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Three-Dimensional Flow Analysis Inside Consortium Impeller at Design and Off-Design Conditions

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Three-dimensional flow fields inside the Consortium impeller were analyzed with a Navier-Stokes code. The numerical results at the design and off-design conditions are compared with the experimental data.

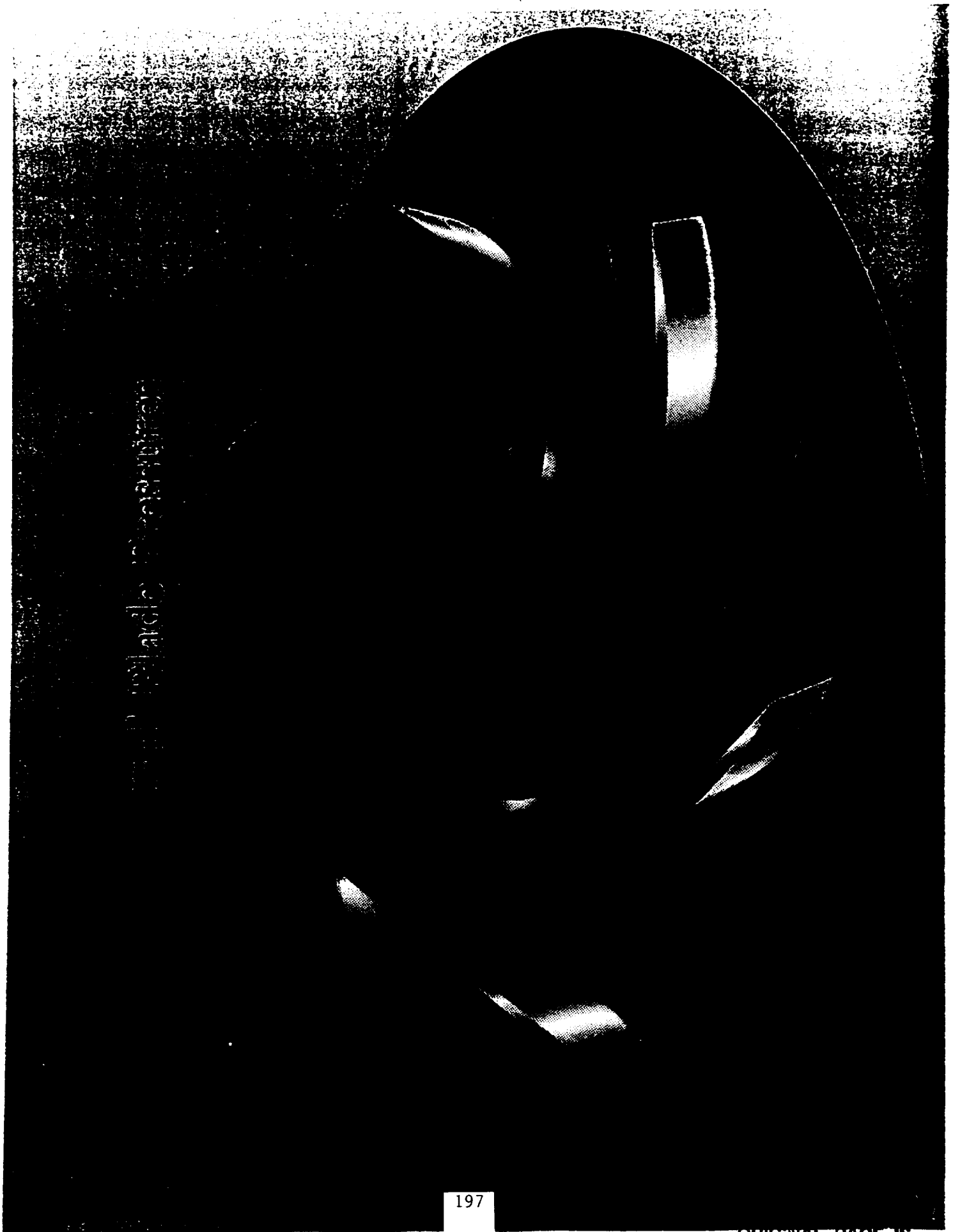
**THREE-DIMENSIONAL FLOW ANALYSIS INSIDE
CONSORTIUM IMPELLER AT DESIGN AND
OFF-DESIGN CONDITIONS**

