Annex 5.2
DHA Water Dispersion Modeling

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IX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                     CORMIX MIXING ZONE EXPERT SYSTEM
                         CORMIX Version 5.0GT
                     HYDRO1:Version  March,2007
SITE NAME/LABEL:                  DHA Cogen,  Karachi
  DESIGN CASE:                    Water Dispersion modeling
  FILE NAME:                      C:\Program Files\CORMIX 5.0\DHA Cogen\DHA-1.prd
  Using subsystem CORMIX1:       Single Port Discharges
  Start of session:               11/04/2008--13:52:41
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                              = unbounded
  Average depth                     HA       = 8 m
  Depth at discharge                HD       = 8 m
  Ambient velocity                  UA       = 2 m/s
  Darcy-Weisbach friction factor    F        = 0.0157
    Calculated from Manning's n              = 0.02
  Wind velocity                     UW       = 2 m/s
  Stratification Type               STRCND   = U
  Surface temperature                        = 31 degC
  Bottom temperature                         = 31 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                   RHOAS    = 995.3405 kg/m^3
  Bottom density                    RHOAB    = 995.3405 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:               Single Port Discharge
  Nearest bank                               = left
  Distance to bank                  DISTB    = 100 m
  Port diameter                     D0       = 0.35 m
  Port cross-sectional area         A0       = 0.0962 m^2
  Discharge velocity                U0       = 1008.20 m/s
  Discharge flowrate                Q0       = 97 m^3/s
  Discharge port height             H0       = 6.5 m
  Vertical discharge angle          THETA    = 0 deg
  Horizontal discharge angle        SIGMA    = 0 deg
  Discharge temperature (freshwater)         = 40 degC
  Corresponding density             RHO0     = 992.2107 kg/m^3
  Density difference                DRHO     = 3.1298 kg/m^3
  Buoyant acceleration              GP0      = 0.0308 m/s^2
  Discharge concentration           C0       = 40 deg.C
  Surface heat exchange coeff.      KS       = 0.000000 m/s
  Coefficient of decay              KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.31 m          Lm  = 156.36 m          Lb  = 0.37 m
  LM  = 3197.59 m       Lm' = 99999 m           Lb' = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number    FR0      = 9704.69
  Velocity ratio                    R        = 504.10
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                            = no
  Water quality standard specified           = no
  Regulatory mixing zone                     = yes
  Regulatory mixing zone specification       = distance
  Regulatory mixing zone value               = 500 m (m^2 if area)
  Region of interest                         = 400 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = IPH5   |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 8 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):
-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    100 m from the left bank/shore.
  Number of display steps NSTEP = 10 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.1592 deg.C
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  Dilution at edge of NFR                  s = 251.3
  NFR Location:                            x = 2464.68 m
    (centerline coordinates)               y = 0 m
                                           z = 8 m
  NFR plume dimensions:  half-width (bh) = 203.75 m
                         thickness (bv) = 8 m
Cumulative travel time:       1308.1282 sec.
------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
------------------------------------------------------------------------
Near-field instability behavior:
  The discharge flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
------------------------------------------------------------------------
Weak contact/interaction of the discharge plume with one bank/shore occurs
  within the NFR.
------------------------------------------------------------------------
The REGION OF INTEREST (ROI) specification occurs before the near-field
  mixing (NFR) regime has been completed.  Specification of ROI is highly
  restrictive.
------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 0 m
  downstream and continues as vertically mixed into the far-field.
