"Environmental Impact Assessment of Thermal Power Plants"

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Prof. B. Padmanabhamurty, M. Sc, D.Sc.
Professor of Meteorology
School of Environmental Sciences
Jawaharlal Nehru University

New Delhi-110067

Date : 22-4-97.

To

Shri P.R.Menon,
Director (Technical),
Nagarjuna Fertilizers & Chemicals Ltd.,
Ngarjuna Hills,
Hyderabad - 500 082.

Sub: Location of additional air quality monitoring stations at Kakinada NFCL plant
Ref: Correspondence resting with my Lr.dated 31-3-97.

Dear Sir.

Summary of discussions during the Field visit to select additional air monitoring stations.

The additional locations arrived at theoretically numbering 21 (locations of the first four glc maxima in each of the four seasons and five points at the periphery in the north) are plotted on a map. Locations very close to the centre of the plant, to the sources of pollution and nearer to the existing air monitoring stations are avoided. The choice thus narrowed down to two clusters; one in the north-east comprising locations at 12,10, A3, A4, 9 & 11 and 8/14, 5/13,A1,A2 & 6/15. One station in the north-west, near the NFCL Main Security Gate, in between Point No.5/13 and A1 with coordinates N-2880 & E-1650 and another on top of the D.M.Plant in the north-east corner covering the points 9,10,11 & 12 with coordinates N-2880 & E-2380 are finally selected taking into full consideration the exposure, accessibility and utility. Station in the north-east also serves the additional purpose of identifying other polluting sources with the help of continuous records of wind speed and direction, in case of unusual deterioration of air quality. It is also suggested that after collection of air quality data from all the five stations (three existing + two presently proposed) for over an year, the data may be subjected to critical statistical analysis to eliminate redundancy in the stations and optimize their number.

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B Padmanabhamurthy

Prof.B.PADMANABHAMURTHY
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi-110067. (India)

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Location of additional air quality monitoring stations at NFCL Plant at Kakinada.

1.0 Introduction:

Ministry of Environment & Forests have stipulated while giving environmental clearnace to the expansion project of Nagarjuna Fertilizers & Chemicals Ltd at Kakinada that five ambient air quality monitoring stations be established in the site in consultation with State Pollution Control Board. Already three ambient air quality monitoring stations are in operation for the last five years. Two more stations are to be located. The present Report suggests, based on a scientific study, additional locations objectively.

2.0 Materials used:

2.1 Plant characteristics

The pollutants released from the Fertilizer Plant are SO_2, NO_x, SPM and NH_3. The present study is confined to SO_2 only. However, the results are equally applicable for all gaseous pollutants.

Stack No.	Stack Name	Coordinates X	Coordinates Y	Q	H	D	T	V
7.	Naptha Preheater	-375	923	0.8	30.2	0.75	723	5.72
8.	Feedstock Preheater	-375	826	0.3	30.2	1.2	723	7.15
9.	Primary Reformer	-361	708	3.48	40.0	3.1	443	8.64
3.	Staem generation	0	0	9.26	119.5	2.5	423	7.4
10.	HRSG - Stack C	-187	416	2.82	29.75	3.0	413	12.0

Q = Emission of SO_2 (gms/sec) 16.66

H = Height of stack (m)

D = Diameter of stack at the top (m)

T = Temperature of Flue gas at the exit (^oK)

V = Exit velocccity (m/s)

2.2 Meteorological data:

On-site hourly meteorological data collected during the last three years viz. 1994,1995 & 1996 are used for computing hourly ground level concentrations (GLC) of SO_2. The wind data is thoroughly scrutinized and anomolous data is deleted from the analysis. The data is stratified into four seasons viz. Winter (Jan + Feb), Pre-monsoon (March to May), Monsoon (June to September) and Post-monsoon (Oct. to Dec.)and wind roses are drawn. They are presented seriatim in Figs. 1 to 4. At the plant site winds are from North to East sector in Winter and Post-monsoon season. Southwesterlies are dominant during monsoon. In the pre-monsoon season winds are predominantly from southeast to southwest sector. The wind distribution suggests that the pollutants are likely to be transported towards southwest quadrant during winter and post-monsoon seasons, towards northeast quadrant during monsoon and towards northeast to west-north-west sector in the premonsoon season. As Bay of Bengal lies on the east, the locations of the monitoring stations are restricted to the western side of the land surface within the precincts of the plant only. The exact locations of the monitoring sites are suggested by the seasonal spatial distribution of SO_2 arrived at by a mathematical model.