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NASA LEWIS RESEARCH CENTER

R. GARCIA

NASA MARSHALL SPACE FLIGHT CENTER



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Objective

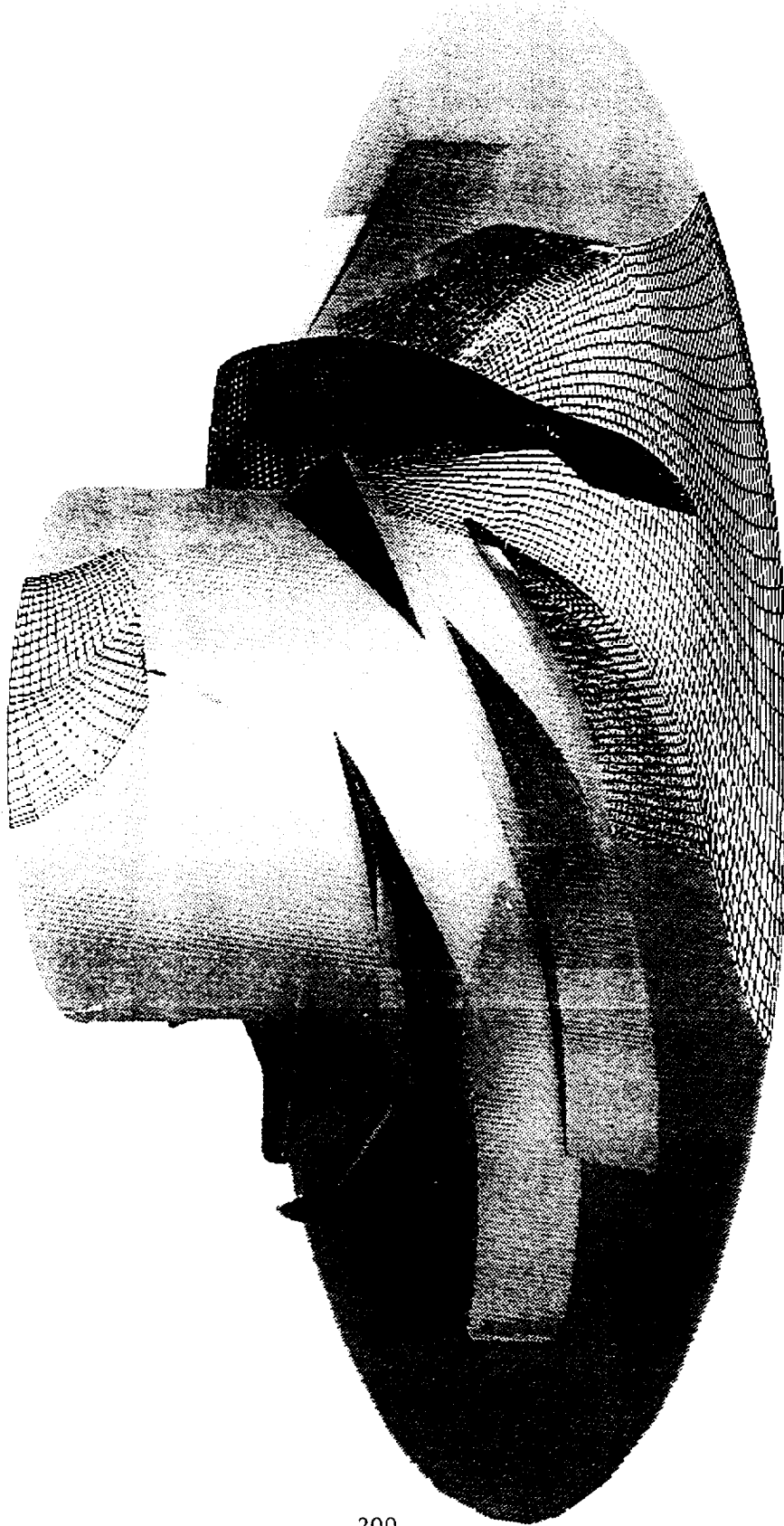
- o Design and Off-Design Performance
- o Numerical Optimization of Splitter