------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 0 m downstream.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration                c = 0.367347  deg.C
  Corresponding dilution                 s = 110.6
  Plume location:                        x = 500 m
    (centerline coordinates)             y = 0 m
                                         z = 8 m
  Plume dimensions:        half-width (bh) = 46.01 m
                           thickness (bv) = 8 m
Cumulative travel time < 1308.1282 sec. (RMZ is within NFR)
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
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CORMIX1 PREDICTION FILE:
1111111111111111111111111111111111111111111111111111111111111111111111111111111
                         CORMIX MIXING ZONE EXPERT SYSTEM
                Subsystem CORMIX1:  Single Port Discharges
                             CORMIX Version 5.0GT
                         HYDRO1 Version 5.0.0.0 March 2007
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   DHA Cogen,  Karachi
 Design case:       Water Dispersion modeling
 FILE NAME:         C:\Program Files\CORMIX 5.0\DHA Cogen\DHA-1.prd
 Time stamp:        Tue Nov  4 13:52:41 2008

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =       8.00  HD    =       8.00
 UA    =      2.000  F     =      0.016 USTAR =0.8860E-01
 UW    =      2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U          RHOAM =  995.3405

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT       DISTB =     100.00
 D0    =      0.350  A0    =      0.096 HD    =       6.50  SUB0  =       1.50
 THETA =       0.00  SIGMA =       0.00
 U0    =   1008.198  Q0    =     97.000       =0.9700E+02
 RHO0  =  992.2107   DRHO0 =0.3130E+01  GP0   =0.3084E-01
 C0    =0.4000E+02   CUNITS=  deg.C
 IPOLL =  3          KS    =0.3583E-06  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.9700E+02   M0    =0.9780E+05  J0    =0.2991E+01  SIGNJ0=       1.0
 Associated length scales (meters)
 LQ    =       0.31  LM    =    3197.59 Lm    =     156.36  Lb    =       0.37
                                        Lmp   =   99999.00  Lbp   =   99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =    9704.69  R     =     504.10

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =    IPH5   1
 1  Applicable layer depth HS =     8.00   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.4000E+02  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  1
 REGSPC=  1          XREG  =     500.00  WREG  =       0.00  AREG  =       0.00
 XINT  =     400.00  XMAX  =     500.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
       100.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-------------------------------------------------------------------------------

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

 COANDA ATTACHMENT immediately following the discharge.

        X        Y        Z          S       C          B
      0.00     0.00     8.00       1.0 0.400E+02    0.25

END OF MOD101: DISCHARGE MODULE
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Surface-attached jet motion.
   UNSTABLE NEAR-FIELD: Jet/plume will mix over full layer depth.
   Following MOD133 will include recirculation into jet region.

 Profile definitions:
```

B = Gaussian 1/e (37%) half-width, normal to trajectory
Half wall jet, attached to bottom.
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

X	Y	Z	S	C	B
0.00	0.00	8.00	1.0	0.400E+02	0.18
7.44	0.00	8.00	3.4	0.118E+02	1.00
14.88	0.00	8.00	6.2	0.649E+01	1.80
22.32	0.00	8.00	8.9	0.447E+01	2.60
29.76	0.00	8.00	11.7	0.341E+01	3.39
37.20	0.00	8.00	14.6	0.275E+01	4.18
44.72	0.00	8.00	17.4	0.230E+01	4.96
52.16	0.00	8.00	20.2	0.198E+01	5.73
59.60	0.00	8.00	23.1	0.173E+01	6.49
67.04	0.00	8.00	25.9	0.154E+01	7.25
74.48	0.00	8.00	28.7	0.139E+01	8.00

Cumulative travel time = 0.8769 sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD133: LAYER BOUNDARY IMPINGEMENT/FULL VERTICAL MIXING

Control volume inflow:

X	Y	Z	S	C	B
74.48	0.00	8.00	28.7	0.139E+01	8.00

Profile definitions:
BV = layer depth (vertically mixed)
BH = top-hat half-width, in horizontal plane normal to trajectory
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic average (bulk) dilution
C = average (bulk) concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH	ZU	ZL
66.48	0.00	8.00	28.7	0.139E+01	0.00	0.00	8.00	8.00
68.08	0.00	8.00	28.7	0.139E+01	8.00	2.22	8.00	0.00
69.68	0.00	8.00	28.7	0.139E+01	8.00	3.14	8.00	0.00
71.28	0.00	8.00	28.7	0.139E+01	8.00	3.84	8.00	0.00
72.88	0.00	8.00	28.7	0.139E+01	8.00	4.44	8.00	0.00
74.48	0.00	8.00	28.7	0.139E+01	8.00	4.96	8.00	0.00
76.08	0.00	8.00	30.4	0.131E+01	8.00	5.44	8.00	0.00
77.68	0.00	8.00	34.2	0.117E+01	8.00	5.87	8.00	0.00
79.28	0.00	8.00	37.5	0.107E+01	8.00	6.28	8.00	0.00
80.88	0.00	8.00	39.3	0.102E+01	8.00	6.66	8.00	0.00
82.48	0.00	8.00	40.2	0.994E+00	8.00	7.02	8.00	0.00

Cumulative travel time = 1.4539 sec

END OF MOD133: LAYER BOUNDARY IMPINGEMENT/FULL VERTICAL MIXING

BEGIN MOD153: VERTICALLY MIXED PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The plume is VERTICALLY FULLY MIXED over the entire layer depth.