3.0 The Model

Glc's in this report are calculated using AUSPLUME Model developed by the Victorian Environment Protection Authority, Australia which is based on US EPA's Industrial Source Complecx (ISC-ST) Model with the following additonal features.

-- simulates dispersion from single/multiple/area/volume sources
-- allows calculations to be made at a user specified regular rectangular/radial grid or at specified special receptors.
-- provides estimates of concentration for any averaging time period from 3 minutes to 59 minutes or 1,2,3,6,8,12,24 hours, 90 days, 3 months or the length of the meteorlogical data given.
-- allows calculations to be underwritten for source groups as selected by the user.
-- uses Pasquill-Gifford or Briggs dispersion curves as selected by the user, to derive the plume spread parameters.
-- adjusts dispersion curvess to account for user specified information on aerodynamic roughness of the local surface.
-- adjusts for wind speed variation with height, using user specified default urban/rural power law coefficients.
-- simulates dispersion from buoyant and non-buoyant point sources, non-buoyant area sources and non-buoyant volume sources.
-- simulates dry deposition using a simple tilted plume model with user specified reflection coefficients.
- simulates building wake effects
-- can include the effects of exponential decay
-- treats the effects of terrain either by assuming a straight line plume trajectory with increases in terrain height resulting in the decrease in the effective plume height or using the Egan half height method in which the plume centreline changes in response to terrain changes according to user specified (or default) coefficient which determine the strength of the plume coupling to the terrain.
-- uses Briggs' 1975 plume rise algorithm to calculate plume height.

With these assumptions the three dimensional concentration field due to steady point source in a uniform unbounded air flow is expressed as

$$\chi_{(x,y,z,T)} = \frac{Q}{2\pi u \sigma_y \sigma_z} \exp\left\{-\frac{y^2}{2\sigma_y^2}\right\} \exp\left\{-\frac{z^2}{2\sigma_z^2}\right\}$$

where

χ	concentration at a point (x,y,z) averaged over time T
x,y,z	distances downwind, crosswind and in vertical with the source at z = 0
Q	Emission rate of pollutants
u	wind speed
σ_y & σ_z	dispersion coefficients crosswind and vertical varying with x and T.

Considering the ground and base of elevated inversion as flat and perfectly reflecting surfaces, the above equation is modified by introducing an "imaginary source". For a non-buoyant plume source at a height H above the ground and no elevated inversion to restrict upward dispersion the above equation for ground level concentration (z=0) can be rewritten as

$$\chi_{(x,y,0,T)} = \frac{(1+h)Q}{2\pi u \sigma_y \sigma_z} \exp\left\{-\frac{y^2}{2\sigma_y^2}\right\} \exp\left\{-\frac{H^2}{2\sigma_z^2}\right\}$$

h = reflection coefficient.

Adding the extra sources to account for an inversion base at a height Hm > H above the ground, the expression becomes

$$\chi_{(x,y,0,T)} = \frac{(1+h)Q}{2\pi u \sigma_y \sigma_z} \exp\left\{-\frac{y^2}{2\sigma_y^2}\right\} \left[\exp\left\{-\frac{H^2}{2\sigma_z^2}\right\} + \sum_{n=1}^{\infty} h^{n-1}\left[\exp\left\{-\frac{(2nH_m-H)^2}{2\sigma_z^2}\right\} + h\exp\left\{-\frac{(2nH_m+H)^2}{2\sigma_z^2}\right\}\right]\right]$$

Alternatively, if the inversion base is below H (i.e H > Hm), is set to 0 to simulate the effect of a plume trapped in the inversion. These equations are derived on the assumption that the plume centre line remains at constant height H above flat terrain. When the plume height changes due to gravity, momentum/buoyancy loss or terrain effects, the local height H of the plume above the terrain is adjusted as H = H(x,y). The basic structure of the equation remains unchanged, but an algorithm is required to calculate H for each receptor. The plume rise is added to the difference in elevation (or height above sea level) from the receptor to give the first estimate of H (x,y). If the constituent material of the plumes settle under gravity, with settling velocity Vs, the estimate of H(x,y) is reduced by an amount $V_s x/u$ where V_s, u are the settling velocity and wind velocity respectively.

The parameter Q and Hm in the basic equations are the inputs into the model. When the pollutants reach the ground they are reflected back partly and partly absorbed. In the present report perfect reflection at the ground is assumed considered.

ISI recommended (IS 8829 (1978) with later ammendments in 1980 & 1983) Pasquill-Gifford stability classification, dispersion coefficients, wind escalation laws using Irwin exponents for Rural terrain are used in the model.

Spatial distribution of SO_2 in the four seasons suggested the following potential locations for air quality monitoring as they represent the maximum concentrations in the respective seasons. These are presented in Figs. 5 to 8 and tabulated below.