Computational grid

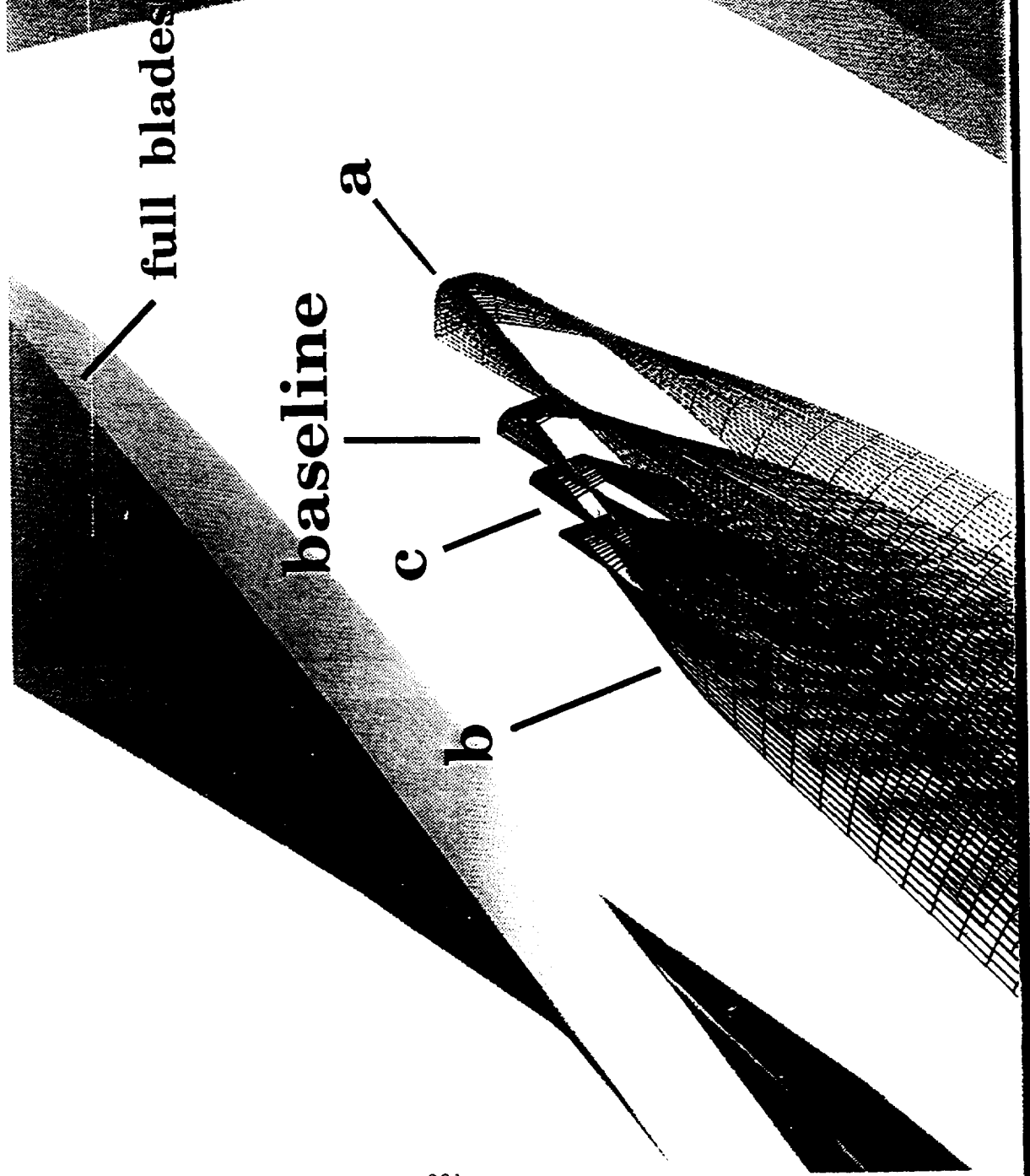
- o I-GRIDS

- o 40x24x123, 30x24x123, and 12x12x80

Computational Grid



Impeller Partial Blade Configurations



Flow Cases Studied

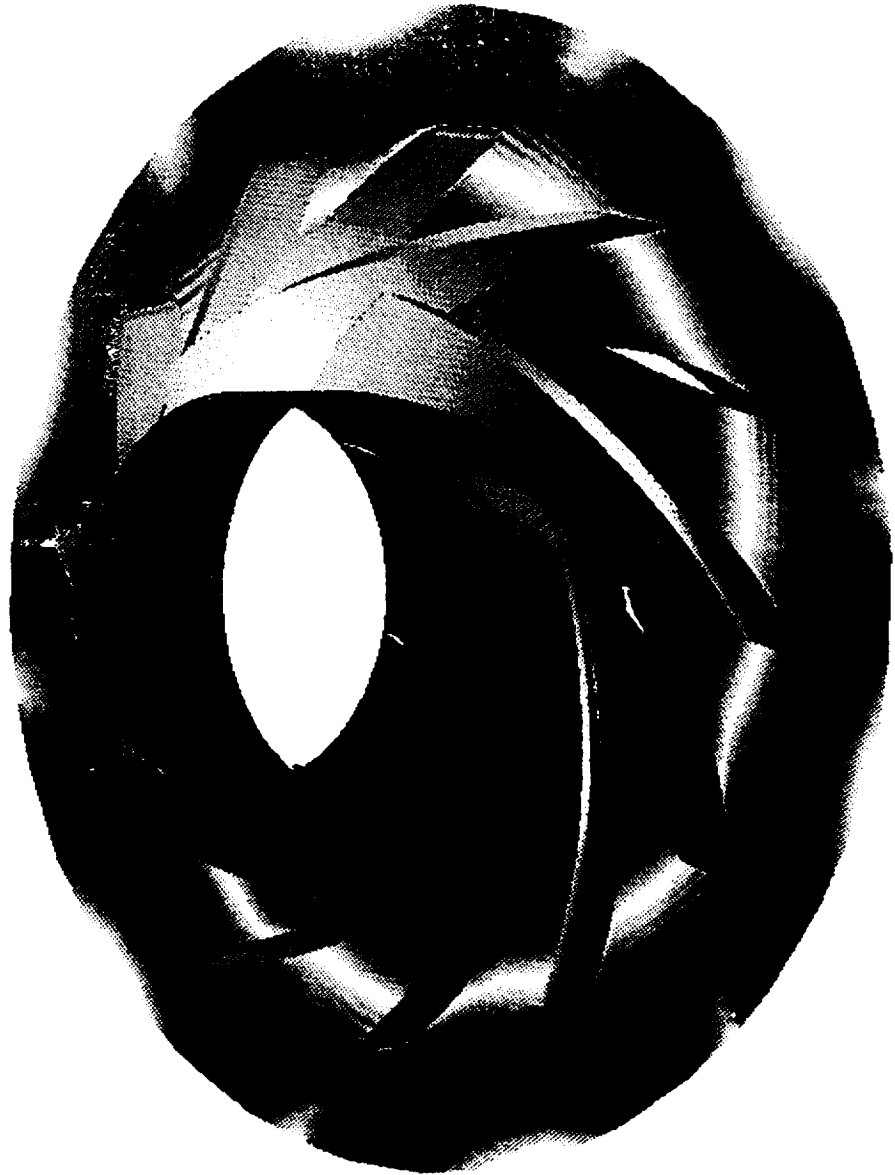
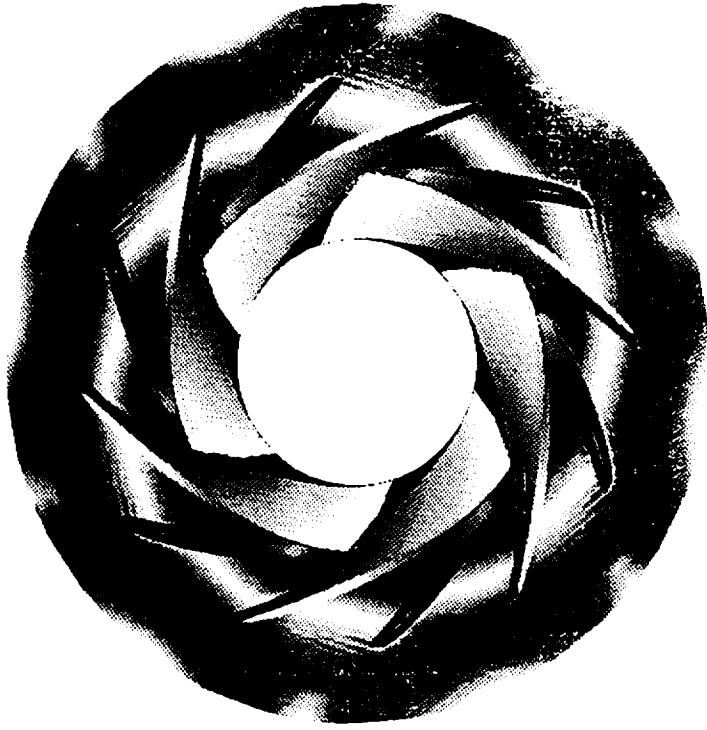
- o Baseline**
- o Design Flow**
- o 120 % Design Flow**
- o 88 % Design Flow**
- o Optimization of Splitter**
- o Baseline**
- o Cases A, B, C**