Profile definitions:
BV = layer depth (vertically mixed)
BH = Gaussian 1/e (37%) half-width in horizontal plane normal to trajectory
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH	ZU	ZL
82.48	0.00	8.00	40.2	0.994E+00	8.00	6.52	8.00	0.00
320.70	0.00	8.00	88.2	0.454E+00	8.00	29.64	8.00	0.00

** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
In this prediction interval the plume DOWNSTREAM distance meets or exceeds
the regulatory value = 500.00 m.
This is the extent of the REGULATORY MIXING ZONE.

558.92	0.00	8.00	118.0	0.339E+00	8.00	51.39	8.00	0.00
797.14	0.00	8.00	141.7	0.282E+00	8.00	72.25	8.00	0.00
1035.36	0.00	8.00	162.0	0.247E+00	8.00	92.42	8.00	0.00
1273.58	0.00	8.00	180.0	0.222E+00	8.00	112.02	8.00	0.00
1511.80	0.00	8.00	196.3	0.204E+00	8.00	131.14	8.00	0.00
1750.02	0.00	8.00	211.4	0.189E+00	8.00	149.83	8.00	0.00
1988.24	0.00	8.00	225.5	0.177E+00	8.00	168.14	8.00	0.00
2226.46	0.00	8.00	238.7	0.168E+00	8.00	186.10	8.00	0.00
2464.68	0.00	8.00	251.3	0.159E+00	8.00	203.75	8.00	0.00

Cumulative travel time = 1308.1279 sec

Entire region is occupied by Phase 1.
Plume does not re-stratify in this flow region.

END OF MOD153: VERTICALLY MIXED PLUME IN CO-FLOW

** End of NEAR-FIELD REGION (NFR) **

At the end of the NFR, the plume POSITION EXCEEDS SPECIFIED LIMITS
for the regulatory mixing zone (RMZ) and/or the region of interest (ROI).
Specifications may be overly restrictive.
Use larger ROI values in subsequent iteration!
SIMULATION ENDS.

The initial plume WIDTH values in the next far-field module will be
CORRECTED by a factor 3.74 to conserve the mass flux in the far-field!
The correction factor is quite large because of the small ambient velocity
relative to the strong mixing characteristics of the discharge!
This indicates localized RECIRCULATION REGIONS and internal hydraulic JUMPS.
Width predictions show discontinuities, dilution values should be acceptable.

In this design case, the discharge is located CLOSE TO BANK/SHORE.
Some boundary interaction occurs at end of near-field.
This may be related to a design case with a very LOW AMBIENT VELOCITY.
The dilution values in one or more of the preceding zones may be too high.
Carefully evaluate results in near-field and check degree of interaction.

Consider locating outfall further away from bank or shore.

CORMIX1: Single Port Discharges End of Prediction File
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*************************** FLOW CLASS DESCRIPTION ***************************

The following description of flow class IPH5 applies to the FULL WATER DEPTH at the discharge site.

FLOW_CLASS_IPH5

A sligthly submerged positively buoyant effluent issues horizontally or near-horizontally from the discharge port. The discharge is cross-flowing or counterflowing with respect to the ambient current.

The discharge configuration is hydrodynamically "unstable", that is the discharge strength (measured by its momentum flux) dominates the flow in relation to the limited layer depth. The effect of buoyancy is negligible and the initial discharge is usually attached to the surface.

This may be a complicated and perhaps undesirable discharge configuration. The laterally discharging jet the tends toward full vertical mixing and will block the ambient flow. This will cause a recirculating eddy region downstream of the discharge.

1) Momentum-dominated near-field jet (surface-attached): The flow is dominated by the effluent momentum (jet-like). The jet attaches to the surface and is weakly advected by the ambient flow.

2) Strongly deflected wall jet: After some distance, the surface jet is strongly deflected and advected by the ambient flow. (This flow region may be absent for very shallow water depths.)

3) Layer boundary contact / full vertical mixing: After some distance the jet has grown vertically over the full layer depth. From now on the flow is vertically mixed, but may re-stratify later on.

4) Vertically mixed plume in cross-flow: The discharge induced momentum flux is still controlling the flow. However, lateral entrainment and diffusion lead to a spreading of the plume and additional mixing. Initially, the plume is cross-flowing, but it becomes progressively deflected into the direction of the ambient flow. At the beginning, the plume is vertically mixed over the full layer depth. At some distance, re-stratification may take place depending on the strength and direction of the plume buoyancy.