Season	Maximum glc (µg/m^3)	Co-ordinates X	Y
Winter	1.24	-300	-1500
Pre-monsoon	0.88	-1500	+1300
Monsoon	2.30	+1500	+400
Post-monsoon	1.21	-1100	-900

As these locations are outside the limits of NFCL and maintenance of such stations is wrought with innumerable difficulties, it was decided to locate the monitoring stations within the plant premises. Therefore, the modelling area is restricted to the following co-ordinates with the steam generator, being the maximum polluter, as the centre of the coordinate system i.e. 0,0.

East	upto 100 m.
West	upto 600 m.
North	upto 700 m.
South	upto 600 m.

As the distnace of modelling as well as the stacks are short, the plumes are unlikely to reach the mixing height (mean mixing height at Visakhapatnam which is the nearest station where data is available is never less than 1200 m. in any saeason),glc's are computed under unlimited mixing conditions only.

5.0 Results:

Figs 9 to 12 show the isopleths of SO_2 within the premises of the Industry. The primary, secondary and tertiary maximum concentrations with their coordinates in different seasons are given below.

Season	Winter	Pre-monsoon	Monsoon	Post-monsoon
Maximum glc. (g/m^3)				
Primary	4.16 (-400, +700)	0.88 (-600, +700)	1.63 (100, 700)	2.34 (-600, +700)
Secondary	3.62 (-200, +400)	0.79 (-500, +700)	1.53 (0, 700)	2.19 (-600, +600)
Tertiary	2.0 (-100, +400)	0.75 (-300, +700)	1.39 (100, 600)	2.07 (-500, +700)
Fourth	1.95 (-300, +700)	0.70 (-600, +600)	1.26 (0, +600)	1.99 (-600, +500)

5.0 Conclusion

The above nine locations are potential monitoring sites within the premises of the Fertilizer plant. Sites which are closer to the existing monitoring stations may be avoided.Two out of the remaining six choices may be selected by visiting the plant site taking into consideration the safety of equipment, approachability in all seasons by day and night, infrastructural facilities like uninterrupted power supply and water, communication and transport in case of emergency, personnel security etc.

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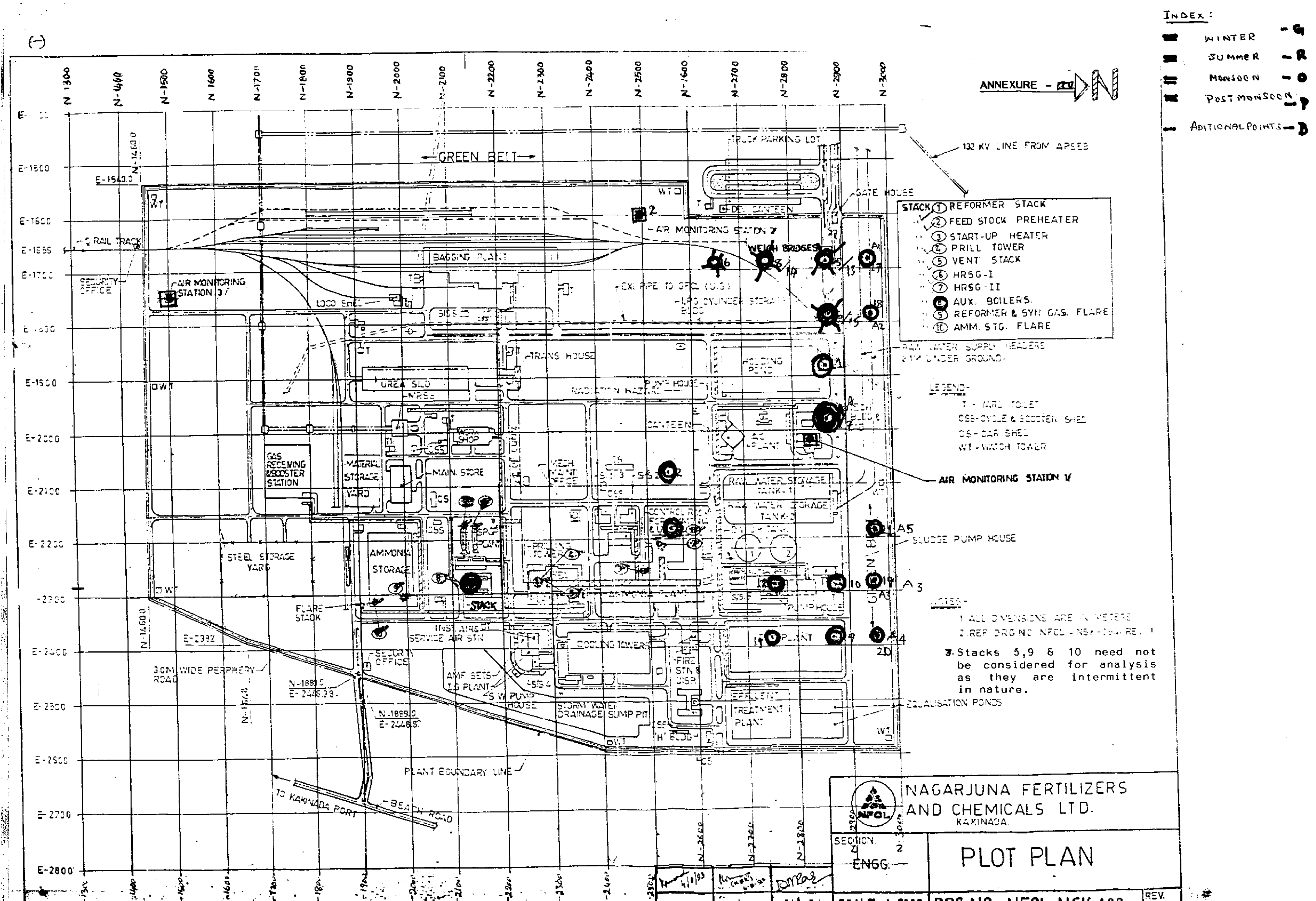
ANNEXURE - IV



