KAKRAPAR ATOMIC POWER PROJECT
O&M OFFICE
No. 6
Date 17-10-89
P.O. ANUMALA 394 651

ENVIRONMENTAL APPRAISAL FOR PROPOSED KAKRAPAR SITE

ENVIRONMENTAL APPRAISAL OF NUCLEAR POWERPROJECT
BASIC INFORMATION FOR ENVIRONMENTAL APPRAISAL

1. NAME AND LOCATION

1.1	Name/Title of proposed nuclear power project	:	Kakrapar Atomic Power Project-KAPP # 3 & KAPP # 4.
1.2	Name of the project authority and contact address	:	Nuclear Power Corporation (A Govt. of India Enterprise) Homi Bhabha Road, Colaba, Bombay - 400 005.
1.3	Site where proposed plant is to be located (Site map to be enclosed)	:	Site is situated on the left bank of the river TAPTI,in Mandvi Taluka of Surat District.Gujarat State. Location map is attached in Annexure-I.
1.4	Capacity of project under consideration	:	2 x 500 MWe PHWRs
1.5	Is this an extension ? If so,indicate capacity of existing plant.	:	Yes. The two units KAPP-1&2 of 235 MWe each are already under construction.
1.6	What is the ultimate capacity of existing plant	:	1470 MWe (2x235 MWe and 2 x 500 MWe)

2. GENERAL ENVIRONMENTAL INFORMATION

2.1	What major pollution generating (including radio-active pollution) establishments exist within a radius of ten kilometers of your plant? Give details.	:	There are no major industries within a radius of 10 Km around the plant.
2.2	What is the total human population within a radius of 10 Km of the plant site.	:	Total 80805 persons(1981 census) within a radius of 10 km around the plant.Exclusion zone* and Sterilized zone# around the plant are established for KAPP-1 & 2. No additional rehabilitation and land acquisition for the proposed units KAPP-3 & 4 will be required.

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The population distribution around the proposed site is as follows:

Distance	Population
0 to 1.6 kms.	Nil
1.6 to 5.0 kms.	30,465
5.0 to 8.0 kms.	21,180
8.0 to 16.0 kms.	1,72,194

The total population in the area covered by radius of 16 kms. from the site is 2,23,839.

The population in the sterilized zone of 5 km is 30465 (Villages : Moticher, Umarkuva, Ghata, Ratania,Jamankuva, Mandvi, Wareth, Kakrapar, Rajwad,Vankla,Kanja,Bedkuvadur) There is no population centre having population more than one lakh within the radius of 50 kms

An index plan of an area of 10 km around the site is in Annexure-2A.

* Exclusion Zone - An area of 1.6 Km around the plant, as marked in Annexure -2, which will be under the exclusive control of the station and where no public habitation will be allowed.

Sterilized Zone - Annulus between an area of 5 Km around the plant and Exclusion zone where natural growth is permitted but new/expansion of activities which would lead to enhanced population growth are referred to DAE for evaluation and decision.

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2.3	Give the broad description of the site including plan, area of land required physiography, topography, nature of soil demographic profile, villages to be to be uprooted and population to be displaced and plans for their resettlement.	:

The proposed site is situated on the left bank of the river Tapti in Mandvi Taluka of Surat District, Gujarat State. The nearest village is Moticher. Kakrapar is connected to Vyara (Vyara on Surat-Dhule State Highway) by a major district road of about 20 km in length. Vyara is at a distance of 67 km from Surat and about 148 km from Dhule. Dhule is on National Highway - NH-3.

The nearest broad-gauge rail-head is at Songadh, which is about 25 km from Vyara and about 40 km from the site. Vyara is on the Udhna-Jalgaon section of Western Railway. The railway siding is already augumented for KAPP-1 & 2.

The site is situated on a large flat elevated area down-stream of Kakrapar weir. The bed rock is hard greyish basalt underlying 5 to 6m thick overburden consisting of black cotton soil and weathered zone.

The typical bore log giving the characteristics of sub-strata is given for information in the Annexure - 2B.

The site grade elevation for the proposed units at location A is from RL + 47 m to RL + 50 m with plant grade elevation fixed at RL + 51.3 meter. The contour of the area of site-A is shown in MAP-6 - Annexure-2C.

The topography is generally plain around this proposed site with gentle slopes.

The general ground water level is reported to be at a depth of 3 to 6 m (within overburden) below ground level.

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AMBIENT TEMPERATURE & RAINFALL RECORDED AT KAPP SITE

Year	TEMPERATURE Maximum	Minimum	RAINFALL
1983	39° C	18° C	1735 mm
1984	40° C	15° C	1264 mm
1985	40° C	14° C	694 mm
1986	43° C	16° C	725 mm
1987	44° C	14° C	485 mm
1988	42° C	13° C	1949.3 mm

The site area lies in Zone-III as per the seismic zoning Map of India IS.1893-1984,IV Revision with amendment No.1.

No villages are to be uprooted for the proposed expansion of the plant as 1.6 kms Exclusion zone for the existing plant KAPP 1 & 2 is already existing. The proposed expansion is adjacent to the location of the existing units.

The land acquired for the Township at Unchamala for KAPP-1 & 2 is adequate (160 hectare) for expansion of the proposed units also.

2.4 Give a general discription of the vegitation within 10 km of your plant site(give name of species) : About 70% of the land within 10 Km around the site is agriculture land,15% of the land is forest and the rest is waterspread and low lying area.

Crops
Forest
Scrub
Grassland
Other(specify)

In the agriculture land, the main products are sugarcane,ground nut, Jawar, and rice once a year. In addition, pulses are also cultivated. The yields of the crops are considered to be moderate. Within the exclusion area, the land has been completely acquired. It is under the control of DAE/NPC & hence the

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			use of this land by public for agricultural purpose is not existing.
2.5	List any important species of wild life (animal or plant) that exist within the same radius.	:	No wild life sanctuary exists within 15 km of the proposed site.
2.6	List of the sites of cultural, historic or other touristic interest within 20 km of your plant.	:	BARDOLI(Radial distance - 29 km) National Freedom Movement - Satyagraha started by Shri Sardar Patel.
3.0	WATER USE AND LIQUID WASTE DISCHARGE		
3.1	a) What is your source of water?	:	The source of cooling water for two existing units at this site is the Kakrapar left bank canal which takes off from Kakrapar weir on the river Tapti (river This canal feeds to the Moticher lake.
	b) Will it be adequate for your use ?	:	Yes. State Govt. has assured that the water level in Moticher lake will always be maintained higher than +45 meter with availability of 1200 cusecs of water in the Kakrapar left canal from UKAI-dam. (The copy of the letter received from State Govt. authorities is enclosed in Annexure-7.)
	c) Do you propose any measures to augment water supply ?	:	No. Not required.
3.2	Quantity required for condenser cooling. process cooling. sanitary/domestic use.	:	Condenser cooling system will be closed system with cooling towers using river water. Process water system will have multiple loops with closed primary & closed secondary and closed tertiary systems. The tertiary system will be closed

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system with cooling towers and would use river water as the coolant.

	2 x 500 MWe units	
	(in Cubic meters per hr.)	
	Drawal	Consumptive use
Fresh water for Condenser Cooling, Process Cooling & Domestic & Sanitary use	12000 (120 Cusecs)	7250 (72.5 Cusecs)

3.3 What type of cooling system is proposed? Give details including temp. difference between inlet & outlet. : Condenser cooling system is proposed to be closed loop system with cooling towers. The process water systems will have multiple loops with closed primary and secondary systems. The teritary systems would be also closed system with induced draught cooling towers. Blow down from the cooling towers of condenser cooling system would be about 5 degree C more than the ambient temperature.Quantity of blowdown is quite small(5000 cu.m/hr or 50 Cusecs)for 1000 Mwe (2x500) power potential and hence is not of consequence from thermal pollution angle.

3.4 Adverse effect on the aquatic life, if any may please be mentioned due to thermal discharge which may be coupled with radio activity. : Since closed loop system of cooling with cooling towers would be adopted, the question of thermal pollution of aquatic environment is not of consequence. Further the blowdown waters from cooling tower would be small to be of any consequence for thermal pollution.

3.5 Total quantity and characteristics of waste water discharged per day. The quantity of waste water generated is approximately about 0.25 cu.m/day per MWe installed capacity.

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	Characteristics	
Active Chemical wastes	- decontamination first wash	3000 ppm total solids
	- regenerant solutions	
Active non chemical wastes	- floor & equipment drains	300 to 500 ppm total solids
Potentially active waste	- drains from laundry & showers	30 to 80 ppm total solids

Some or all of the above streams,after treatment,will be diluted with blow-down flow from cooling towers. Treatment methods include filtration, ion exchange, chemical treatment and evaporation given in 3.6. Blowdown from cooling towers of condenser cooling system would be of the order of 5000 cubic meter/hr or 50 Cusecs for 1000 MWe (2 x 500 MWe).

Waste water containing radio-activity is not discharged directly but only through treatment process followed by dilution and monitoring system within authorised limits stipulated by AERB.

3.6 Type of waste water treatment proposed to be adopted (if any) and standards to be adhered to. : The schematic diagram of liquid waste management is given in Annexure- 4. Treatment methods include filtration, ion exchage, chemical treatment. Waste water containing radio activity are not discharged directly but only through a treatment & monitoring system at the waste management plant. The shower wastes and other washings are led to storage tank monitored and diluted with blowdown flow from cooling towers before discharge into the lake.

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Arrangement also exists to lead these washings to a post treatment tank for monitoring and discharge. Active non chemical wastes(ANCW) are further segregated to ANCW-1(low tritium) and ANCW-2 (tritium rich) streams. ANCW-1 is subjected to chemical treatment or reverse osmosis followed by ion exchange and/or dilution and discharged. ANCW-II is evaporated in a steam evaporator. Active chemical wastes (ACW) are evaporated (Steam). The concentrates are solidified and fixed in cement. After treatment, the treated waters are discharged with dilution flow available in the blowdown waters of condenser cooling system cooling towers, within authorised limits.

Standards applicable are authorised limits derived from ICRP dose equivalent limit,which are based on critical pathway analysis, critical radionuclides and critical foods. These are site specific parameters to be evaluated at pre-operational siteinvestigation stages. Limits are fixed by AERB for tritium and beta, gamma radionuclides other than tritium.

3.7	Mode of final discharge open channel/pipe line/ others.	:	Through steel pipe lines or concrete conduit pipe lines.
3.8	Point of final discharge fallow land/agricultural land/sewer/river/lake/ wetland/bay/estuary/sea.	:	Discharge into the reservoir after treatment and monitoring within authorised limits specified by AERB.
3.9	Is any proportion of the waste water to be recycled ? If so give details.		Waste water containing radio-activity is sent to Waste Management Facility for treatment. After treatment the residue is solidified in cement and sent to burial ground existing inside the plant premises.

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After treatment the treated water is mixed with cooling tower blow downs for further dilution before discharge through a monitoring system.

4. AIR EMISSION (RADIO ACTIVE AIR BORNE EFFLUENT

4.1 Nature and quantity of radio active airborne effluents within the plant at the various locations where to be engaged on permanent or casual basis.

: The design provides for ventilation systems for the reactor containment building, service building and other active systems, intended for dilution and clean-up of the air within, to ensure that airborne activity levels in all areas are below the derived air concentration values stipulated by AERB.

Purge rate - total 500000 cum/hr through stack for 2x500 MWe PHWRs. A stack height of 100 m will be adopted.

4.2 Quality and characteristics of airborne effluent emitted out in the genral environment.

: Exhaust air from ventillation system may contain small amounts of tritium, noble gases, radioiodines and particulates. The air is passed through pre- and High Efficiency Particulate Absolute` (HEPA) Filters which remove essentially all the particulates. Discharged air may contain minute quantities of tritium and active inert gases and all of which will be below authorised limits. The authorised limits are derived from ICRP dose limits to the members of the public, apportioned to the appropriate route and radio nuclide under consideration. These are stipulated by AERB taking into account the release from the existing units KAPP # 1 & 2 & the proposed unit KAPP # 3 & 4.

4.3	Details of preventive and and control measures proposed to be adopted for containment of radioactive emissions both within and outside the nuclear plant. Standards to be mentioned.	:	All areas in active zones are under continuous surveillance for presence of air-borne activities/radiation fields. Prompt corrective action is taken in case of abnormal releases.In addition to installed equipment for recording activity, spot sampling is done regularly. The air is passed through pre and high efficiency particulate absolute (HEPA) filters which remove essentially all particulates.Provision also exists to seal the reactor building, if required,to contain the air pollutants. Standards are ICRP dose limits for members of the public apportioned to the air route, the installation and the radionuclide in question, translated into appropriate authorised limits on the basis of the atmospheric dispersion characteristics of the site, which is a site - specific parametr. Normal releases, anticipated, abnormal occurances and accident situation are considered in the dose limitation system. A copy of the philosophy used to develope radiation protection standards based on ICRP recommendations is enclosed as Annexure-5.
5.	DETAILS OF RADIO ACTIVE MONITORING AND SURVEILLANCE PROGRAMME ENVISAGED		
5.1	What equipment/mechanism is proposed to be adopted for this purpose?	:	Measureremements are done using radioactivity/radiation monitors and detectors. Measurements of external radiation are done using survey meters such as GM counters, ionization chambers or scientillation detectors.Air and surface containmination measurements are done by analysing the radio-activity content of samples.