*** The zones listed above constitute the NEAR-FIELD REGION in which strong initial mixing takes place. ***

5) Buoyant spreading at layer boundary: The plume spreads laterally along the layer boundary (bottom or pycnocline) while it is being advected by the ambient current. The plume thickness may decrease during this phase. The mixing rate is relatively small. The plume may interact with a nearby bank or shoreline.

6) Passive ambient mixing: The vertically fully mixed plume is further advected by the ambient flow and spreads laterally through turbulent diffusion. The plume may interact laterally with any nearby bank or shoreline.

*** Predictions will be terminated in zones 5 or 6 depending on the definitions of the REGULATORY MIXING ZONE or the REGION OF INTEREST. ***

SPECIAL CASE: If the ambient is stagnant, so that advection and diffusion by the ambient flow (zones 5 and 6) cannot be considered. The mixing is limited to the discharge-induced mixing zones (zones 1 and 2) and the predictions will be terminated at this stage. Such predictions will present a conservative lower bound on the mixing capacity as they neglect any further mixing beyond the stage where the jet has grown to the full layer depth. Such stagnant water predictions may be a useful initial mixing indicator for a given site and discharge design.

For practical final predictions, however, the advection and diffusion of the ambient flow - no matter how small in magnitude - should be considered.

END OF FLOW CLASS DESCRIPTION ***

CORMIX1 **
DESIGN RECOMMENDATIONS: SINGLE PORT DISCHARGES:

A reliable environmental analysis and mixing zone prediction is possible only if each design case is evaluated through several iterations of CORMIX1. Small changes in ambient or discharge design conditions can sometimes cause drastic shifts in the applicable flow configuration (flow class) and the size or appearance of mixing zones. Iterative use of CORMIX1 will give information on the sensitivity of predicted results on design and ambient conditions.

Each predictive case should be carefully assessed as to:
- size and shape of RMZ,
- conditions in the TDZ (if present),
- bottom impact of the discharge flow,
- water surface exposure,
- bank attachment, and other factors.

In general, iterations should be conducted in the following order:
A) Discharge design changes (geometry variations)
B) Sensitivity to ambient conditions
C) Discharge flow changes (process variations)

When investigating these variations the CORMIX1 user will quickly appreciate the fact that mixing conditions at short distances (near-field) are usually quite sensitive and controllable. In contrast, mixing conditions at large distances (far-field) often show little sensitivity unless the ambient conditions change substantially or drastic process variations are introduced.

A) DISCHARGE DESIGN CHANGES (GEOMETRY VARIATIONS):
Most of the following recommendations are motivated by the desire of improving conditions in the applicable mixing zones (i.e. minimizing concentrations and/or areal extent):

1) Outfall location: Consider moving the discharge farther offshore to a larger water depth in order to delay flow interaction with the bank and/or surface, and to improve near-field mixing.

2) Height of discharge port: For positively buoyant or neutral discharges it is usually desirable to minimize the port height in order to provide a long submerged jet/plume trajectory. However, undesirable flow bottom attachment may result if the port height is too small. A typical range for port heights is from two to ten diameters. For negatively buoyant discharges, on the other hand, it may be desirable to maximize the port height. Navigational requirements may put further limits on large port heights.

3) Vertical angle of discharge (THETA): Near-field dilution for positively or neutrally buoyant discharges is often improved by providing a near-horizontal discharge. In order to prevent bottom interference a slight upward orientation (in the range of +15 to +30 degrees) may be advisable. In contrast, a vertical or near-vertical angle may be favorable for negatively buoyant discharges.

4) Horizontal angle of discharge (SIGMA): This angle provides the discharge orientation relative to the ambient current. A co-flow design (angle of about 0 degrees) or a cross-flow design (about 90 or 270 degrees, respectively) are preferable. A counter-flow design (about 180 degrees) is undesirable from the viewpoint of mixing zone predictability and bottom impacts. Cross-flow designs may be particularly effective in optimizing near-field mixing, and if they are chosen, the port should point in the offshore direction.

5) Port diameter/area (discharge velocity): Remember that for a given discharge flow rate the port area and discharge velocity are inversely related: a small discharge port implies a high discharge velocity, and a consequently high discharge momentum flux. Typically, a high velocity discharge will maximize near-field mixing. Note, however, that high velocity discharges a) may lead to unstable near-field flow configurations perhaps involving undesirable mixing patterns, and b) usually have little, if any, effect on dilutions over the far-field where a RMZ may apply. Discharge velocities in typical engineering designs may range from 3 m/s to 8 m/s. Very high velocities may lead to excessive pumping energy requirements. Very low velocities (less than 0.5 m/s) may lead to undesirable sediment accumulation within the discharge pipe.