- o Baseline**
- o Design Flow**
- o 120 % Design Flow**
- o 88 % Design Flow**

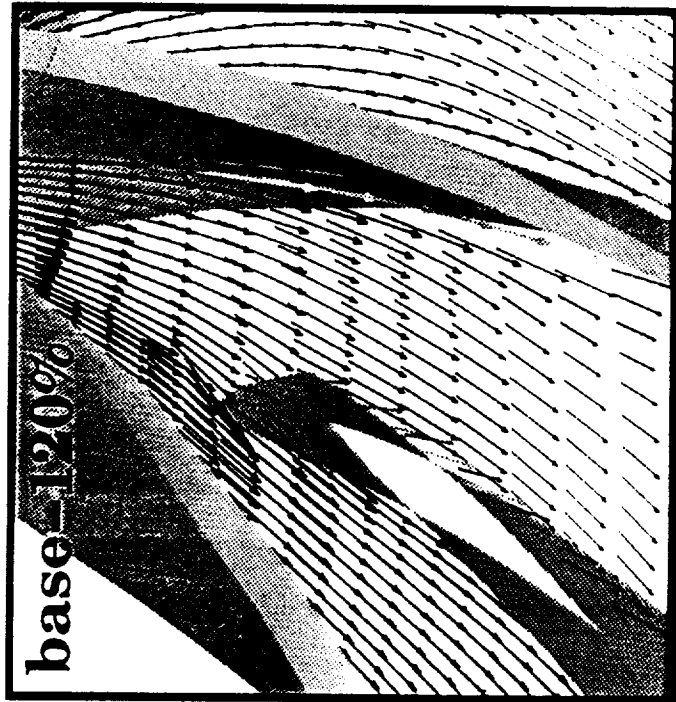
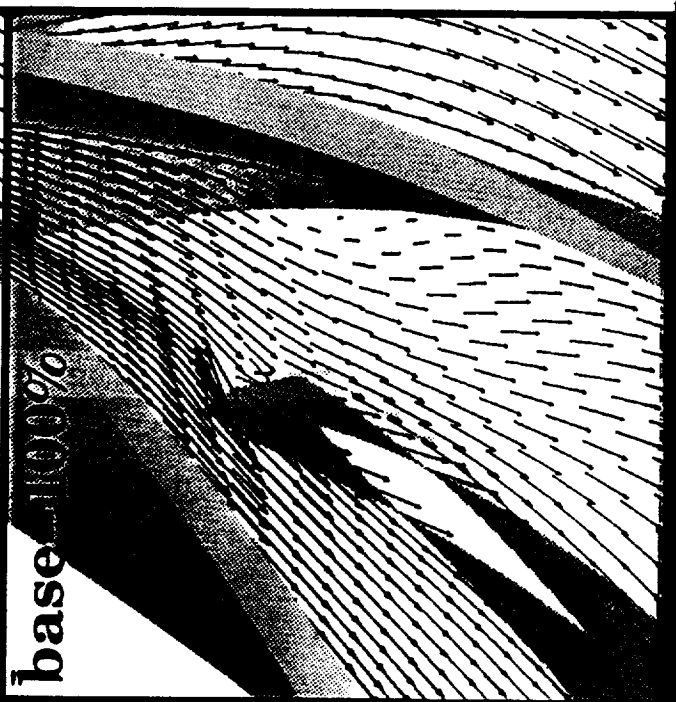
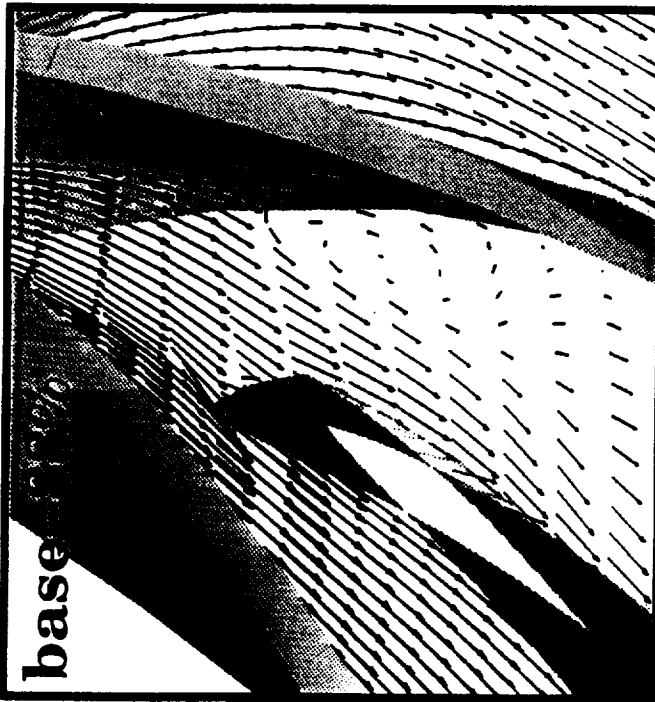
Blade Surface Pressure Contour