The analysis both in the plant and outside the plant premises are carried out under a regular sampling/monitoring programme by BARC personnel who do not form part of the plant O & M organisation.

5.2 Give details of the organisation set up for maintenance of pollution control equipment and level of expertise and authority of person in-charge.

: Procedures are established for normal releases, anticipated abnormal occurances and corrective actions there of Alarm & isolation devices are also incorporated in design to prevent uncontrolled releases. The technical specifications prescribe the testing and maintenance frequency of each monitoring equipment and the agency doing this.

Operators and engineers are trained intensively in station operation in particular on station safety aspects and handling of emergencies and are licenced. The surveillance programme is carried out on a permanent basis by Health Physics Division. BARC (which is outside the control of the plant O & M organisation). The personnel in-charge of the surveillance programme are trained in India and abroad. The results of all operational aspects of the station are subject to review by a three-tier safety committee system which has the power to implement safety regulations. The final review is by Atomic Energy Regulatory Board.

5.3 What special procedures do you propose to lay down for radio active pollution control during periods when emission exceeds prescribed limits for any reason including malfunctioning of equipment.

: As mentioned in 5.2, the plant systems can either prevent an uncontrolled release, limit such release or limit consequences of such releases. The discharge philosophy includes flexibility in operation within the allowed limits laid down and suitable

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safety margins. Corrective actions laid down in technical specification include identification and isolation of the system malfunctioning. In some rare cases boxing up of areas/buildings in which the faulty system is located is also resorted to. Where manual intervention is likely to be delayed automatic action of the safety system is built-in in the design.

6. Quantity and characteristics of radio-active solid wastes likely to be generated vis-a-vis its proposed methods of treatment and disposal envisaged. : About 540 cu.m/year solid wastes are likely from a two reactor complex of 500 MWe each, 20% of which will be medium and high level wastes.

The wastes comprise waste cotton, paper-mops, plastic waste etc.(which can be compressed), and equipment parts replaced,spent resin,particulate filters, strainers, filter-cartridges etc. The activity in these wastes includes activation fission products and activation & corrosion products. All such wastes are segregated into different categories, treated, put in containers and stored in underground reinforced cement concrete trenches/vaults and tile holes. The RCC vaults/tile holes are engineered and constructed to be leak tight for any water ingress or seepage. Also borewell facilities are provided in the surrounding area for monitoring any migration of the activity.

7. Details of disaster planning for meeting the emergency situation including the early warning system if any, proposed. : Emergency planning in the plant includes :
- on site plan
- off site plan

The on-site plan deals with emergency actions when the radio-activity spread is confined to the plant area only.

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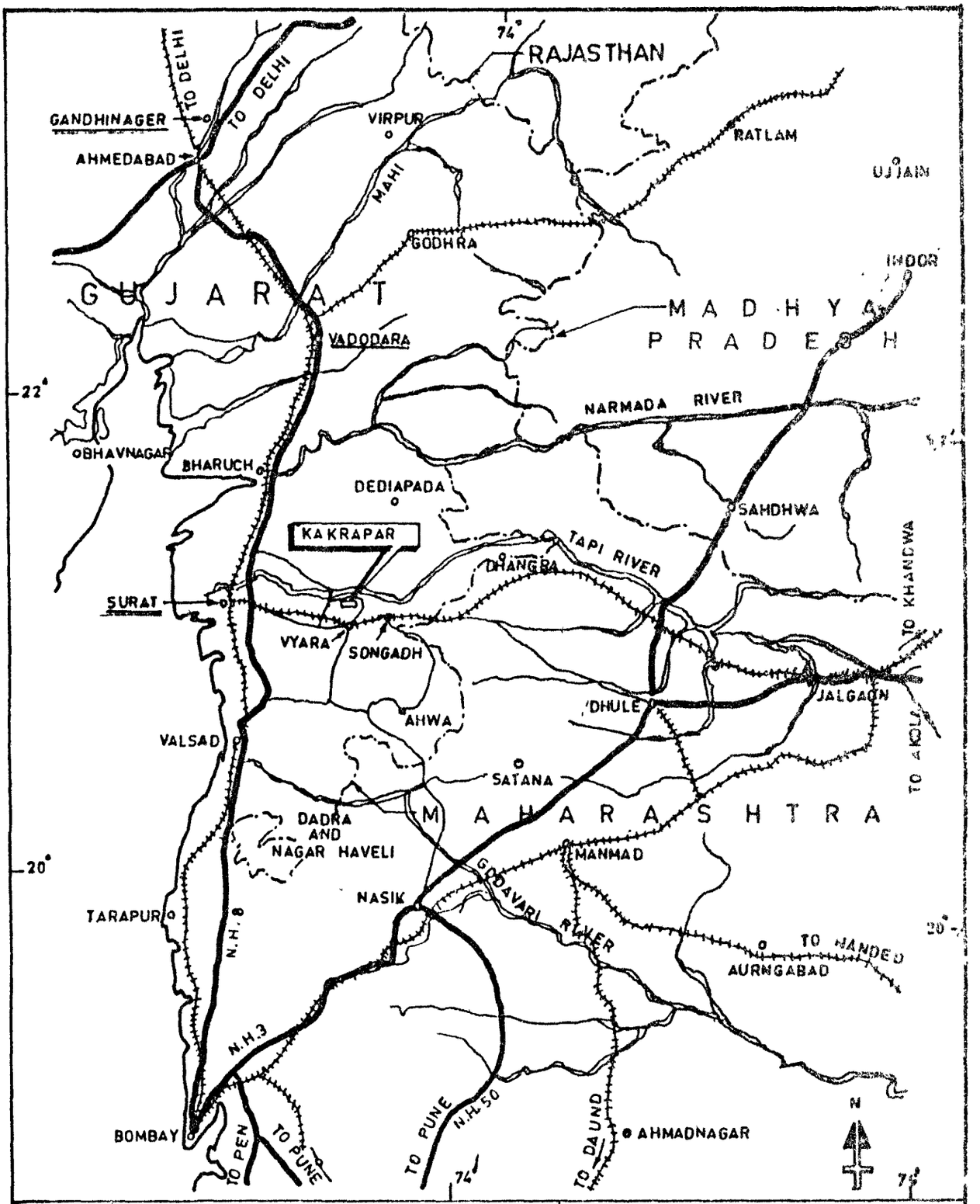
The off-site emergency plan deals with the course of actions in those extremely unlikely situations when the release from the plant have exceeded the prescribed alert or intervention levels. Functions, responsibilities of the different agencies within the plant management as well as the off-site public authorities in ensuring that appropriate protective actions are intiated/carried out and terminated as per procedures laid down to limit the radiation exposure to memebrs of the public as well as plant personnel are contained in the off-site plan.

These plans were prepared(in consultation with State Govt. Agencies). These were reviewed and approved by National level Emergency Response Co-ordination Committee. The copy of the approval of these plans by Gujarat State Government is enclosed in the Annexure # 8. These are applicable to the proposed unit KAPP # 3 & 4 also.

8. Other information. : A report on the environmental impact assessment of the site is enclosed as Annexure-6.

ANNEXURE-1



LEGEND :-

1. STATE BOUNDRIES .....
2. ROADS :-
   - NATIONAL HIGHWAYS — N.H.
   - STATE HIGHWAYS
3. RAILWAYS :-
   - BROAD GAUGE LINE
   - METER GAUGE LINE
4. LOCATION OF PROPOSED ATOMIC POWER STATION