B) SENSITIVITY TO AMBIENT CONDITIONS:
Variations - of the order of 25 percent - of the following ambient design conditions should be considered:
- ambient velocity (or ambient flowrate),
- ambient depth (or river/tidal stage), and
- ambient density structure (notably density differences).

Such variability is important for two reasons:
1) the usual uncertainty in ambient environmental data, and
2) the schematization employed by CORMIX.

Please refer to the detailed advice on the specification of environmental data, including the density structure, that is available in program element DATIN. In particular, note the advisory comments on stagnant ambient conditions.

C) DISCHARGE FLOW CHANGES (PROCESS VARIATIONS):
Actual process changes can result in variations of one or more of three parameters associated with the discharge: flowrate, density, or pollutant concentration. In some cases, such process changes may be difficult to achieve or too costly. Note, that "off-design" conditions in which a discharge operates below its full capacity also fall into this category.

1) Pollutant mass flux: The total pollutant mass flux is the product of discharge flow (m^3/s) times the discharge pollutant concentration (in arbitrary units). Thus, decreasing the pollutant mass flux will, in general, decrease the resulting pollutant concentration in the near-field and far-field. This occurs, of course, during off-design conditions.

2) Discharge flow: For a given pollutant mass flux, an increase in discharge flow implies an increase in discharge pollutant concentration, and vice versa. For the variety of flow classes contained in CORMIX1 there is no universal rule whether high or low volume discharges are preferable for optimizing near-field mixing. Mostly, the sensitivity is small, and even more so for far-field effects. Note that a change in discharge flow will influence, in turn, the discharge velocity and hence the momentum flux.

3) Discharge density: The actual density of the discharge flow controls the buoyancy effects relative to the ambient water. Occasionally, the discharge density is controllable through the amount of process heating or cooling occurring prior to discharge. Usually, near-field mixing is enhanced by maximizing the total density difference (positive or negative) between discharge flow and ambient water. In most cases, however, this effect is minor.

END OF DESIGN RECOMMENDATIONS ***

Date: 11/04/08
Time: 13:52:41

Design Case: Water Dispersion modeling
Site Name: DHA Cogen, Karachi
Prepared By: Dr. Muhammad Hanif

Project Notes:

VALIDATING INPUT DATA ...

Checking Pages for invalid or missing inputs...

Effluent Page has been validated.
Ambient Page has been validated.
Discharge Page has been validated.
Mixing Zone Page has been validated.

Finished checking Pages for invalid or missing inputs.

Loading Correct RuleBases

Validating RuleBases ...

AMBIENT DATA

Equivalent Darcy-Weisbach friction factor = 0.016

Ambient density = 995.3405 kg/m^3.

Ambient Rule Base has been validated.

DISCHARGE DATA:
CORMIX1: Single Port Discharges

Port cross-sectional area A0 = 0.096 m^2.

Discharge flowrate Q0 = 97 m^3/s.

Discharge velocity U0 = 1008.198 m/s.
Note:
Discharge Velocity (U0) < 2.5 m/s may in some cases be recommended to avoid possible adverse conditions for sensitive fish populations.

This is a Slightly Submerged or Above Surface Discharge, where the height of the discharge port (H0 = 6.5 m) and the local ambient water depth (HD = 8 m).

The submergence of the port below the water surface is SUB0 = 1.5 m.

Discharge density RHO0 = 992.2107 kg/m^3.

The kinematic heat exchange coefficient (transfer velocity) is 0.0000004 m/s.

Discharge Rules for CORMIX1 have been validated

MIXING ZONE SPECIFICATION:

REGULATORY MIXING ZONE (RMZ) Specifications:

In general practice, there are two possible interpretations for the RMZ:

Interpretation 1: The RMZ is a spatially defined (by State/Federal agencies) restricted region at whose boundary a specified water quality standard for conventional pollutants - or the CCC for toxic pollutants - has to be met.

Interpretation 2: The applicant or the State/Federal agency may propose on an ad-hoc basis an RMZ as that region at whose boundary a water quality standard - or CCC - has been demonstrated to be met. That demonstration is usually made by means of a mixing zone prediction.

CORMIX will evaluate the RMZ conditions on the basis of both interpretations.

Mixing Zones Rule Base has been validated.

Finished validating RuleBases.