Hub Surface Pressure Contour



Relative Velocity Vector



radial
velocity
0.33

0.17
0.00

Nondimensional Radial Velocity

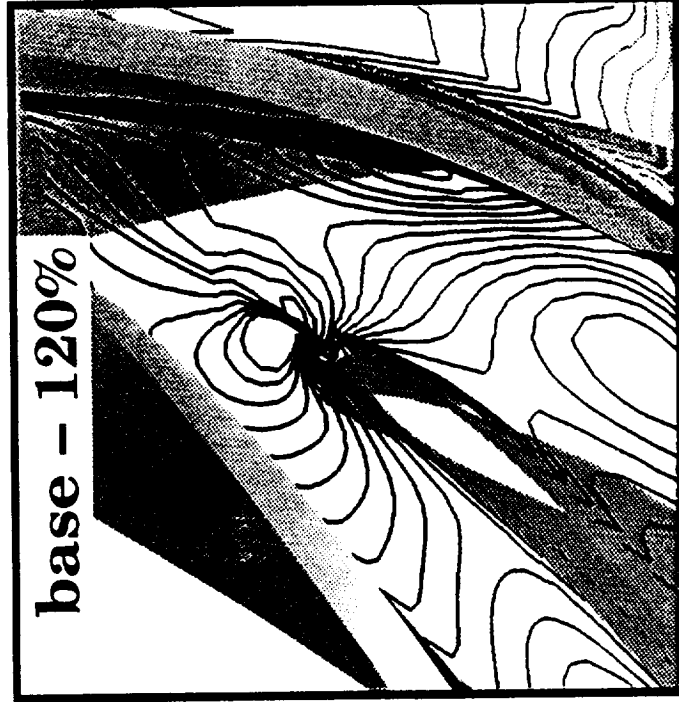


velocity

0.33

0.17

0.00



Particle Trace

baseline-coarse



baseline-dense

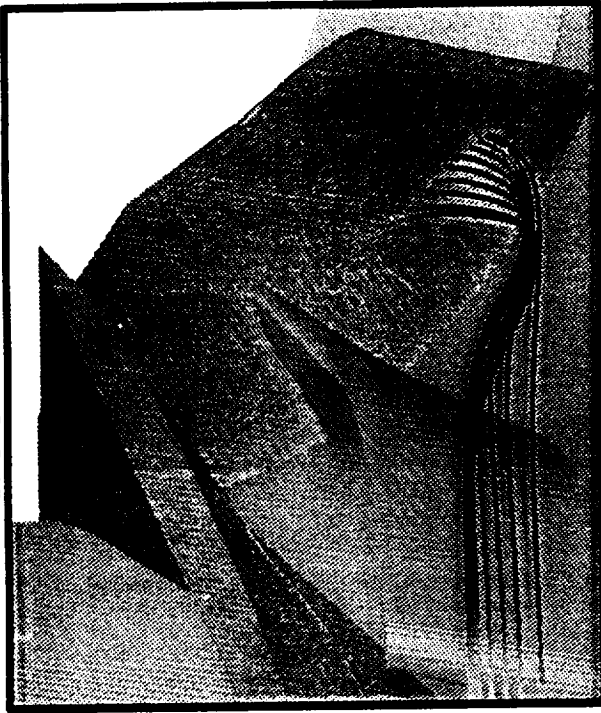