GENERAL LOCATION PLAN OF KAKRAPAR SITE

25KM 0 25 50 75 100KM

SCALE

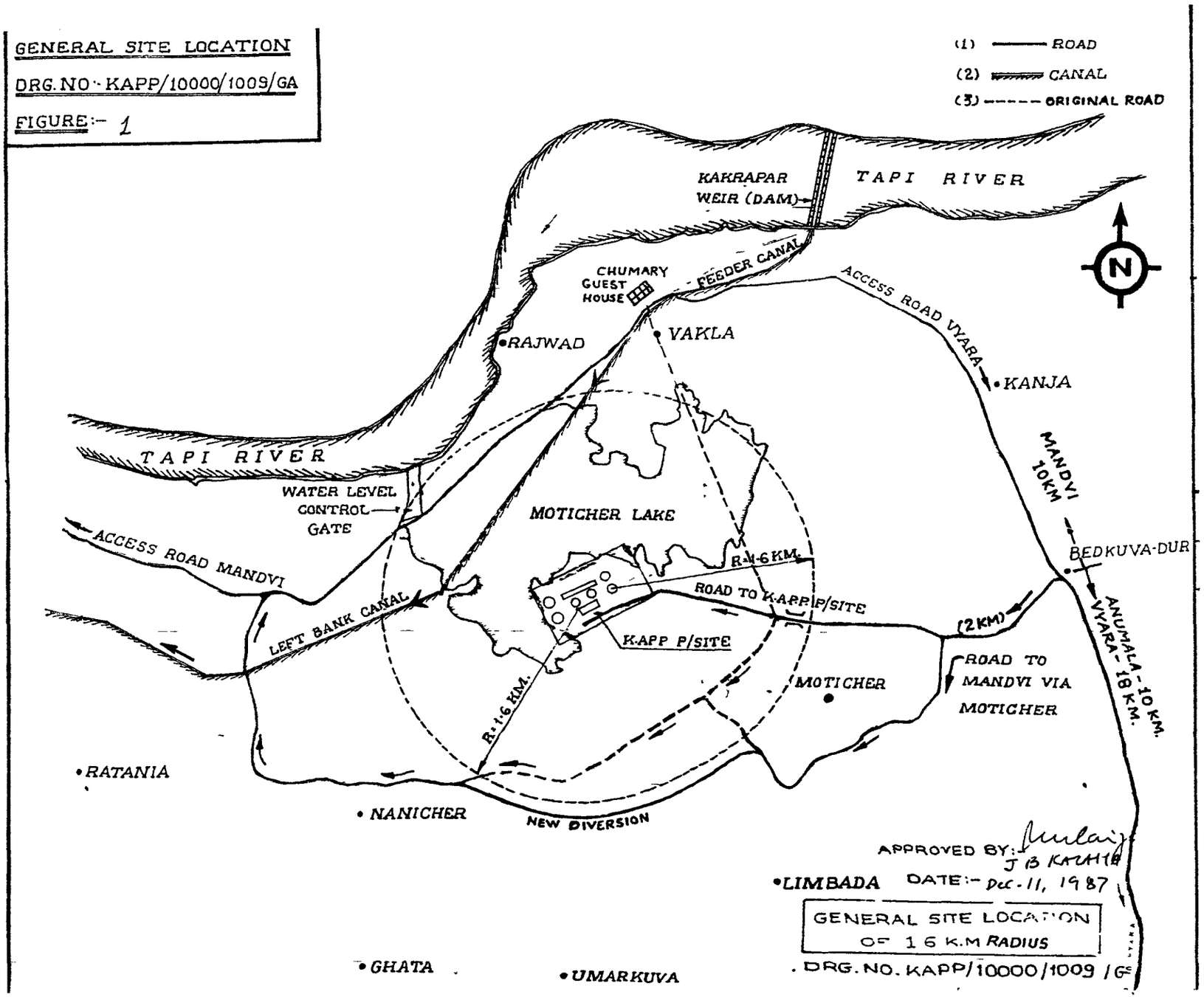
SK. NO.-14

ANNEXURE-2

GENERAL SITE LOCATION

DRG. NO - KAPP/10000/1009/GA

FIGURE :- 1



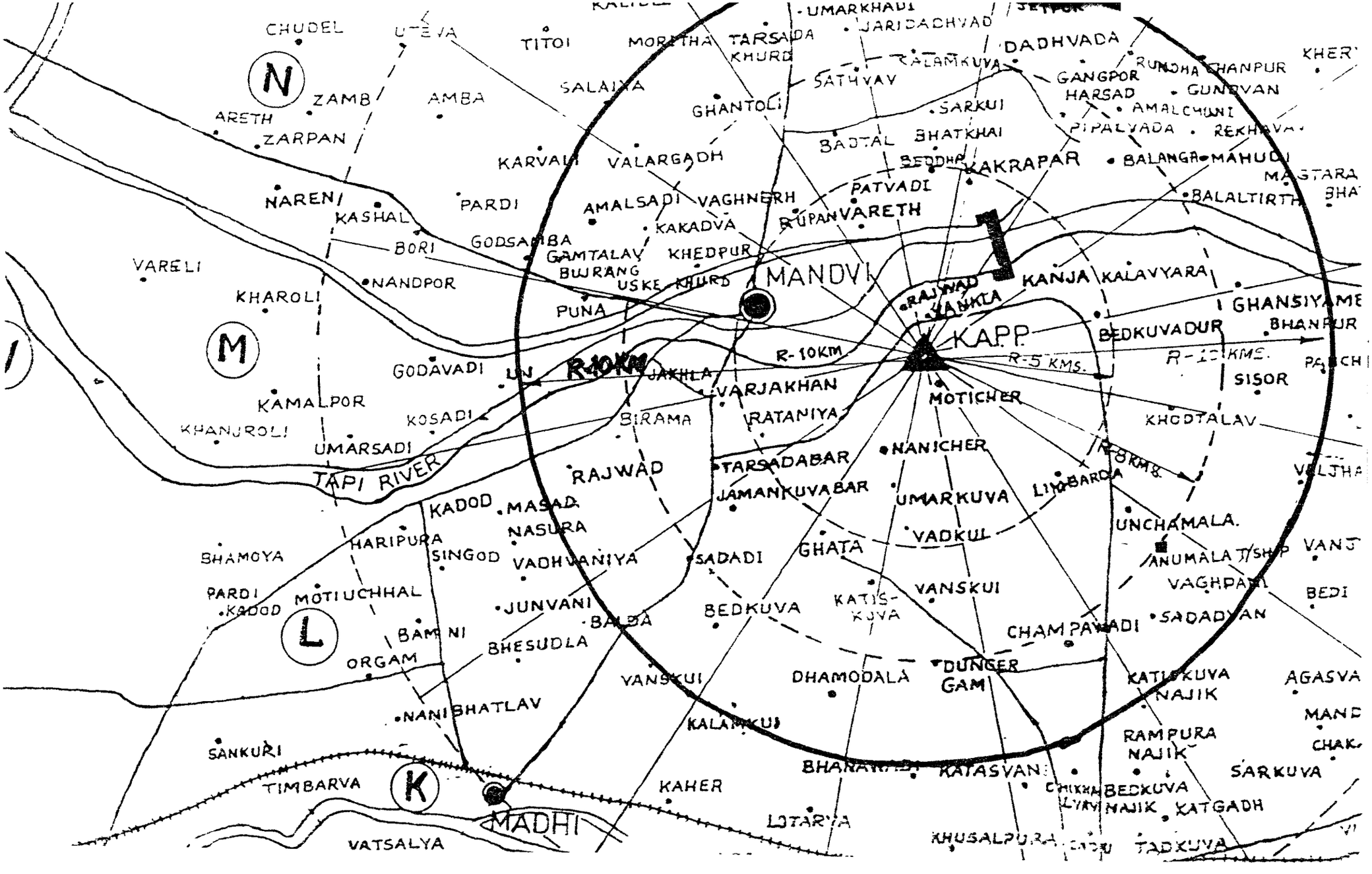
APPROVED BY: J B KACHHIA

DATE :- Dec-11, 1987

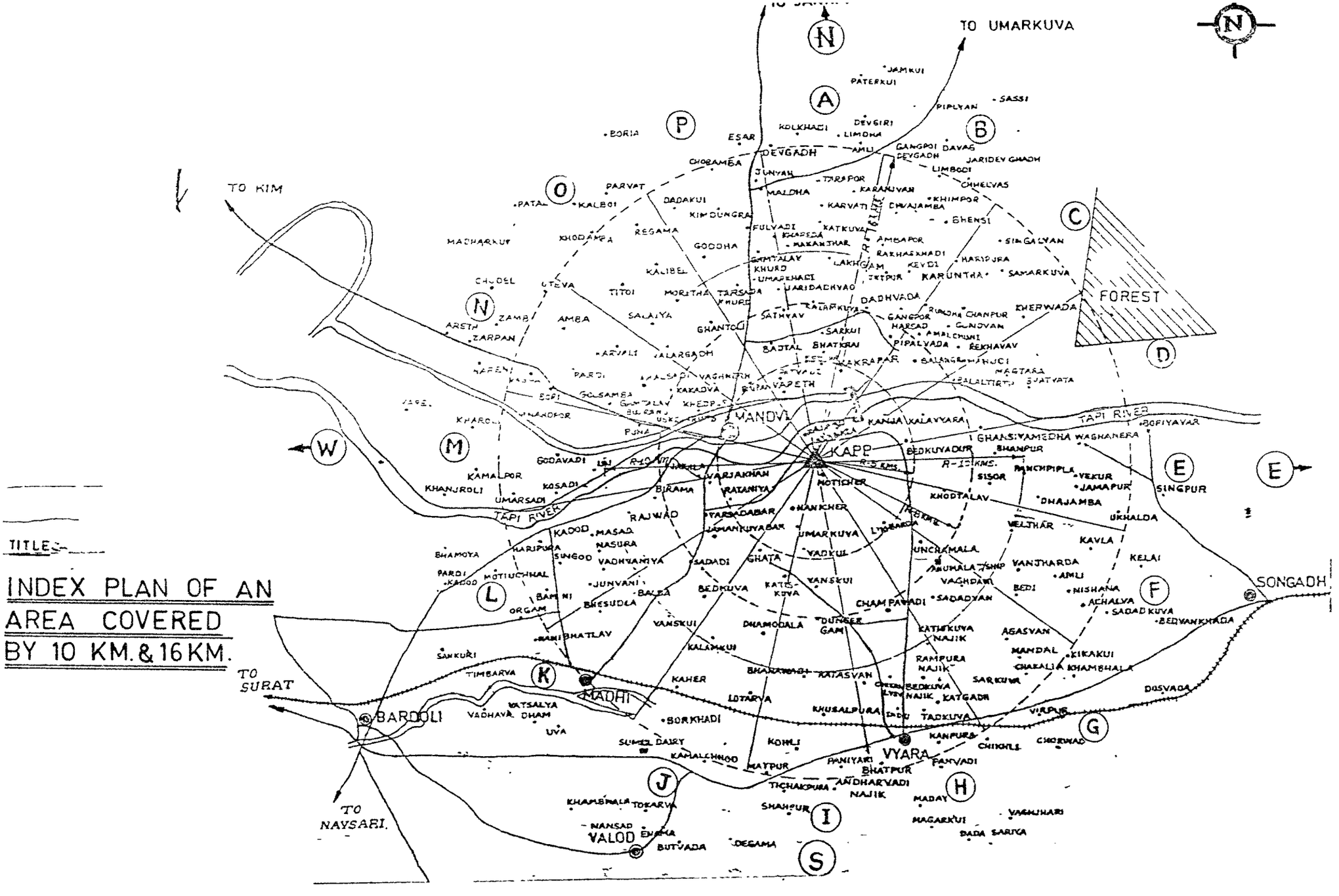
GENERAL SITE LOCATION OF 16 K.M RADIUS

DRG. NO. KAPP/10000/1009/GA

ANNEXURE-2A



TITLE :- INDEX PLAN OF AN AREA COVERED BY 10 KM.


TO UMARKUVA
TO KIM
TO SURAT
TO NAVSARI.
FOREST
TAPI RIVER
MANOVL
KAPP
VYARA
MADHI
BARDOLI
VALOD
SONGADH
SINGPUR
TITLE:-
INDEX PLAN OF AN AREA COVERED BY 10 KM. & 16 KM.

ANNEXURE-2B

BORING RECORD

PROJECT: KAKRAPAR ATOMIC POWER PROJECT

CLIENT: P. P. E. D.

MAIN - WELL

TYPE OF BORING	SHELL & AUGER	PERCUSSIVE [redacted]-BORING	CORING
DIA. OF BORING (mm)		400	[redacted]
DEPTH (MTS.)		10.20	
COMMENCED ON :	11.10.82	COMPLETED ON:	12.10.82
WATER STRUCK :		G WATER LEVEL	3.20

CONTRACT NO. B- 1873 | BORE HOLE NO. -

CO-ORDINATES	
GROUND/BED R. L. MTS.	
AREA	

DESCRIPTION OF STRATA	Depth/RL Metres
DARK BROWN SILTY CLAY.	1.90
YELLOWISH BROWN SANDY SILT.	3.90
YELLOWISH BROWN SANDY SILT WITH GRAVELS.	5.20
YELLOWISH GREY MURRUM.	8.20
YELLOWISH BROWN WEATHERED BASALT WITH JOINTS.	10.20

Scale | Samples | N-blows/30 cm %Core Recovery 40 80

Borehole completed at 10.20m

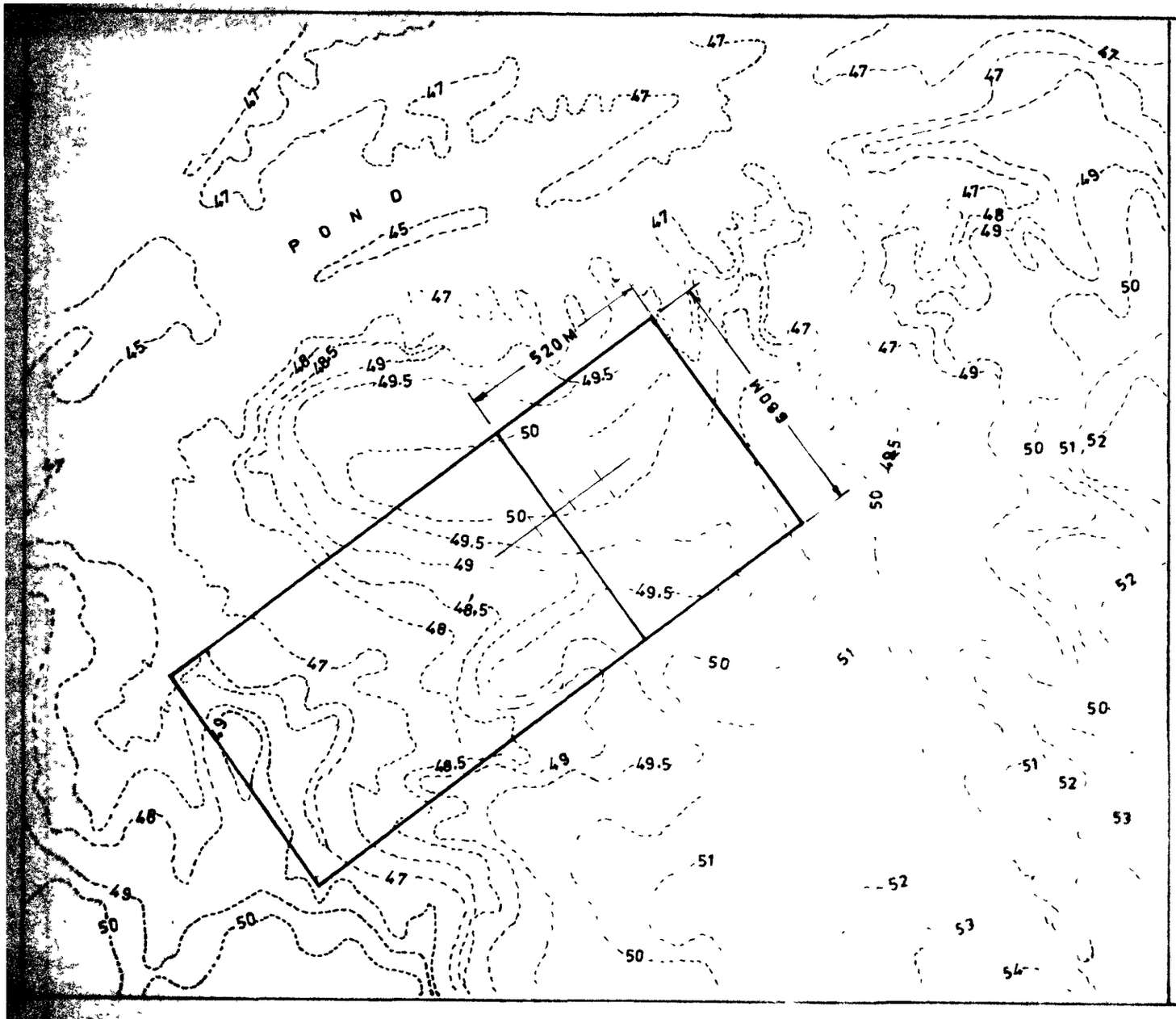
Cemindia

CODE: U-Undisturbed D-Disturbed W-Water P-Penetrometer Test.

Scale-1:20

DRG. No. B-1873 / 26

ANNEXURE-2C



MAP-6

NORTH

NOTES:-

1. CONTOURS ARE IN METERS ABOVE MIL.
2. THIS DRAWING IS BASED ON DRG NO KAPP/10100/2005/GA, REV 1 TITLED CONTOUR PLAN PLANT SITE AREA.

