FIGURE 6.1

AHRDS Design for Rapel
Meridional View with Streamlines

FIGURE 6.2

AHRDS Blade Design
for Rapel

FIGURE 6.3

Suction Side Pressure Pattern,
107 cms, 24.5 m Tailwater

****** RAPEL ******

-9.8 -5.6 -1.3 2.9 7.2 11.4 15.7 19.9 24.2 28.4 32.7

Pressure Plot

FIGURE 6.4

Suction Side Pressure Pattern
115 cms, 24.5 m Tailwater

FIGURE 6.5

Suction Side Pressure Pattern
115 cms, 23.5 m Tailwater

FIGURE 6.6

Suction Side Pressure Pattern
117 cms, 24.5 m Tailwater

Rapel High Power Performance
Turbine Efficiency & Turbine Discharge Vs. Turbine Output
at 72.3m (237.2ft) , 75.5m (247.7ft) and 78.8m (258.53ft)
Turbine Efficiency (%)
Turbine Discharge (cms)
Turbine Output (MW)
High Load Cavitation
Low Load Cavitation
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95

Figure 6.7

Rapel Base Case Performance
Turbine Efficiency & Turbine Discharge Vs. Turbine Output
at 72.3m (237.2ft) , 75.5m (247.7ft) and 78.8m (258.53ft)
Turbine Efficiency (%)
Turbine Discharge (cms)
Turbine Output (MW)
High Load Cavitation
Low Load Cavitation
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
20
25
30
35
40
45
50
55
60
65
70
75
80
85

Figure 6.8

FIGURE 6.9

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ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

531-05-178 **AHC**

EFFICIENCY CURVES

FIGURE 6.10

N11 [rpm]
100* Q11 [m3/s]
0.923
MODEL EFFICIENCY HILLCHART RUNNER :
D_ref_m = 0.40378 m Nm = 823 rpm at plant sigma
SHEET No:531-05-166
N11_opt = 73.25 Q11_opt = 1.123 m3/s Eta_m* opt = .927
Relief holes open, model setting Runner DJ2b & Nosecone NC2 & Stay vanes SV1
Scale up Sheet No ; Measuring date
MODEL EFFICIENCY Eta_m * (Re = 9.6 E06)
WICKET GATE OPENING [deg]
POWER FACTOR P11
Hp min = 36.13 m
Hp nom = 39.63 m
Hp max = 40.38 m
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FIGURE 6.11

531-06-104 **AHC**

Cavitation: Hp = 39.63 [m], Pp = 49.05 [MW]

531-06-147 **AHC**

Cavitation: Hp = 40.38 [m], Pp = 50.4 [MW]

531-06-147 (Hp=40.38, Pp=50.4 MW)