Particle Trace

base - 88%



base - 120%



Flow Split

88 % Flow : .46/.54

100 % Flow : .49/.51

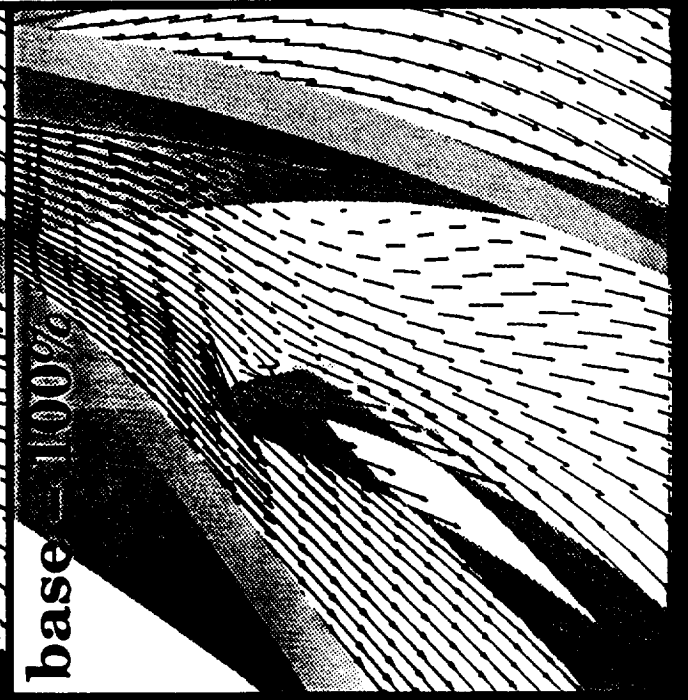
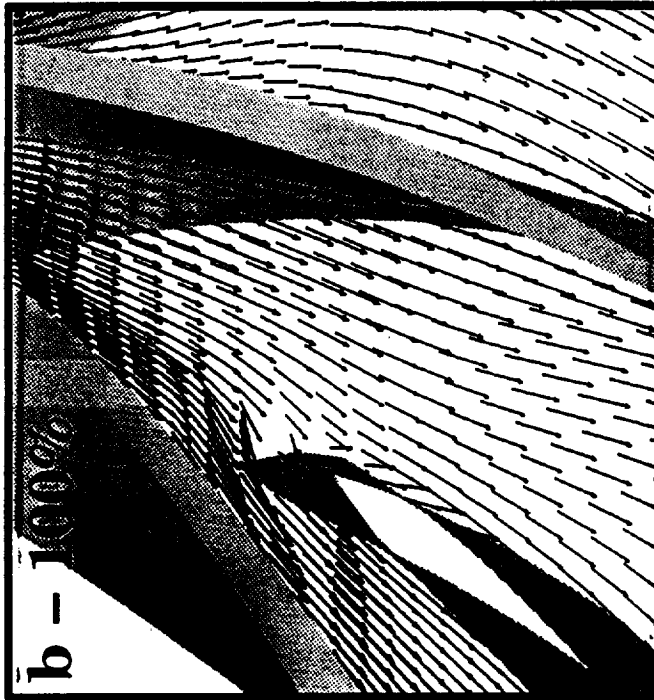
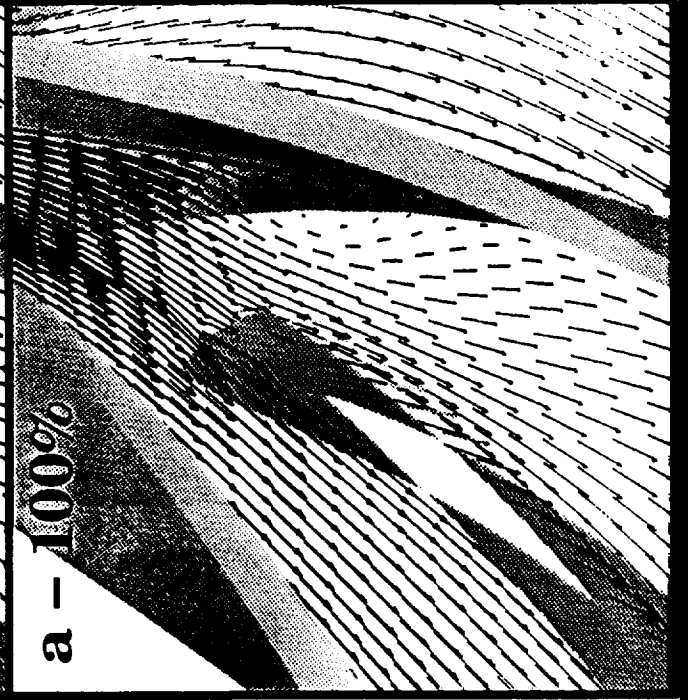
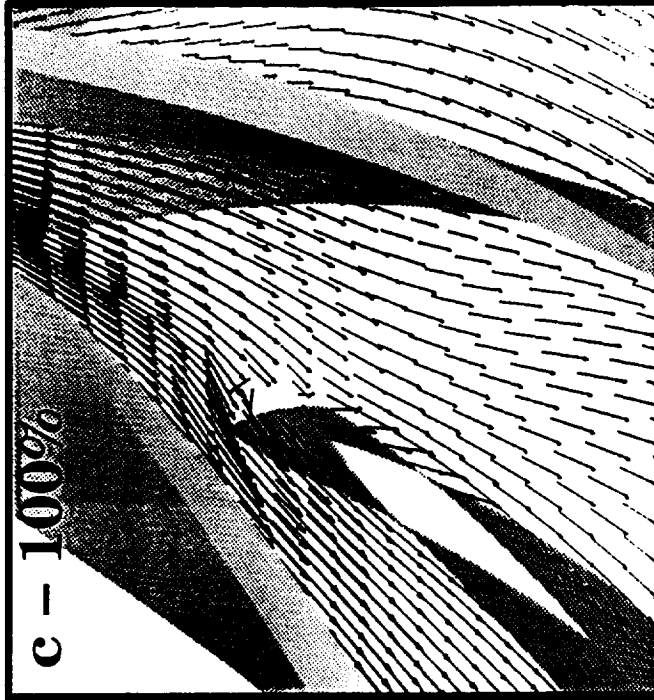
120 % Flow : .52/.48