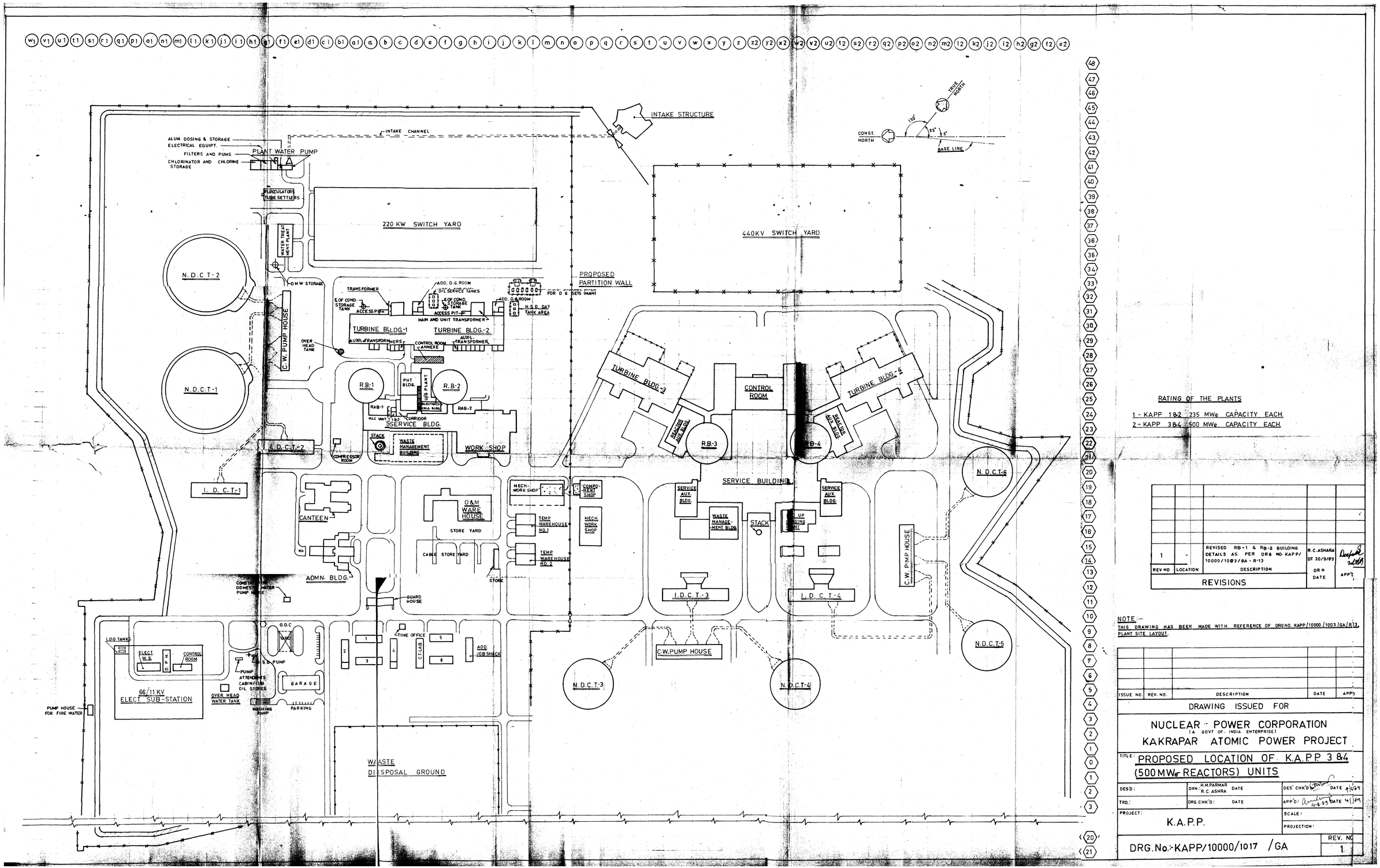
CONTOUR PLAN OF SITE AT KAKRAPAR

200M 0 200 400M

SCALE

SK. No 26

ANNEXURE-3



RATING OF THE PLANTS

1 - KAPP 1&2 235 MWe CAPACITY EACH
2 - KAPP 3&4 500 MWe CAPACITY EACH

REV NO	LOCATION	DESCRIPTION	DR'N DATE	APP'D
1	-	REVISED RB-1 & RB-2 BUILDING DETAILS AS PER DRG NO. KAPP/10000/1003/GA - R-13	R.C.ASHARA DT 20/9/89	

REVISIONS

NOTE:-
THIS DRAWING HAS BEEN MADE WITH REFERENCE OF DRG NO. KAPP/10000/1003/GA/R13, PLANT SITE LAYOUT.

ISSUE NO.	REV. NO.	DESCRIPTION	DATE	APP'D

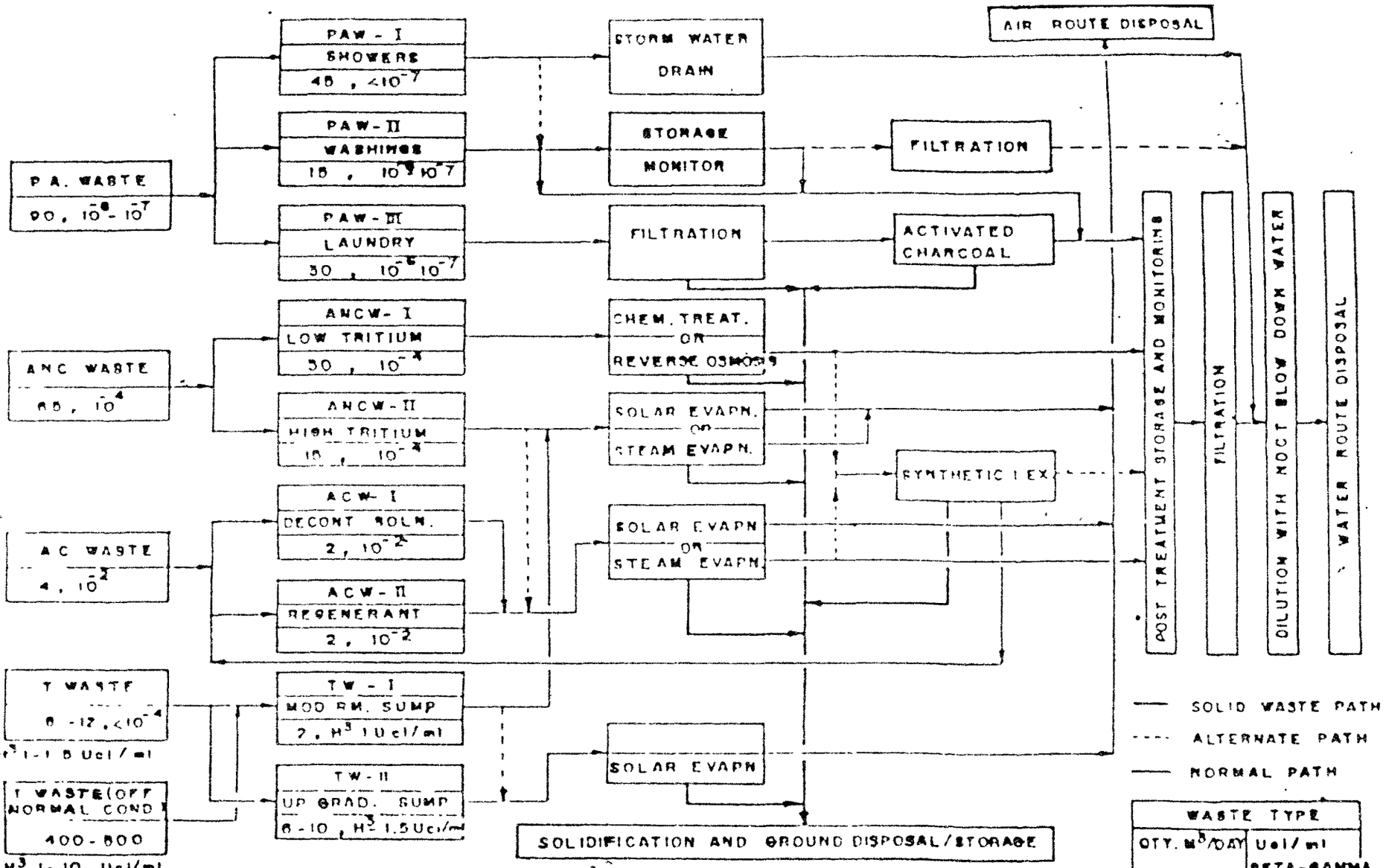
DRAWING ISSUED FOR

NUCLEAR POWER CORPORATION
(A GOVT OF INDIA ENTERPRISE)
KAKRAPAR ATOMIC POWER PROJECT

TITLE: PROPOSED LOCATION OF K.A.P.P 3 & 4 (500 MWe REACTORS) UNITS

DES'D:	DRN.: H.M.PARMAR R.C. ASHRA DATE	DES' CHK'D: DATE 4/1/89	
TRD.:	DRG. CHK'D: DATE	APP'D: DATE 4/1/89	
PROJECT: K.A.P.P.		SCALE:	
		PROJECTION:	
DRG. No.:- KAPP/10000/1017 /GA			REV. NO. 1

ANNEXURE-4



WMP 500 MWe RAD. WASTE MANAGEMENT SCHEMATIC (LIQUID) FOR REFERENCE SITE.

ANNEXURE-4

ANNEXURE-5

ANNEXURE-5

THE PHILOSOPHY OF RADIATION PROTECTION

The recommendations of the Internatioanl commission on Radiological Protection (ICRP) have been used for development of radiation protection standards applicable to nuclear power plant operations in our country. The recommendations encompass not only close limitation to workers in the nuclear power plant but also dose equivalent limits to members of the public living in the neighbourhood of such facilities and to the population at large in a collective way. Limitation of dose is aimed at both for normal conditions of operations as well as uncontrolled releases.

An individual memebr of the public at the fence post of the exclusion zone (1.6 km radius of NPP area) shall not receive more than 100 mrem/year of life long, whole body exposure(not including natural background and medical exposures) from all sources and from all routes under normal operating conditions and 10 rems under design basis accident conditions. (ICRP states that it is permissible to use a subsidiary dose limit of 500 mrem in a year for some years, provided that the average annual effective dose equivalent over a life time does not exceed the principal limit of 100 mrem in a year). To achieve this, in addition to engineerd safety features, a nuclear power plant is surrounded by an exclusion zone upto 1.6 km which is under the exclusive control of the station and within which no public habitation is allowed. In other words, the area within the exclusion zone is "restricted to plant operations only".

Surrounding the exclusion zone is an annular area upto 5 km radius, called the "sterilized zone" in which natural growth of public activities is permitted but any new or expansion activities leading to an enhanced population growth will be subject to review and appropriate regulation. Since dose limitaion to memebrs of the public is achieved mainly by assessment and not by individual monitoring, there is need to keep a surveillance on the environment to enable this assessment to be made. As a result, the option to monitor all environmental matrices such as food and water, air, milk, agricultural produce etc., and to excercise control over expansion of public activities is kept with the plant management.

In formulating the radiation protection recommendations, ICRP has evolved a system of dose limitation comprising three components as follows:

1. No practice involving the use of ionizing radiation shall be adopted unless its introduction produces a positive net benefit.

2. All exposures (so justified) shall be as low as reasonably achievable (ALARA) economic and social factors being taken into account.

3. The dose equivalent to individuals shall not exceed the limits recommended by the ICRP for the appropriate circumstances.

Of these three, component (2) namely the ALARA Principle is the most important requiring optimization of risks and benefits. This requires the prescription of a collective dose limit for the nuclear power plant. In consonance with this provision, the sites for NPP are normally chosen to be in low population zones.

Under normal conditions of operation, the total collective dose in the population shall be restricted to 10 man rem in a year from all sources and from all routes (excluding natural background and medical exposures) when the population dose is summed up to an atmospheric dose of 1 m rem per year(the deminimis level).

Under severe accident conditions the total population dose shall be restricted to 10 man rem when the summation of the atmospheric dose is carried out to a value of 20 mrem.

METHODOLOGY OF SETTING AUTHORISED LIMITS

It was mentioned earlier that dose limitation to members of the public shall encompass dose contributions from all sources and from all routes. Consequently the task of setting appropriate release limits consists of identiifying all the sources that contribute to dose to individual members of the public and assess the respective dose component thereof.The doses comprise not only the present sources but doses incurred in the future also. Further more, the local, regional and global components of the total dose commitment need to be assessed and accounted for. Such a task involves consideration of many parameters some of which are difficult to evaluate quantitatively. Pending this, provisionally, a fraction of the total dose equivalent limit to memebers of the public is assigned to the nuclear fuel cycle and to its various components by further fractionation.