Calculating Parameters.

FLOW PARAMETERS AND LENGTH SCALES:

Relative density differences between discharge and ambient:

Ambient density at the discharge level RHOAH0 = 995.3405 kg/m^3.
Vertical mean ambient density RHOAM = 995.3405 kg/m^3.

The effluent density (992.2107 kg/m^3) is less than the surrounding ambient water density at the discharge level (995.3405 kg/m^3).

Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

Flow bulk parameters:

Discharge volume flux Q0 = 37 m^3/s.
Discharge momentum flux M0 = 97795.19082 m^4/s^2.

Discharge buoyancy flux J0 = 2.991106 m^4/s^3.

Flow length scales:

Jet-to-crossflow length scale Lm = 156.36 m.

Plume-to-crossflow length scale Lb = 0.37 m.

Discharge length scale LQ = 0.3102 m.

Jet-to-plume transition length scale LM = 3197.59 m.

Non-dimensional parameters:

Densimetric Froude number FR0 = 9704.69
Jet/crossflow velocity ratio R = 504.10

Parameters for CORMIX1 have been calculated

Classifying Flows.

FLOW CLASSIFICATION:

CORMIX1 includes SIX MAJOR CLASSES of possible flow configurations:
Classes S, IS : Flows trapped in a layer within linear stratification.
Classes V, H : Near Bottom, Positively buoyant flows in a uniform density layer.
Classes IV, IH : Near Surface, Negatively buoyant flows in a uniform density layer.
Classes NV, NH : Near Bottom, Negatively buoyant flows in uniform density layer.
Classes IPV,IPH: Near Surface, Positively buoyant flows in uniform density layer.
Classes A, AI : Flows affected by dynamic bottom or surface attachment.

The NEAR FIELD FLOW will have the following features:

The discharge near-field behavior is dominated by either the positive buoyancy of the discharge or the upward vertical orientation of the discharge port leading to surface interaction.

The discharge flow will experience instabilities with full vertical mixing in the near-field. There may be benthic impact of high pollutant concentrations.

The following conclusion on the NEAR-FIELD FLOW CONFIGURATION applies to a layer corresponding to the FULL WATER DEPTH at the discharge site:

*** FLOW CLASS = IPH5 ***

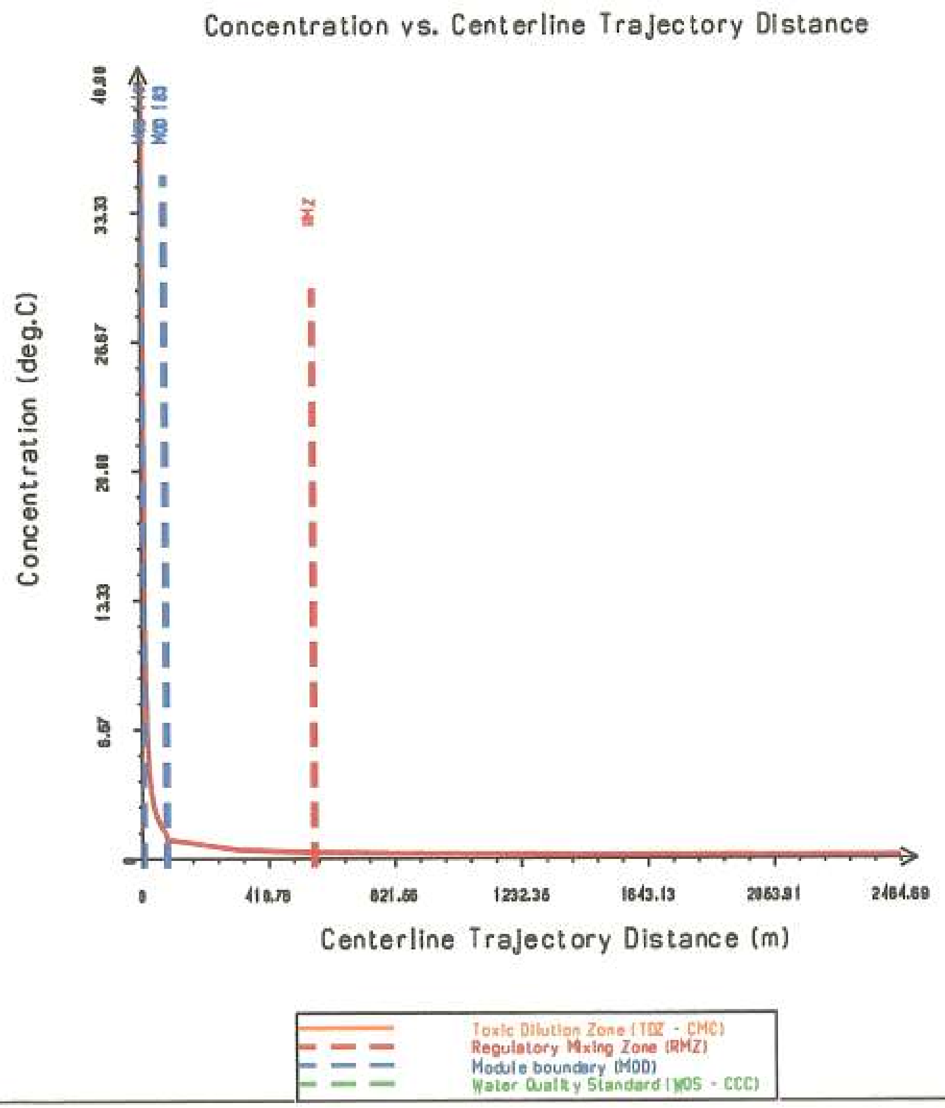
Applicable layer depth HS = 8 m.

