japan and M/S BHEL. The units operate at minimum reservoir water level of 110.64 meters. These six units have been commissioned in a phase manner during Feb-05 to June-06. The generation of energy depends upon inflow of water from upstream projects and need of water for irrigation in Gujarat. The CHPH is a surface power station in a saddle dam on right bank of the reservoir having total installed capacity of 250 MW (5 x 50 MW) with operating under head range of 46.13 m. to 18.12 m. These five units have been commissioned in a phased manner during Aug-04 to Dec-04. These units can be operated with minimum reservoir water level of EL110.18 m. The units are operated in consultation and as per advice of NCA based on irrigation requirement of Gujarat/Rajasthan and availability of water in reservoir as well as the release from upstream project of Madhya Pradesh. The energy generated from both the power houses is evacuated through 400 KV level through interconnecting transformers situated in RBPH switch yard. The 400 KV switchyard is indoor type having Gas Insulated Switch (GIS) Gear and Bus bars. The energy is transmitted to party states i.e. Gujarat, Maharashtra and Madhya Pradesh in the proportion of 16:27:57 through 400 KV double circuit transmission lines, namely SSP-Kasor & SSP-Asoj, SSP-Dhule and SSP-Nagda respectively. All the transmission lines are commissioned and charged. The operation and maintenance of SSP power complex and transmission lines is done by Gujarat State Electricity Company Limited (GSECL). A series of micro hydel power stations are also planned on the branch canals where convenient falls are available. It is estimated that in all SSP to generate 5,000 million units of electricity with target of annual power generation worth of about Rs. 400 crores. The power generation at CHPH depends upon the releases for irrigation for Gujarat and Rajasthan and power generation at RBPH depends upon the water surplus arising after meeting the irrigation requirements of the states. The NWDT in its report considered the likely pace of irrigation development by the party states for utilization of their allocated shares and indicated three stages of irrigation development in the basin, reckoned from the date of Gazette notification of the report. Thus the power benefits from SSP will depend upon the irrigation use by the party states which is a complex situation involving multipurpose river system which has dynamic characteristics. The Central Electricity Authority together with the power beneficiary states of Madhya Pradesh, Maharashtra, and Gujarat carried out different studies for evaluation of power benefits from SSP complex using multi reservoir simulation system. All the studies were taken into account while arriving at the power benefits. The power benefits with effect of the three stages of irrigation development given in **Table:2**.

Table:2 POWER BENEFITS EFFECT OF IRRIGATION DEVELOPMENT

Stage of Irrigation Development	Years	RBPH(GWH)			CHPH(GWH)		
		Firm	Seasonal	Total	Firm	Seasonal	Total
Stage-I ¹	00 - 10	3635	1431	5066	213	190	403
Stage-II ²	20 - 30	517	1334	1851	676	111	787
Stage-III ³	30 - 45	0	520	520	440	345	785

¹Partial Irri. dev. in Gujarat and full in Raj. to utilize 3.74cu km out of 11.65cu km share of two States.

² Irri. dev. in Guj. to increase from 3.74 to 11cu km. For MP up to 15.94cu km out of 22cu km allotted.

³ Full irri. dev. in M.P.as well.

Thus, it can be observed that the firm energy from the RBPH would vary from 3635 GWH (415 MW continuous) in the initial years to NIL in the final stages of irrigation development. To preserve the capacity value of this station and its continued utility as a peaking station throughout its life, pump- turbine (reversible) and generator- motor sets are installed at this station. The machines at RBPH would thus run for about 6 hours daily during the period of peak demands, discharging water into the lower reservoir, created by constructing a tail pool dam at Garudeshwar 12 Km downstream of Sardar Sarovar Dam. During the off-peak periods the water from this lower reservoir would be pumped back into the main reservoir by drawing power from the grid thus making the water available in the upper reservoir for peaking operation of the next day. The power benefits from CHPH would increase from 213 GWH (24.3 MW continuous) to 440 GWH (50.2 MW continuous) in the final stages of irrigation development.