INDEX:
WINTER - G
SUMMER - R
MONSOON - O
POST MONSOON - P
ADITIONAL POINTS - B
ANNEXURE - IV
N
132 KV LINE FROM APSEB
STACK ① REFORMER STACK
② FEED STOCK PREHEATER
③ START-UP HEATER
④ PRILL TOWER
⑤ VENT STACK
⑥ HRSG-I
⑦ HRSG-II
⑧ AUX. BOILERS.
⑨ REFORMER & SYN GAS. FLARE
⑩ AMM. STG. FLARE
RAW WATER SUPPLY HEADERS (TO UNDER GROUND)
LEGEND-
T - MALE TOILET
CSS-CYCLE & SCOOTER SHED
CS- CAR SHED
WT-WATCH TOWER
AIR MONITORING STATION IV
SLUDGE PUMP HOUSE
NOTES-
1 ALL DIMENSIONS ARE IN METERS
2 REF DRG NO NFCL-NS/-CIVIL-RE 1
3 Stacks 5,9 & 10 need not be considered for analysis as they are intermittent in nature.
EQUALISATION PONDS
TRUCK PARKING LOT
GATE HOUSE
GREEN BELT
AIR MONITORING STATION II
WEIGH BRIDGES
AIR MONITORING STATION III
RAIL TRACK
SECURITY OFFICE
BAGGING PLANT
LOCO SHED
EXI PIPE TO GFCL (U.G)
LPG CYLINDER STORAGE BLDG
TRANS HOUSE
HOLDING POND
UREA SILO
RADIATION HAZARD
PUMP HOUSE
CANTEEN
A/C PLANT
GAS RECEIVING & BOOSTER STATION
MATERIAL STORAGE YARD
MAIN STORE
RAW WATER STORAGE TANK-1
RAW WATER STORAGE TANK-2
CONTROL ROOM
STEEL STORAGE YARD
AMMONIA STORAGE
STACK
PRILLING TOWER
AMMONIA PLANT
PUMP HOUSE
FLARE STACK
INST. AIR & SERVICE AIR STN
COOLING TOWERS
FIRE STN & DISP.
30M WIDE PERIPHERY ROAD
N-1889.5 E-2448.38
N-1889.0 E-2448.5
AMF SETS I.G PLANT
S W PUMP HOUSE
STORM WATER DRAINAGE SUMP PIT
EFFLUENT TREATMENT PLANT
PLANT BOUNDARY LINE
TO KAKINADA PORT
BEACH ROAD
N-1300 N-1400 N-1500 N-1600 N-1700 N-1800 N-1900 N-2000 N-2100 N-2200 N-2300 N-2400 N-2500 N-2600 N-2700 N-2800 N-2900 N-3000
E-1500 E-1600 E-1655 E-1700 E-1900 E-2000 E-2100 E-2200 E-2300 E-2400 E-2500 E-2600 E-2700 E-2800
NAGARJUNA FERTILIZERS AND CHEMICALS LTD.
KAKINADA.
SECTION
ENGG.
PLOT PLAN
REV.