Observation

- o Small Flow Separation at Design Flow rate**
- o Large Flow Separation at 88 % Flow rate**
- o No Flow Separation at 120 % Flow rate**

- o **Optimization of Splitter**
 - o **Baseline**
 - o **Cases A, B, C**

Relative Velocity Vector



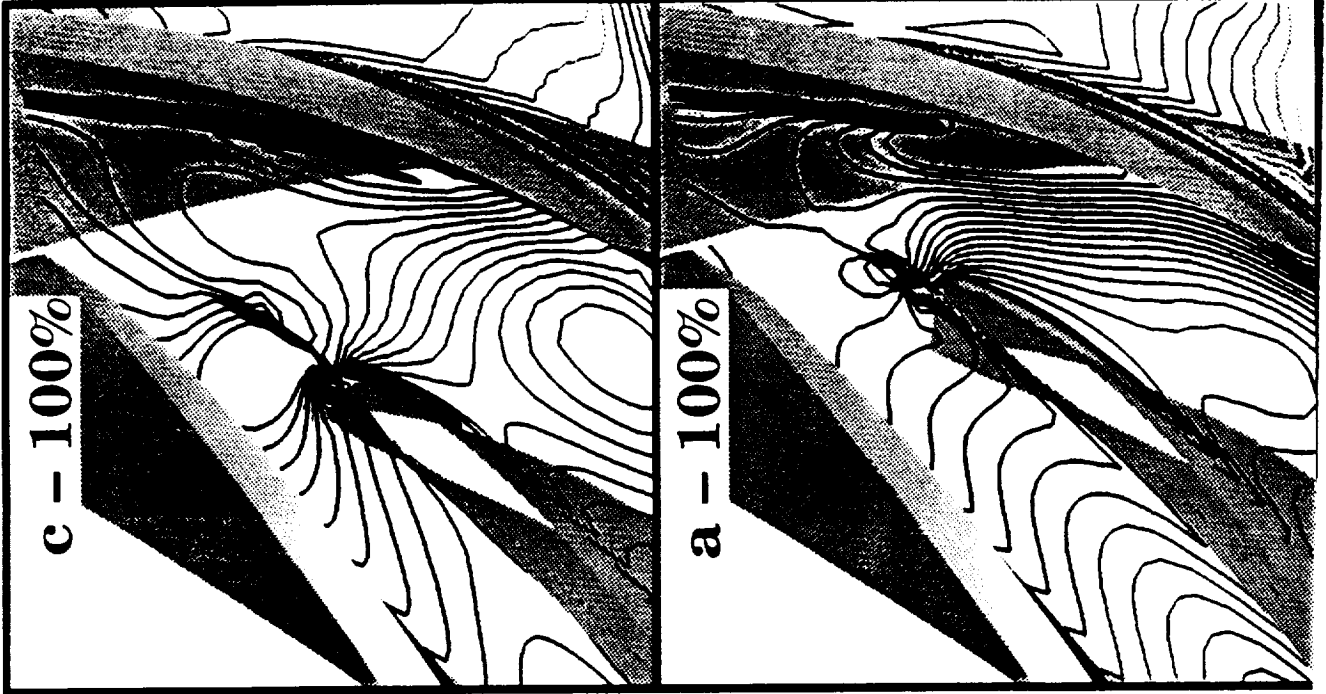
radial
velocity

0.33

0.17

0.00

Nondimensional Radial Velocity



velocity

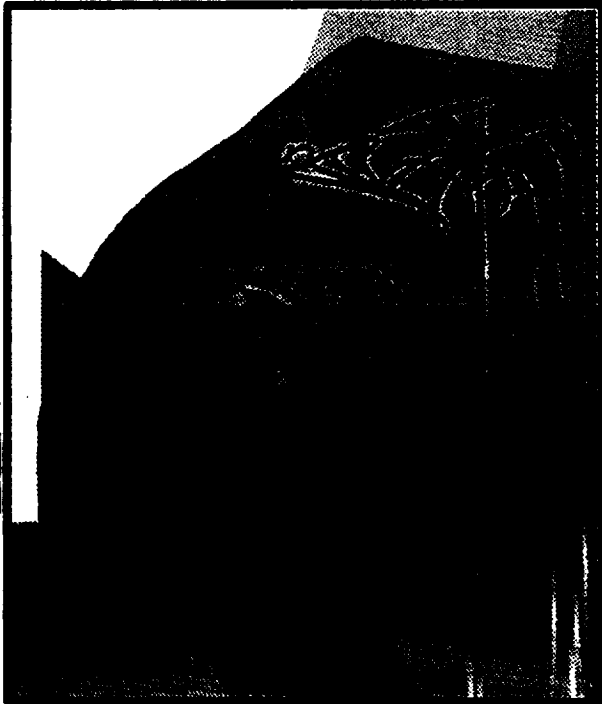