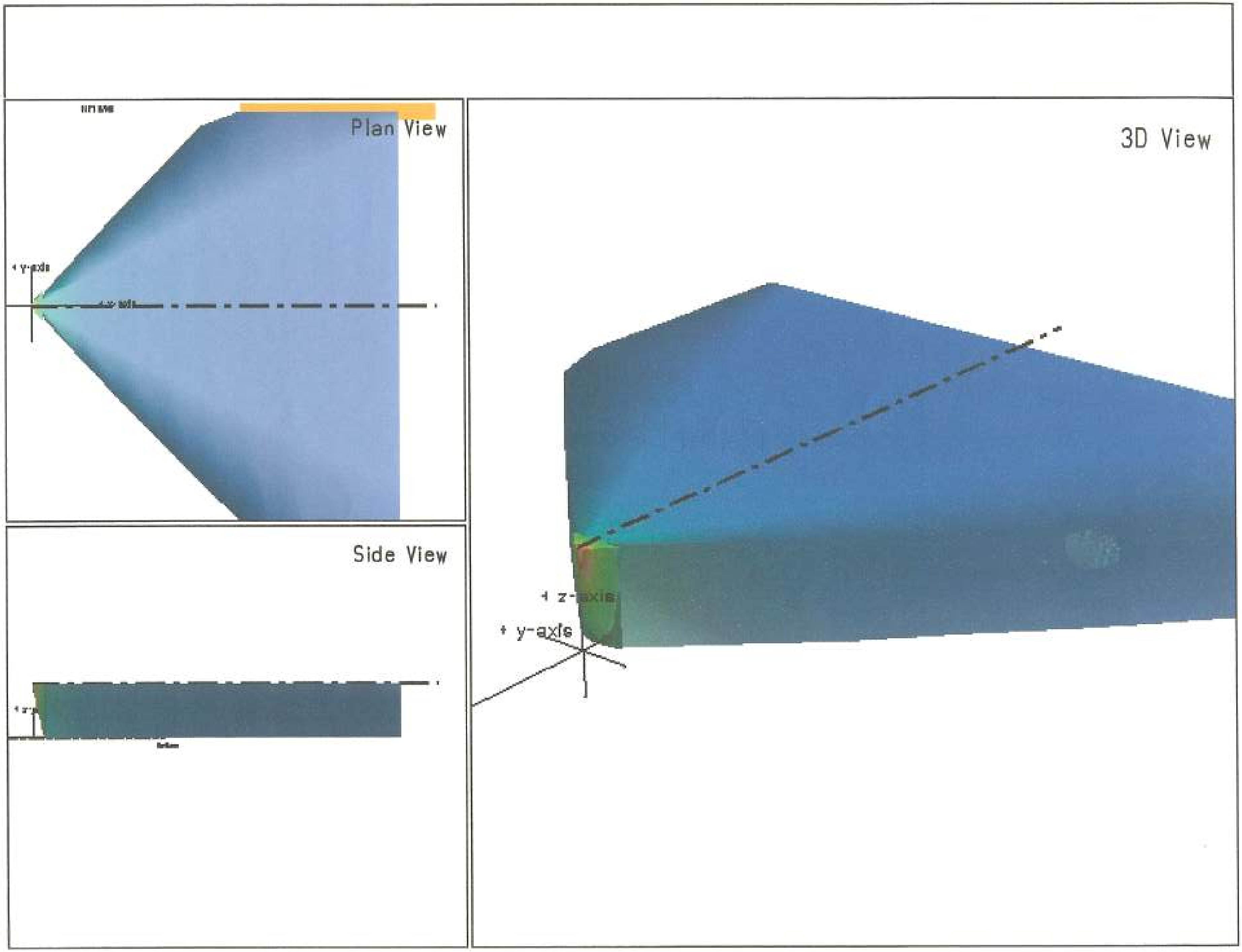
Flow has been classified.