In this excercise, all sites have been treated as multifacility sites having a single exclusion perimeter. Hence the dose limit as recommended by ICRP is apportioned as follows:

1. Apportionment to the pathway considered i.e water route, air route.

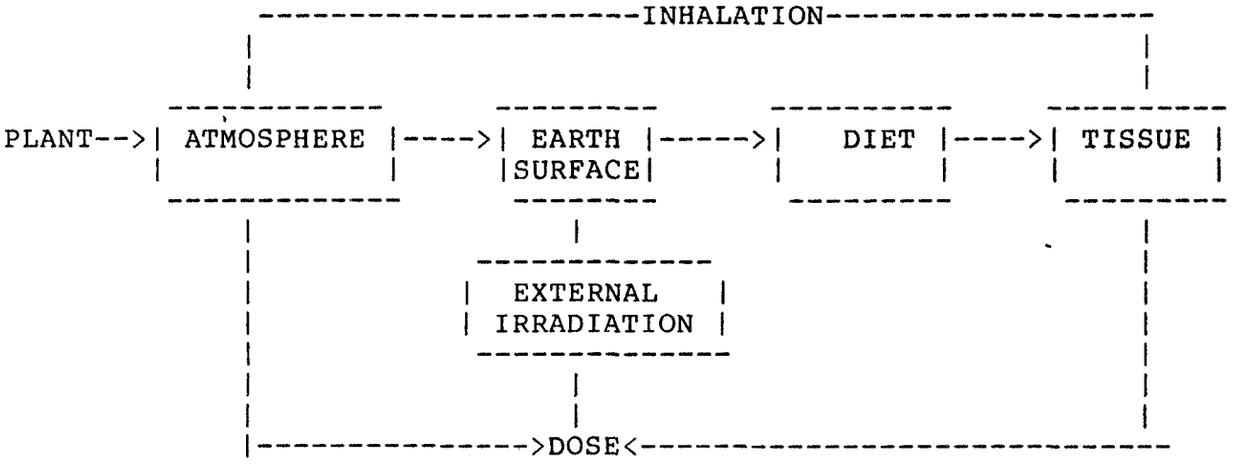
2. Apportionment of the above to the various facilities in a given site taking into account the need to have a reserve for the future.

3. Apportionment of item (2) above to some of the important radio-nuclides encountered in a facility.

From the points of view of waste management,the practice adopted is to have a single point of collection wastes, treatment thereof and single point of discharge, particularly from the point of view of handling liquid wastes. The apportionment for the water route is then assigned to the single point discharge, taking into account all streams of liquid wastes that flow into this single point treatment centre.

It should be noted that the apportionments referred to above are expressed in terms of mrem per annum. For purposes of practical usage it is necessary to convert these into other limits. eg. ci/d, ci/m-3, etc. These limits are then known as derived secondary limits. The derivation of such limits is a complex process, depending to a great deal on the parameters which are site specific. It is therefore necessary to study all the mechanisms of dispersal of radionuclides in the environment. In this excercise, it is found that certain pathways and certain radiaonuclides and also certain foods may be more significant in delivering dose to members of the public than the rest. Experience indicates that if these "critical" pathways, radionuclides and food items are taken into account in establishing the derived limits, then the dose contributions by all other pathways and radionuclides can be held to be very insignificant. Nevertheless, one of the aims of the environmental surveillance programme is to assess the actual dose and to monitor all site oriented parameters to provide assurance that actual dose incurred by members of the public are well below the limits set forth.

For purposes of arguments set forth above, the following example can be cited.



For each of the compartments in the figure above, a transfer factor should be established based on site investigations during the pre-operational stages. Some transfer factors may be in series and some in parallel. The sum of all parallel transfer factors and the product of all series transfer factors are used in the relationship between the dose limit and its derived counterpart.

WASTE MANAGEMENT PRACTICES

From the foregoing paragraphs it can be seen that the ratio of the input activity into the waste management facility and what is permitted out of it into the environment is the decontamination factor that should be aimed at. The facility should obviously have sufficient capacity to accommodate normal as well as surge volumes.

The achievement of the desired decontamination factor depends highly on several parameters such as :

1) the physical nature of the waste.

2) the chemical and radio-chemical properties of the waste.

3) the volumes encountered.

4) the treatment method chosen.

The basic philosophy of waste management can be classified into two broad classes namely :

a) the C-C philosophy - concentration and containment

b) the D-D philosophy - dilution and dispersal

The various methods of waste processing are listed below :

SOLID WASTES

1) baling and incineration of all combustible wastes

2) baling of all compressible wastes

3) burial in

   a) concrete trenches
   b) concrete trenches lined with asphalt
   c) concrete trenches lined with SS
   d) tile holes

LIQUID WASTES

1) Direct discharge with filtration and/or dilution.
2) Ion exchange
3) Chemical treatment
4) Evaporation
5) Storage in underground tanks
6) Fixing

   a) bitumen
   b) glass matrix

GASEOUS WASTES

1) Filtration and discharge through stack.

2) Filtration, delay and discharge through stack.

THE ENVIRONMENTAL SURVEILLANCE PROGRAMME

It was mentioned earlier that assessment of doses to memebrs of the public is done not by individual monitoring but by assessments through sampling in the environment and statistical calculations. In order to achieve this, a comprehensive environmental surveillance programme is established at all major facilities. The programme has the following objectives :

1) Base-line radio-activity measurements.

2) Pre-operational studies regarding identification of critical pathways, radionuclides and foods to help in the establishment of authorised limits.

3) Collection of data to assess the receipient capacity of the environment.

4) Monitoring during normal operation of the plant.

5) Provision of monitoring services in cases of uncontrolled releases of radio-activity into the environment.

Experience during the last 15 years of such programmes has given satisfactory results to contain radio-activity within ICRP limits.

ANNEXURE-6

ANNEXURE-6

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED KAKRAPAR ATOMIC POWER PLANT

1. INTRODUCTION

The Nuclear Power Plant(NPP) at the proposed Kakrapar Site will consist of two reactors of 500 MWe each of the Pressurised Heavy Water Reactor (PHWR) type in addition to the existing two units KAPP # 1 & 2 of 235 MWe each which are under the advance stage of construction. The proposed plant belongs to the Mark V-type of the Indian PHWR design evolution and incorporates several new safety features developed as a result of 20 years of design and operating experience. In this report, the general safety objectives of the Indian Programme for Nuclear Power development, the specific features of the proposed Kakrapar NPP and its impact on the environment are outlined.

2. THE PHILOSOPHY OF RADIATION PROTECTION

The Radiological Protection Programme (RPP) adopted in the Indian NPPs is based on the recommendations of the International Commission on Radiological Protection (ICRP). The International Atomic Energy Agency, World Health Organisation and the International Labour Organisation have formulated these recommendations into a joint document called the Basic Safety Standards (BSS) of Radiation Protection. India as a Member State of the IAEA has used the BSS as the basis for its RPP. Figure-I gives the exposure control philosophy of the RPP.

3. SAFETY OBJECTIVES

The overall safety objectives adopted in the progrmme are based on the principles enunciated by the founders of the atomic energy programme in the early years.

"Radioactive materials and sources of radiation should be handled not only in a manner which fully ensures that no harm can come to workers in the establishment or any one else but also in an examplary manner so as to set a standard which other organisations in the country may be asked to emulate".

To fulfil these objectives, the following measures are taken :

- the plant is designed with multiple barriers and built-in engineered safety features which (i) prevent accidents, (ii) limit the magnitude of the accident and (iii)mitigate the consequences of an accident,should one occur. These measures reduce both the probability and the potential magnitude of the consequence of an accident.

- during normal operations, the dose equivalent to workers and members of the public at the fence post (1.6 km radius exclusion zone boundary around the plant) are to be kept " as low as reasonably achievable " (ALARA) and should not exceed the dose equivalent limits set by ICRP (Figure-1).

- The non-radiological accident in the plant should be very low in frequency and severity compared to those in similar non-nuclear plants.

- Notwithstanding the site safety features and the in-built plant safety features outlined above, every plant prepares plans and procedures for emergencies. It is recognised that emergency planning and protective measures are regarded only as second level of protection to mitigate the consequences of an accident.

- Each plant trains its staff in the disciplines such as plant operation, mainteanance activities, radiological protection and emergency control and qualify them for the work entrusted to them. This is with a view to reduce the chances of human errors.

To minimise the impact on the environment, the following principles are adopted:

a). the plant operations shall not interfere in any manner with utilisation of environmental resources in the area outside its control

b). no deleterious effects,either of an acute or chronic nature, shall accrue from plant operations.

c). the ecological balance of life forms including humans shall not be disturbed.

d) the discharges of radioactive/non-radioactive pollutants from the plant to the environment shall be at such levels and quantities that the resultant accumulation of the pollutants in any component of the environment including life forms will not affect them in a manner detrimental to the ecosystems.

4.0 SAFETY ASSESSMENT METHODOLOGY

4.1 SITING

The main considerations governing safety in the siting of NPP are,

a) The risk to the NPP from external events (natural and man-induced) should be less than the intrinisic risk from the NPP itself;

b) The radiological consequences in the environment due to the NPP should be "as low as reasonably achievable (ALARA)" both for normal operation as well as accident situations.

To meet these conditions detailed analysis of the following are under taken.

4.2 EXTERNAL NATURAL EVENTS

4.2.1 SEISMICITY

The KAPP site lies in zone III of seismic zoning map of India as per the IS 1893-1984;IV revision with amendment No. # 1.

The Kakrapar site is in the proximity of Western Ghats and lies almost at the end of Deccan Trap in Gujarat State.

The site is surrounded by the Aravallis and Delhi folding in north, Vindhyan syneclise and rocks of Satpura folding in northeast, Cambay Graben in northwest, Saurashtra Kutch Shelf in west and Deccan syneclise in the south of the project site.

The significant geomorphologic - tectonic units present around the project site are Narmada - Tapti belt, Cambay graben and Deccan syneclise.

The project site lies at the junction of Narmada Tapti belt and Deccan Traps trending NS to SW, NW-SE, EW, NE-SW. Major Tapti lineaments close to the site lie at an approximate distance of 27 Kms. towards South, trending E-W, at a distance of 28 Km. N-E trending and NW-SE, at a distance of 36 KM. towards East tremding N-S, and yet another at a distance of 44 KM. towards West trending N-S.

Based on geology and scismotectonic set up of the project area, the following earthquake parameters are adopted for ground accelaration at the Site, Magnitude = 6.5;
Epicentral Distance = 30 Km;
Focal depth = 20 KM.

Based on the above parameters a peak horizontal ground accelration of 0.2g. have been arrived for the Safe Shutdown Earthquake condition which has been taken into the designs for KAPP # 1&2.

4.2.2 FLOODING

The safe elevation for the finalised grade level at KAPP site for the present two units of 235 MWe under construction is 51.00 M. This has been arrived at after detailed study of flood routing of Probable Maximum Flood of 70,000 cumecs (25.00 lakh cusecs) with return period of 1 in 1000 years. This flood, when routed downstream of Ukai, will result in a spill over of 49000

cumecs (17.6 lakh cusecs) just downstream of Kakrapar weir and will result in a flood water level of around RL + 50.00 m. Kakrapar weir is about 2 km upstream of site location. This flood when further routed through the TAPTI river cross-section results in an elevation of RL + 48 m at the location of Moticher weir which is about 2 km down stream of site location. Hence the flood level at site is likely to be around RL + 49 m. Considering the flooding due to precipitation in the local area to coincide with the flooding due to precipitation in the local area to coincide with the above peak flood, it is expected that maximum flood level will reach upto elevation RL + 50 m near the site. As such, the elevation of RL + 51.0 m has been fixed by DAE SRC(SARCOP). Safety of upstream Ukai dam design has also been assessed and found to be adequate, as per the expert opinion.

4.3 MAN INDUCED EVENTS

For this purpose, air craft crashes, storage and use of flammable, corrosive or toxic chemicals and explosives in the vicinity of the site have been considered. Adequate screening distances are available in this regard. There are no airports nearby within a radius of 50 km around the plant. The nearest airport is at Surat about 60 km (radial) from the site. Major storage of toxic chemicals, explosives, corrosives, flammable liquids are neither existing nor permitted within sterilized zone. At Ukai, about 30 km (radial) upstream of the site,thermal power station & hydro power station under GEB are operating. There is no mining activity within 10 km around plant. The industrial development in the vicinity of the plant will be regulated through the State Government for reasons stated in 4.4.1. The state highway Vyara--Mandvi-Kim is about 3 km from the proposed site.

4.4 RADIOLOGICAL IMPACT AND ITS ASSESSMENT

4.4.1 GENERAL

The average doses to the individual and collective doses to the population are functions of the sorrounding population and its distribution. To minimise the radiological impact, regulation of the population and its distribution is required. The 1.6 km radius exclusion area defines the boundary between the plant and public habitation. A sterilized zone of upto 5 km is also established such that within the sterilized area, only natural growth is permitted and the option to sample environmental matrices such as food items, water, air, meat, fish, eggs and milk is excercised. These measures help in obtaining assurances that control measures to limit doses to the public are indeed effective. They also make implementation of emergency measures more practicable in the event of an accident.(Fig.2).