9.0 NAVIGATION

One of the important uses of the storages can be the water transport. With the series of reservoirs all along the Narmada river, linking the land locked state of Madhya Pradesh to the sea could be of great advantage. As per the plans of inland water ways, the river Narmada is one of the 10 water ways identified by Ministry of Surface Transport, Govt of India. Pre-feasibility study carried was out in 1981. The Phase-I of the study for navigation in a length of 637 km of the Narmada from Hoshangabad to the sea was completed in 1985. Phase -II includes the crossing other difficult river stretches and Phase -III relates to financial and economic analysis. It is proposed to cross the 4 major dams by providing by passes. The study on Phase-II & Phase-III is carried out by Inland Waterways Authority of India (IWAI) under Union Ministry of Shipping through WAPCOS.

10.0 ECONOMIC ASPECTS

As per the NWDT award, the cost of dam and appurtenant works (Unit-I) is shared between irrigation and power in the ratio of 43.9:56.1. The capital cost of power portion of SSP is shared by Madhya Pradesh, Maharashtra and Gujarat in the ratio of 57:27:16 respectively. The upstream Indira Sagar project in Madhya Pradesh being the feeder storage for the SSP, as per the award, Madhya Pradesh to take up and complete the construction of Indira Sagar dam with FRL 262.13 concurrently with or earlier than the construction of Sardar Sarovar dam for which Gujarat credits Madhya Pradesh each year 17.63% of expenditure on account of the cost of construction of Indira Sagar dam. As for the irrigation component, the cost of Sardar Sarovar dam and appurtenant works (Unit-I) is shared by Gujarat and Rajasthan in the ratio of 18:1. The cost of SSP Canal with its design approved by NCA is shared between Gujarat and Rajasthan as per the guidelines laid down by the tribunal.

It is to note that the based on the decision of NWDT Award, the project report of SSP was prepared by GOG in 1981 and submitted to Central Water Commission (CWC) for clearance with an estimated cost of Rs. 3333 crore at 1979-80 price level. The environmental clearance to the project was accorded by Ministry of Environment and Forest in June 1987. Investment clearance was given by the Planning Commission at an estimated cost of Rs. 6406.04 crore at 1986-87 price level in October 1988. Revised estimated cost of the project at 2008-09 price level amounting to Rs. 39240.44 crore has been approved by the Planning Commission. An amount of Rs. 35204.69 crore has been booked as total project expenditure by the GOG, up to the end of December 2011.

11.0 ENVIRONMENTAL AND R&R ISSUES

The total SSP reservoir submergence of about 377 sq km at FRL comprises about 112 sq km of agricultural land, 135 sq km of forests and 130 sq km of river bed and waste land. Percentage of area submerged to area irrigated is 1.65% for the SSP, compared to 4 to 5% in many projects in the country and around the world. It is estimated that the ratio of project beneficiaries to project affected persons stands as high as 100:1. In all 245 villages of the three states viz. 193 Villages of Madhya Pradesh, 33 villages of Maharashtra and 19 villages of Gujarat are affected. Total of over 40 thousand families require to be displaced due to submergence of SSP. The NWDT award has detailed directions on the definition of oustees, lands to be compulsorily acquired, liability of Gujarat to pay compensation for land acquisition and rehabilitation,

provisions for rehabilitation, programme for payment by Gujarat to Madhya Pradesh and Maharashtra on this account.