0.33

0.17

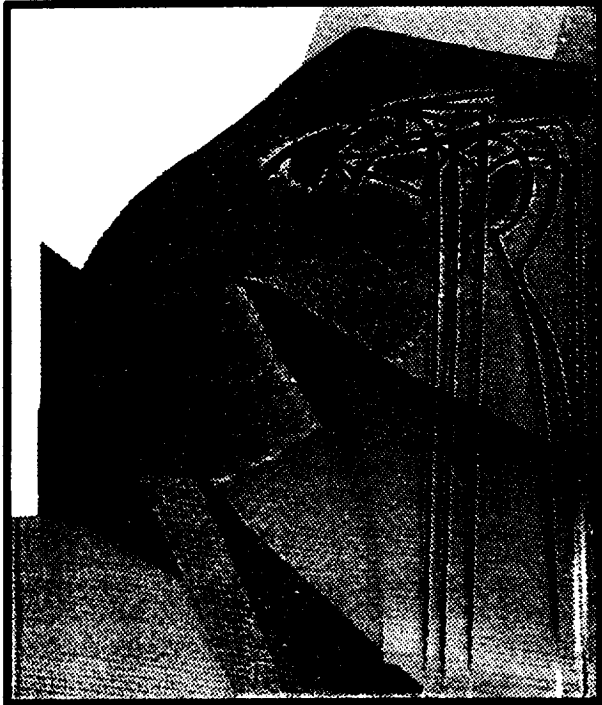
0.00

Particle Trace

base - 100%

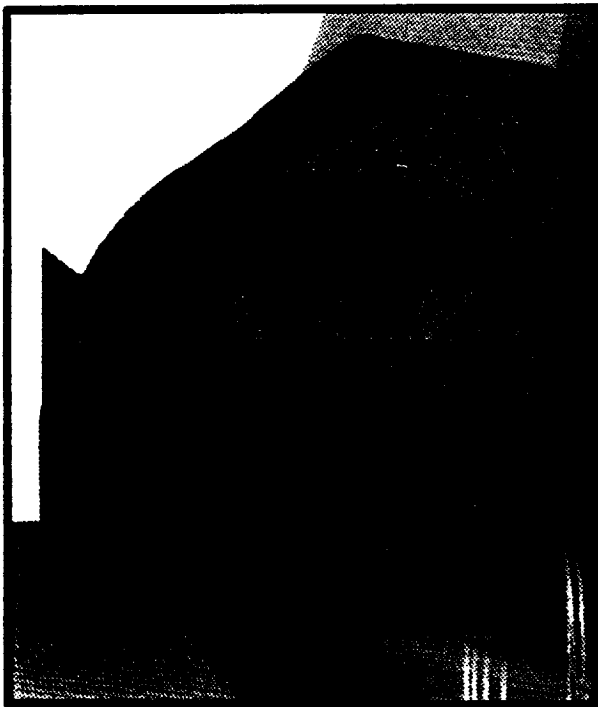


a - 100%

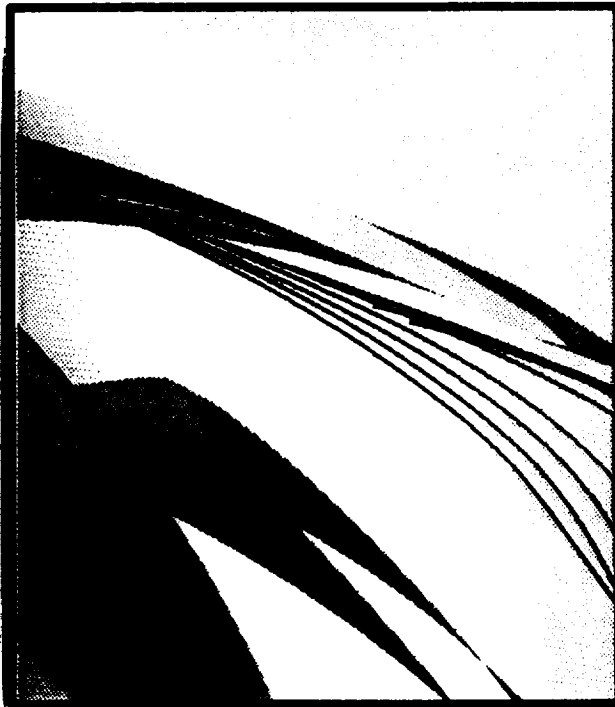


Particle Trace

b - 100%



c - 100%



Observation

- o Small Flow Separation for Baseline Design**
- o Large Flow Separation for Design A**
- o No Flow Separation For Design B**
- o Design C is a Good Compromise**