The meteorology, surface hydrology and hydrogeology at the site are also evaluated to ensure that discharges of gaseous and low level liquid effluents will not pose problems during normal

operations as well as accident situations.

4.4.2 POPULATION DISTRIBUTION

The population distribution around the proposed site is as follows:

Distance	Population
0 to 1.6 kms.	Nil
1.6 to 5.0 kms.	30,465
5.0 to 8.0 kms.	21,180
8.0 to 16.0 kms.	1,72,194

The total population in the area covered by radius of 16 kms. around the site is 2,23,839. The average population density in 16 kms radius area is about 278 persons per sq.km.

There is no population centre having a population more than one lakh within 50 kms. radius from the site.

Villages Ratania, Umarkuva, Vadkui, Nanicher, Kakrapar, Ghata, Bedkuvdur, Mandvi, Limbarda, Unchamala, Kanja, Wakla, Rajwad, and Wareth fall in the sterilized zone.

4.4.3 METEOROLOGY

The data colected at KAPP site from Aug. 87 to May 88 have been studied & the average predominant wind directions in the direction (N-NE), (S), (SW) & (S- SW) are 9.36%, 9.07%, 12.50% and 16.12% respectively.

The data available at KAPP site from 1983 to 1988 for temperature and rain fall are given below:-

AMBIENT TEMPERATURE & RAINFALL AT KAPP SITE

Year	TEMPERATURE Maximum	TEMPERATURE Minimum	RAINFALL
1983	39° C	18° C	1735 mm
1984	40° C	15° C	1264 mm
1985	40° C	14° C	694 mm
1986	43° C	16° C	725 mm
1987	44° C	14° C	485 mm
1988	42° C	13° C	1949.3 mm

4.4.4 LAND USE

About 70% of the area within 10 km around the site is agriculture land, 15% of the land is forest land and the rest waterspread and low lying area. In the agriculture land, the main products are sugarcane, jowar, ground nut, rice, cotton and fodder once a year. In addition, pulses are also cultivated. The yields of the crop are considered to be moderate. The list of agriculture products is as follows:-

Sugar cane	:	20%
Jowar	:	20%
Rice	:	25%
Groundnut	:	10%
Toordal	:	15%
Cotton	:	5%
Fodder(Grass Land)	:	5%

4.4.5 GEOHYDROLOGICAL CONDITIONS

The genral ground water level is reported to be at a depth of 3 to 6 m (within overburden) below ground level. Though some amount of water-logging has been reported from the site area on account of seepage from Kakrapar left bank canal entering Moticher lake,at the grade level as encountered during the excavation for the present KAPP-1&2, no water has been seen which could be, because of the hard unfractured compact basaltic cover. A similar situation is expected in respect of the areas proposed for the additional units KAPP # 3 & 4.

4.4.6 ENVIRONMENT SURVEY LABORATORY

At the Kakrapar site, an environmental survey laboratory is being set up for undertaking environmental studies which consist of two phases namely, (1) the pre-operations phase and (2) the operational phase. The following investigations form part of the pre-operational phase:

- Informations on background radio-activity levels in the vicinity of the plant;

- The distribution of the radio-active material in the various matrices of the environment and the estimation of the receipient capacity (thus helping in identifying the critical pathways of exposure and the dilution capacity of the environment).

- Data on bioaccumulation factors for potentially hazardous radio nuclides, by study of stable element distribution. These yield data on uptake of trace elements and possible isotopic dilution effects.

Micrometeorological charecteristics of the site for evaluating dispersion of airborne radio nuclides.

Figure-3 gives the environmental pathways for the air route and figure-4 presents the pathways of exposure for radio nuclides discharged to the aquatic environment.

During the operational phase,the investigations done during the pre-operational phase are used as base line data upon which any noticeable impact on the environment can then be attributed to the NPP and its operation. Routine surveillance helps in detecting any effect on the environment not hitherto foreseen and also in checking the adequacy of design provisions in controlling effluents from the plant.

4.5 FOUNDATION CONDITIONS

4.5.1 GEOLOGICAL SETTING

The site is situated on a large flat elevated area downstream of Kakrapar weir. The bed rock is hard greyish basalt under-lying 5 to 6m thick overburden consisting of black cotton soil and weathered zone. At the grade level of 17 m below the ground, upto which excavation for the present Kakrapar plant (KAPP-1 & 2) has been completed, very compact poorly jointed hard basalt has been exposed as the foundation for the Reactor Structures. It can be presumed that for the extension also a similar sub-surface profile would become available. No foundation problems are therefore envisaged at this stage.

4.6 WATER AVAILABILITY

Condenser cooling system will be on closed system with cooling towers with river water from Moticher Lake as coolant. Process water system will have multiple loops with closed primary, closed secondary and closed tertiary systems using river water from Moticher Lake as the coolant and tertiary system being on cooling towers. State authorities have assured water availability for drawal and also consumptive use for a power potential of 1470 MWe

4.7 OTHER FACTORS

Other factors such as electrical power supply, construction facilities and access to the site etc. required for proposed units are already existing and in use for the units KAPP # 1 & 2 which are under the advance stage of construction.

5. DESIGN SAFETY FEATURES

The design of the proposed Kakrpar reactors incorporates a number of safety features which supplement the natural safety features offered by the site. This defence-in-depth approach can be described in terms of three levels of safety as described below;

Level 1 : The safety features of this level are intended to prevent an accident. These include reactor control system, radiation monitoring systems and emergency equipment. Besides, the design adopts priciples such as redundancy in protective and safety systems, diversity, physical seperation and independence of systems and fail-safe philosophy. Testability of components and systems, in-service inspection and selection of proven equipment with known and low failure rates are additional features intended not only to enhance the safety level of the plant but also to obtain a high reliability. A comprehensive system of quality assurance at all stages of the NPP is enforced such that fabrication of equipment and their installation and commissioning produce the desired quantified level of safety.

Level 2: This includes those systems intended to minimise the magnitude of an accident should once occur. Examples are :

- fast acting shutdown systems (two independent systems)
- engineered limits on the rate of power rise.
- emergency core cooling system
- redundant off-site and on-site electrical power supply to all components important to safety.

Level 3: Safety features of this level limit the consequences of an accident when the first two levels of safety are assumed to fail simultaneously. The containment system, containment heat removal systems, filtration and pump back system, the ventilation system, the high efficiency particulate and iodine filters and the stack belong to this level. The proposed Kakrapar Plant employs the improved version of the containment system namely,a double containment blended to a vapour suppression pool and filtration and pump back system.

Design and construction of all components, systems and structures associated with reactor safety follow the best applicable codes, standards and practices. Factors influencing common cause failures are identified and corrective action taken in design.

Every stage in design, construction, commissioning and operation of the NPP takes into account aspects of safety and reliability. Well documented methods are adopted during procurement, quality assurance, erection and commissioning of systems.

6. SAFETY ANALYSIS

A unique feature of the safety assessment methodology in NPP is the systematic study of the plant behaviour under conditions which may result in uncontrolled release of radioactivity to the environment. As shown in Fig.1, the ICRP recommendations provide for dose control during accident situations also. To comply with this provision, the siting criteria outllined earlier have been formulated to include also the impact of a maximum conceivable release of radioactivity following a maximum credible accident to the NPP.

The following are considered in the evaluation of the safety of the NPP under accident conditions:

a) The acceptable intervention and contamination levels.

b) Evaluation of the site parameters such as dispersion under worst meteorological conditions, hydrological dispersion, environmental utilisation and population distribution.

c) evaluation of the design and operating conditions of the NPP for identifying the spectrum of possible accidents and release of radioactivity associated with each accident and the overall containment capability of the plant.

A safety analysis report outlining the safety features of the design, their description, performance charecteristics and failure analysis is prepared. The report also includes documented safety analysis describing and evaluating the predicted response of the plant to intiating events (such as postulated disturbances in process variables, postulated malfunctions or failure of equipment, human errors, influence of external events etc.) leading to accident conditions, including relevant combinations of such disturbances, malfunctions, failures and events. The result of such analysis are expressed in terms of likelihood of the events, the extent of damage to the barriers between the sources of radioactivity and the public and the radiation doses to the public and site personnel.

Accident analysis of the plant includes both single failure and dual failure events. A single failure event is the failure of the plant process system namely the fuel, reactor coolant, or reactor regulating system. Single failure events do not create any additional environmental impact and limits for

releases are the same as that applicable to normal operations. The dual failure event is much less likely involving a single process system failure plus simultaneous failure of a safety system. The probability of a dual failure event having serious consequences is less than 10 E-6/year. The reactor design incorporates two independant highly reliable and 100% redundant shut down systems of diverse principles. Core cooling system is backed up by an emergency core cooling system which will get actuated automatically in the event of a loss of coolant accident. The power supply to plant equipment is graded in different levels of reliability. Power supply for safety related systems is backed by power from diesel generators and DC storage batteries.

The reactor building adopts double containment concept and in the event of an accident, the containment will be boxed up and will be isolated from the environment and releases through stack will be controlled. The ICRP has recommended control measures, protective counter measures and intervention levels for accident situations which will be followed.

The safety report is reviwed by AERB through a series of safety committiees constituted by AERB. After a satisfactory review of the report, the plant is formally "licensed" by the AERB after final review to operate under a given set of limits and conditions.

7. SAFETY IN OPERATION

Prior to commissioning of the plant,the staff for operation maintenance and related services are given training and authorisation at various levels as outlined in the Safety Report. Formal class room training with practicals and prolonged on-the-job training at similar plants are given. The requirement for authorisation include successful completion of written examinations, checklists,walk-through and orals. Familiarisation of the emergency plans as well as radiological protection are important pre-requisites.

Along with the safety report, another document, containing the operating limits and conditions is prepared by the plant organisation. This document, called the "Technical Specifications" is reviewed and approved by the Atomic Energy Regulatory Board.

During operation, safety surveillance in the plant and environmental survey in the public domain are provided by a team of qualified personnel independant of the station operation and management. In a similar manner, the design and operation of all waste management facilities are also undertaken by an organisation independent of station management. This set up ensures that radiation protection procedures and the technical specifications are followed properly by the plant management and that exposures of site personnel as well as effluent releases to the environment are property monitored and recorded.Violations,if

any, and all unusual occurances having a bearing on safety are promptly reported and corrective action taken in a timely manner.

The RPP provides for inter alia, monitoring of the workers for external radiation as well as internal contamination, if any. Overexposures, if any are reported promptly and investigated by a special committee whose recommendations are binding on the plant management.

Records of all activities are maintained in a timely and systematic manner. These are reviewed periodically such that the lessons learnt are applied to other facilities as appropriate.

8.0 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 GENERAL

The environmental impact of an NPP can be assessed in terms of the following categories:

- The impact to acquisition of land needed to set up the plant buildings and other support facilities.
- The impact due to discharge into the environment which include radioactive material, conventional chemical pollutants if any and thermal plumes.
- The potential impact due to the unlikely event of an uncontrolled release from the plant, reaching the public domain.

8.2 ACQUISITION OF LAND

For the units (KAPP # 1 & 2) under construction, the land (944 hectares) has already been acquired. The proposed units-KAPP # 3 & 4 are to be located within the exclusion zone area which is already under the control of DAE/NPCIL. The sufficient land for colony purpose has also been acquired. Hence further acquisition of land & rehabilitation of the villages will not be required.

8.3 RELEASES DURING NORMAL OPERATIONS

The nuclear power reactors are not associated with conventional pollutants. Therefore, the environmental impact assessment mainly relates to radioactive releases from the plant. This aspect has been adquately controlled and regulated from the early stages of nuclear power development. In case of the impact due to discharge into the environment, the radiation protection philosophy envisages a dose equivalent limit of 1.0 mSv per year to members of the public from all sources excluding natuaral and medical exposures. Out of the total dose equivalent limit as

above seperate allocations are fixed by AERB for each of the facilities at the site and leaving a margin for future expansion also.

8.3.1 AIR RELEASES DURING NORMAL OPERATION

Out of the limit as above the air route is given a seperate allocation. Based on this allocation for air route, authorised limits for releases are fixed by AERB. The Mark V design has totally eliminated argon-41 releases from the plant. Experience at RAPS and MAPS indicate that only about 25% of the authorised limit is used by the plant in the case of tritium and much less in the case of iodines and particulates. The air releases from the plant are passed through high efficiency particulate absolute filters which essentially remove all the particulates. The discharge air may contain minute quantities of tritium and active inert gases which will be well below the authorised limits.

8.3.2 RELEASE THROUGH WATER ROUTE

Out of the total limit as in 8.3 an allocation is also stipulated for the water route for each facility at the site. Authorised limits will be fixed by AERB. Waste waters in the plant are segregated right at the source based on different levels of activity. A seperate Waste Management facility for the liquids will be set up which provides for segregation, collection, treatment, storage and safe disposal in a manner that fulfils the intent of ALARA (as low as reasonably achievable). Treatment methods include filtration, ion exchange, evaporation and chemical treatment. Waste waters containing radio activity are sent to the Waste Management facility for treatment. After treatment, the radio active residue is fixed in cement for containment and burial within the exclusion zone boundary of the plant. The treated liquids with appropriate dilution are released into the water body within authorized limits stipulated by AERB.