The R & R package includes:

- **Land** - Equivalent to that acquired with a minimum of two Ha. and maximum of eight Ha. fully irrigated, provided 25 per cent of the landholding is lost. All major sons are entitled to land up to two ha. each.
- **Encroacher Oustees** - They are treated as land oustees provided the encroachment is prior to 13th April, 1987. Land entitlement is between one and two Ha. depending on the size of encroachment.
- **Landless Oustees** - to get Rs. 49,300/- for productive assets and others without productive assets to get Rs. 33,150/-.
- **House plots** - Developed residential plots measuring 60'x90' in rural areas to be provided to oustees families and their major sons/unmarried major daughters.
- **Rehabilitation Grant** - Agricultural landless laborers to get Rs. 18,700/- and all other labours to get Rs. 9,350/-. All major sons to be treated as landless.
- **Transportation grant** - Free transport to relocation site or, when not availed of, a lump sum of Rs. 5000/- relocation grant is payable.
- **Facilities at R&R sites** Civic amenities like drinking water, electricity, health, education, play ground, places of worship, etc. to be provided.

In December 1999, Resettlement and Rehabilitation Sub-Group of NCA was constituted with Secretary, Ministry of Social Justice and Empowerment as Chairperson to monitor the progress of land acquisition, and R&R aspects of the project affected families (PAF). The Supreme Court in its final judgment of October 2000, gave directions for completion of dam as per the award of NWDT. The Court gave directions for the immediate raising of the dam from EL 85.0 m to EL 90.0 m with direction to the NCA to give permission for further raising of the dam height on pari-pasu completion of the R&R and Environmental measures. The NCA action plan of 2001 is as per **Table: 3**

Table: 3 JAN 2001 ACTION PLAN OF NCA

Dam Height (EL)	Scheduled Date for completion of R&R	Scheduled Date for completion of dam level
100.00 m	December 2001	June 2002
110.00 m	December 2002	June 2003
121.00 m	December 2003	June 2004
138.68 m [#]	December 2004	June 2005

[#] yet to be achieved

The SSP reservoir submergence includes 135 sq km of forests. Increase in vegetal cover in 3.4 M. Ha. of Gross Command Area, gains due to compensatory forest, tree plantation 100 times and Carbon Dioxide (CO₂) fixation to large extent by 70 times in the region are some of the measures taken by GOG. GOG also proposed to develop wild life sanctuaries viz. Shoolpaneshewar wild life sanctuary on left bank, Wild Ass Sanctuary in little Rann of Kachchh, Black Buck National Park at Velavadar, Great Indian Bustard Sanctuary in Kachchh, Nal Sarovar Bird Sanctuary and Alia Bet at the mouth of the river are some of the measures for protection of flora & fauna.

12.0 LEGAL & INSTITUTIONAL ASPECTS

The NWDT award, includes the orders on sharing of waters (including surplus and distress in any year), related to FRL of Sardar Sarovar dam, sharing of costs and benefits, regulated releases by Madhya Pradesh for the requirements of SSP, payment to be made by Gujarat for regulated releases etc. The award also includes the institutional arrangements to be set up for implementation and compliance of its decisions made which are subject to review at any time after a period of 45 years from the date of publication in the official gazette. Accordingly constitution of an Inter-State Administrative Authority known as 'Narmada Control Authority' (NCA) and a Review Committee for the purpose of securing compliance with and implementation

of the decision and directions of the Tribunal has been established. Also as per the award, the Sardar Sarovar Construction Advisory Committee (SSCAC) has been functioning for execution of Unit-I (Dam & Appurtenant works) and Unit-III (Power Complex) of the project.

13.0 CONCLUSION

The Sardar Sarovar Project on river Narmada is a landmark case as an integrated plan of harnessing Narmada river water resources to meet the water needs of the river basin areas as well as to transfer surplus water to Saurashtra & Kachchh regions of Gujarat and desert areas of Jalore and Barmer districts in Rajasthan which have no other dependable water source, ensuring to minimize the ecological degradation, advancement of desert and salinity ingress in the regions. Even though, one of the most widely discussed and legally implicated projects, resulting into heavy time & cost overrun, the SSP, a technological wonder, is going to prove be the project with huge socio-economic impact, environmental sustainability, and the fine example of interstate cooperation in the history of independent India.

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