Executing the simulation... FORTRAN simulation complete.

Generating Session Report... Session Report complete.

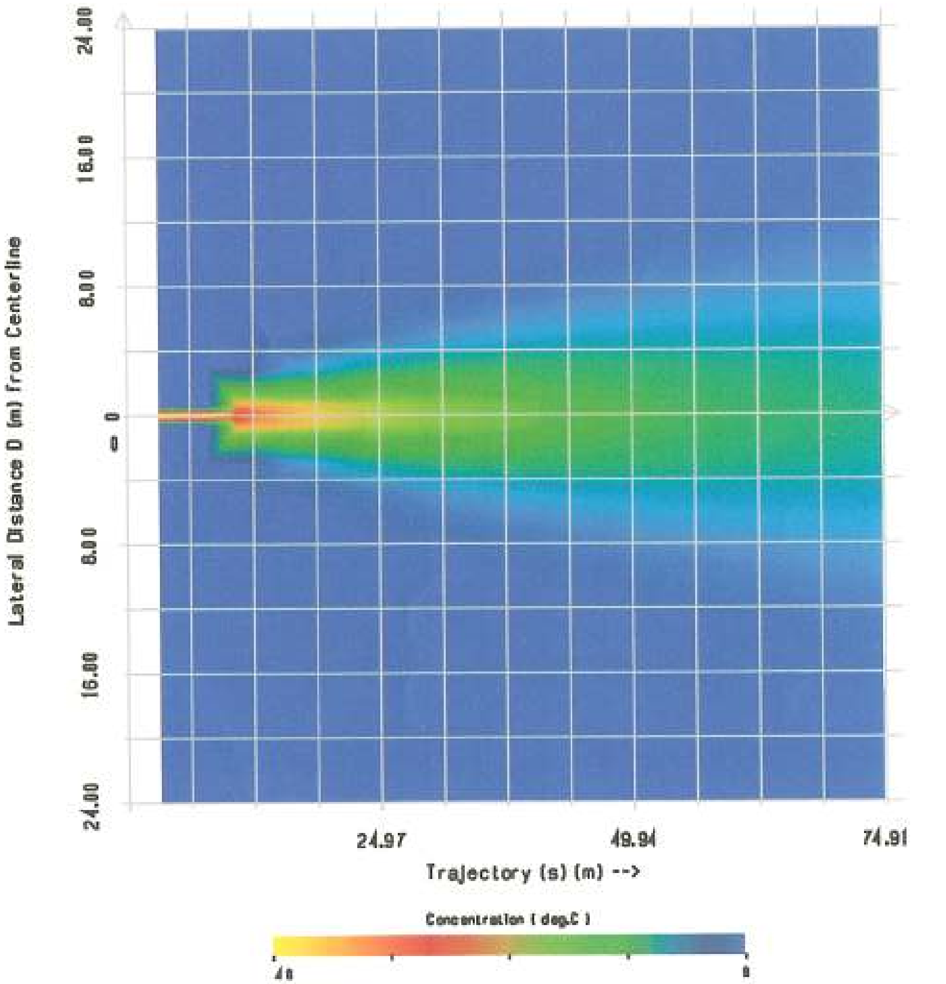
DHA	Cormix1 Simulation
Water Dispersion modeling	DHA Cogen\DHA-1.prd
Time of Run: Tue Nov 4 13:52:41 2008	Flow Class: IPH5




Plan View
+ y-axis
Side View
3D View
+ z-axis
+ y-axis

DHA Water Dispersion modeling Time of Run: Tue Nov 4 13:52:41 2008	Cormix1 Simulation DHA Cogen\DHA-1.prd Flow Class: IPH5

Concentration Profile - Trajectory (s) vs. Lateral Distance D (m) from Plume Centerline



Distortion D:X = 1.600 : 2.497
Right Click to change Scale Value. Currently = 3.00 : 1.00 (Y:D)