The treated effluents from the waste treatment facilities before dilution are expected to contain about 500 ppm of total solids. The quantity of treated liquid effluents for release would amount to about 0.25 cu.m per MWe per day. Closed system of condenser cooling with cooling towers would be adopted for the proposed 2 x 500 MWe NPP . The quantity of treated liquid effluents as above would be mixed with the blowdown waters from cooling towers (condenser cooling) in the outfall, therby, further getting diluted. The quantity of treated liquid effluent flow amounts to only 0.20% of blow down flow in the outfall. Hence there will be practically very small incremental contribution to total solids due to mixing of treated effluents. As closed condenser cooling system with cooling towers would be adopted at this site thermal pollution of aquatic environment is not of significance.

8.3.3 SOLID WASTES

Low level solid wastes after treatment are buried within the plant complex in the exclusion zone. These are contained in leak tight R.C.C. vaults. In special cases, internally steel lined exterally water proofed RCC pits called tile holes are used which are shielded and sealed. High integrity containers are used for retrievability. In the burial area adequate bore well facilities are provided as a check for any migration of activity.

8.4 ACCIDENTS

With respect to the potential impact of the uncontrolled releases in case of accidents, it may be mentioned that the plant is designed to accommodate a design basis accident (DBA) as outlined earlier such that intervention levels given in fig #2 are not exceeded. The proposed Kakrapar reactors are provided with double containment and full vapour suppression. For the remotest possibility of an accident, more severe than the DBA emergency plans are available to ensure that the public are not unduly exposed and that a number of protective counter measures are included in the emergency plan.

ENVIRONMENT AT NPP SITES

The early planners of nuclear energy development have shown foresight in emphasising the aspect of improving the environment at the sites of all its installations. Tree plantation is given prime importance not only from an aesthetic point of view but also to reduce the impact on the environment due to the plant operation both during normal and accident conditions, to minimise dust load, reduce heat radiation and to improve microclimate around the nuclear power stations and laboratories which house sophisticated machinery and equipment. Organised tree planting activity is in progress for the KAPP-1 & KAPP-2 site location where proposal the site for KAPP # 3 & KAPP # 4 is forwarded.

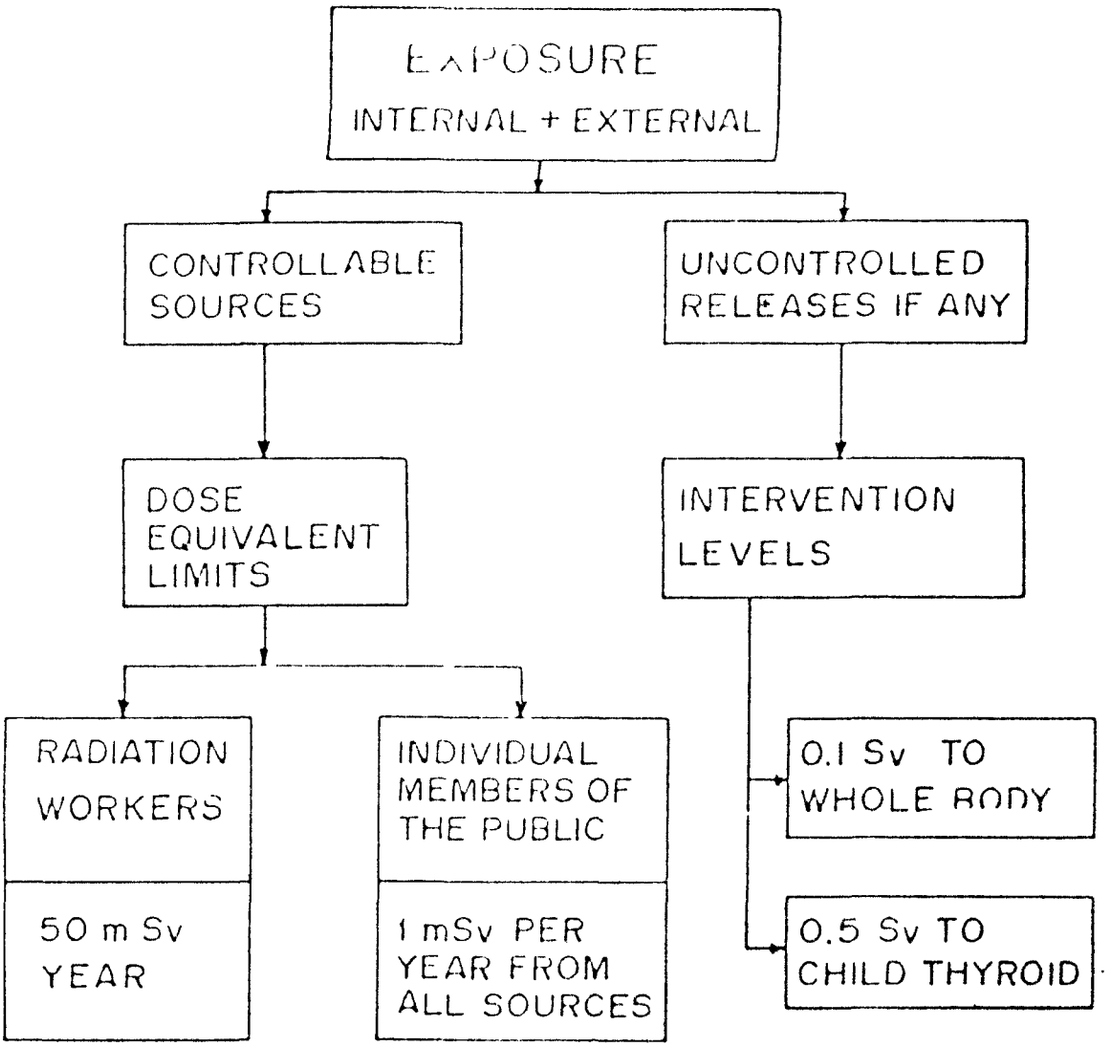
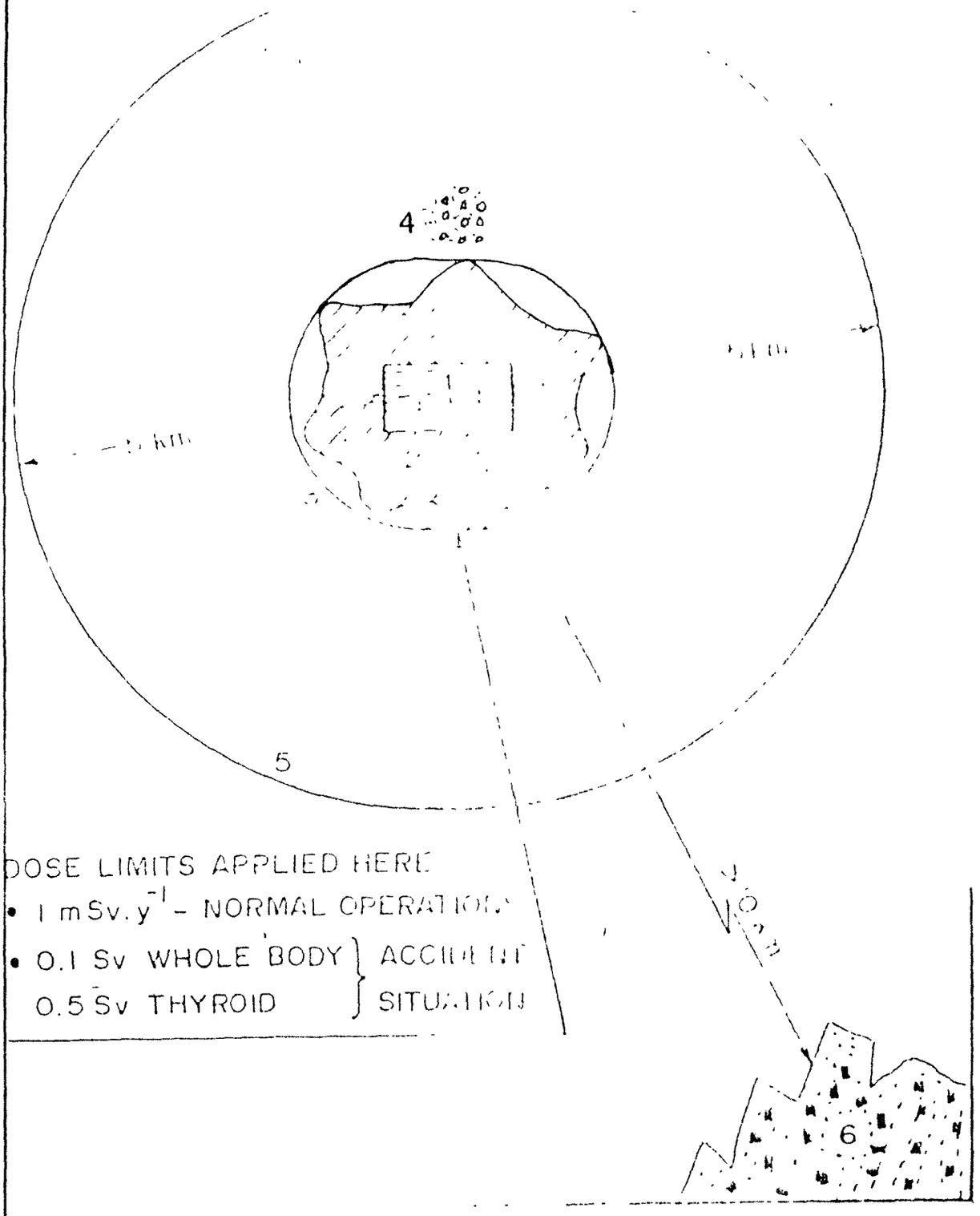

EXPOSURE
INTERNAL + EXTERNAL
CONTROLLABLE SOURCES
UNCONTROLLED RELEASES IF ANY
DOSE EQUIVALENT LIMITS
INTERVENTION LEVELS
RADIATION WORKERS
50 m Sv YEAR
INDIVIDUAL MEMBERS OF THE PUBLIC
1 mSv PER YEAR FROM ALL SOURCES
0.1 Sv TO WHOLE BODY
0.5 Sv TO CHILD THYROID

FIGURE - 1.



DOSE LIMITS APPLIED HERE

- 1 mSv.y^{-1} – NORMAL OPERATION
- 0.1 Sv WHOLE BODY } ACCIDENT
  0.5 Sv THYROID } SITUATION

1 - NUCLEAR POWER STATION COMPLEX
2 - ISODOSE CURVE (SCHEMATIC)
3 - EXCLUSION AREA
4 - HUMAN SETTLEMENT TO WHICH DOSE LIMITS SHOWN APPLY
5 - STERILIZED ZONE WHERE PROTECTIVE ACTIONS ARE ENFORCED
6 - POPULATION CENTRE (SCHEMATIC) $\geq 10^4$ PERSONS

FIGURE - 2

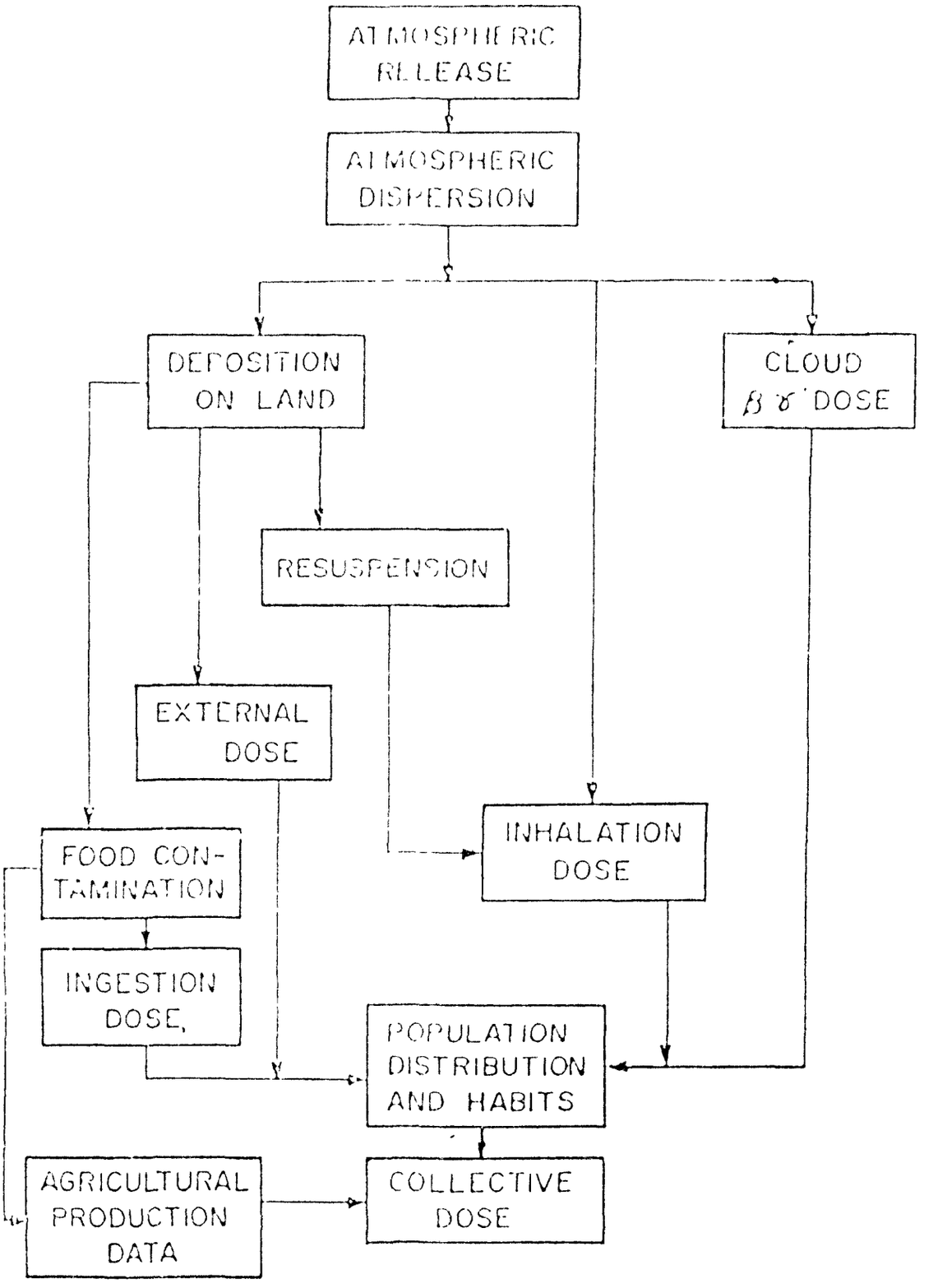


FIG 3 EXPOSURE PATHWAYS FOR ATMOSPHERIC RELEASES.

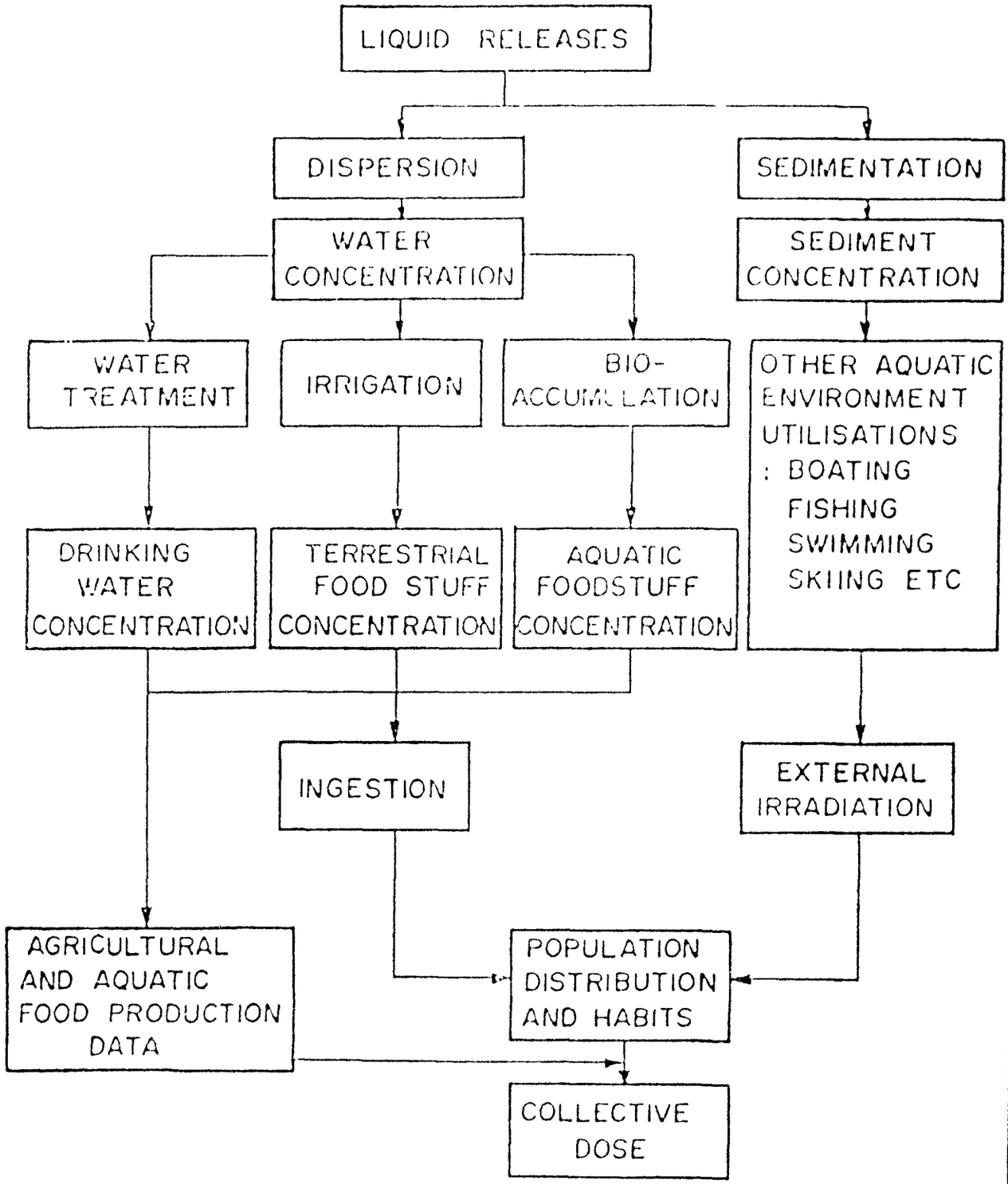


FIG. 4. EXPOSURE PATHWAYS FOR RELEASES TO AQUATIC ENVIRONMENT

ANNEXURE-7

No. WTR/1084/13/P

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તાર : 'ઈરિગેક'
સિંચાઈ વિભાગ
ગુજરાત સરકાર,
સચિવાલય, ગાંધીનગર—૩૮૨ ૦૧૦.
તારીખ 27/3/86

મુખ્ય ઇજનેર (સિંચાઇ યોજનાઓ) અને
સરકારના સંયુક્ત સચિવ.

To,

Shri Y.S.R. Prasad,
Chief Project Engineer,
Government of India,
Department of Atomic Energy,
Kakrapar Atomic Power Project,
P.O. Anumala, Via; Vyara,
Dist. Surat, Pin. 394651.

Sub:- Water supply to Kakrapar Atomic Power Station.....
Fixation of water rates.....

Sir,

Please refer your D.O. letter No.SSC/W-4/85/B/10551, dated Nov. 29, 1985 addressed to Shri Vinay Sharma, Secretary (Energy), I.K.P.D. and subsequent D.O. letter No. KAPP/CPE/00151/86/5/216/1999 dated March 1, 1986 addressed to the Secretary, Irrigation Department on the subject mentioned above, and clarification on various points raised by you is as under.

So far issue of charging water rates is concerned Irrigation Department will charge a rate of 20 paise per 10,000 litres for first 10 (Ten) years as a special case for use upto 50 cusecs of quantity. Thereafter normal water rates prevailing there in the state from time to time will be charged.

For remaining quantity of water above 50 cusecs (i.e. more than 50 cusecs) for original plant as well as for extension capacity, the water rates prevailing from time to time will be charged.

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Irrigation Department has already agreed to maintain water at a higher level than 45.0 M(GTS) vide this department's letter No. WTR/1081/8/P dated 27-9-85 for original plant. In view of this there will not be any difficulty for maintaining higher level than 45.0 M(GTS) for expansion capacity also.

Yours faithfully,

(M.R. Goswami)
Chief Engineer (C) & Jt. Secy.,
Irrigation Department.

M.G.Pathak,
Chief Engineer (I) & Joint Secretary.

D.O.No.NPP-1081/8/P

Government of Gujarat,
Irrigation Department,
Sachivalya, Gandhinagar,
Dated the 21st March, 1983.

Subject:- Requirement of makeup water for Kakrapar Atomic Power Station.

Dear Shri Sastry,

Please refer your letter No.KAPP/40000/82/R/2312 dated the 6th December, 1982 on the subject mentioned above.

The points raised in your above referred letters are confirmed as under:-

(1) The State Govt. agrees for an uninterrupted supply of 200 cusecs of water for Atomic Power station from Kakrapar Weir.

(2) The water level in the Hathisher Pond shall be always maintenance higher than except during the precedent of drought resulting in very poor or no replenishment in Ukai reservior.

With regards,

Yours sincerely,

(M.G.Pathak)

To:

Shri V.V.Sastry,
Chief Project Engineer,
Department of Atomic Energy,
Power Project Engineering Division,
Hamidbhoha Road, Colaba,
Bombay- 400 005.

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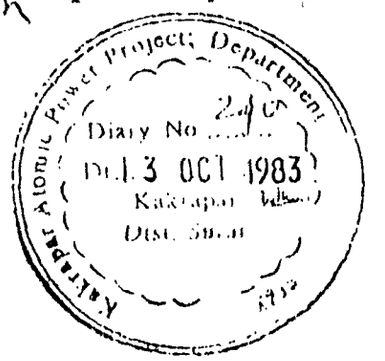
No.WAK-1081/B/P

Government of Gujarat,
Irrigation Department,
Sachivalaya, Gandhinagar,
Dated the 27th September, 1983.

To:

Shri C.V.S.Sastry,
Chief Project Engineer,
Department of Atomic Energy,
Power Project Engineering Division,
Homibhabha Road, Colaba,
Bombay. 400 005.



Subject:- Requirement of make up water for Kakrapar Atomic Power Station.

Ref:- This department's letter of even number dated 21.3.83.

Sir,

I am directed to refer to your D.O. letter No.KAPP/40000/ /83/B/372 dated April,5, 1983 on the subject mentioned above and to confirm as under:-

(i) An uninterupted supply of 200 cusecs of water for Atomic Power station shall be maintained at all times.

(ii) The water level in the motichor pond shall be always be maintained higher than ± 45 mt. (GTS) at all times.

Yours faithfully,

(H.B.Trivedi)
Section Officer,
Irrigation Department.

Copy forwarded with compliments to:-

The Secretary (Power)
Industries, Mines and Power Department,
Sachivalaya, Gandhinagar with reference to his letter No.KAP-1182/601/267/K dated 11.7.83.

The Superintending Engineer,
Surat Irrigation Circle, Surat.

The Superintending Engineer,
Central Designs Organisation, Gandhinagar.

ANNEXURE-8

NO.APS-1188-7091-K.

Government of Gujarat,
Industries, Mines and Energy Department
Block No. 5
New Sachivalaya Complex,
Gandhinagar-382 010.

SECRET

MINISTRY OF INDUSTRIES MINES & ENERGY
GOVT. OF GUJARAT
GANDHINAGAR

Dt. 31.03.1989

ORDER

With the approval of Government of Gujarat, the appended two documents enlisted "Nuclear Off-site Emergency response plans of public authorities" are hereby authenticated :-

Vol. I, Part - I	:	Procedure for site and Off-site Emergency.
Vol. I, Part -III	:	Action Plan for off-site Emergency.

These plans shall be adopted for implementation by the public authorities so assigned as and when need arises.

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By Order and in the name of Governor of Gujarat

Amarjit Singh,
Dy. Secretary,
Ministry of Industries,
Mines & Energy
&

Member Secretary :
State Off-Site Emergency Response
Co-ordination Committee

FORWARD

The Nuclear Emergency Plan of the Government of Gujarat has been developed pursuant to the directions received from the Ministry of Science and Technology, Government of India. The National Emergency Response Committee was formed and based upon the guidelines received from the Committee meetings the off-site emergency preparedness plans were prepared. The State Emergency Response Committee was formed on 3rd Feb. 1987 to go in depth and carry out the excercises needed to demonstrate in around the Nuclear Installations to meet the unlikely off-site Emergency. The state level and district level officials interacted actively to prepare the off-site emergency plans :

All the Emergency Plans are documented thus :-

a) Volume I, Part I : Procedure for site and Off-Site Emergency.

b) Volume I, Part II : Action plan for site emergency

c) Volume I, Part III : Action plan for off-site Emergency.

d) Volume II, : Procedure and Action Plan for Plant Emergency.

Whereas Plant and Site Emergency procedure & action plans are restricted to the Nuclear Power plant personnel,the Off-site Emergency action plans call for action from public authorities.The enclosed two volumes therefore deal with how plant personnel and district level personnel would react to combat an Off-site Emergency in an effective manner.

(Y.S.R.PRASAD) 19/4/89
Chief Project Engineer
Kakrapar Atomic Power Project

Date : 31.03.1989.