Preliminary Design Review

FY'92 Modifications
To The Jet Noise Laboratory
For Forward Flight System
Building 1221A
Agenda

- Introduction/Overview
- Research Requirements
- PRC Design Overview
- Structural
- Mechanical
- Electrical
- Safety Review
- Cost Estimate/Schedule
Design Team

**NASA**

TPE - Mechanical Engineer
Research Engineer
Civil/Architectural Engineer
Mechanical Engineer
Electrical
Facility Representative
Safety Representative

Henry Haskin
Jack Seiner
Ronney Henk
C. T. Moore
John Singleton
Leon Parrish
Dan Folta

**PRC**

Project Engineer
Structural Engineer
Mechanical Engineer
Electrical Engineer

David Hunt
Eric Svendsen
John Martin
Martin Jango
PER Concept

MODIFIED PLAN
PER Concept

Modified Elevation
Alternate PER Concept
MODS TO THE JET NOISE LAB
OVERVIEW

• THIS PROJECT WILL ADD FORWARD FLIGHT SIMULATION CAPABILITY
  TO THE JET NOISE LABORATORY.

• THIS PROJECT COMBINES RESEARCH PROVIDED HARDWARE AND A CoF
  INSTALLATION.

• THE WORK HAS BEEN SUBDIVIDED INTO FOUR WORK PACKAGES AND
  THE CONSTRUCTION OF FACILITY INSTALLATION.

• THE FIRST WORK PACKAGE HAS BEEN RELEASED TO ACQUISITION.
  THE SECOND PACKAGE IS BEING CONSIDERED AS A TASK UNDER
  AN EXISTING CONTRACT OR WILL BE RELEASED AS A NEGOTIATED
  PRICE CONTRACT IN AUGUST.

• THE THIRD / FOURTH WORK PACKAGES CDR WAS HELD ON
  JULY 1, 1991 AND ALL ACTION ITEMS HAVE BEEN ANSWERED.

• A CONCURRENT EFFORT IS UNDER WAY TO CONTINUE THE STATIC
  NOZZLE TESTING TO DEVELOP A DATA BASE ON SUPERSONIC
  SUPPRESSOR NOZZLE DESIGN.
FY '92 REHAB AND MOD PROJECT
MODS TO THE JET NOISE LAB FOR FORWARD FLIGHT (1221A)
WORK PACKAGE DESCRIPTIONS

1) PROPULSION MODEL - INCLUDES: COMBUSTOR, DUAL STREAM
NOZZLE ADAPTOR, LOAD CELL, SUPPORT STRUCTURE, AND
CONTROL HARDWARE.

2) PRIME MOVER SYSTEM - INCLUDES: FANS, MOTORS, VARIABLE
FREQUENCY DRIVES, TRANSFORMER AND SWITCH GEAR

3) FLIGHT SIMULATION DUCT - INCLUDES: INLET FILTER, BELLMOUTH,
SCREEN SECTION, NOZZLE, PLENUM SUPPORTS, PLENUM ACCESS
HATCH.

4) EDUCTOR MODS - INCLUDES: ACOUSTIC BAFFLES, FAN PLENUM,
FAN EXHAUST MUFFLERS, SUPPORT STRUCTURES.

5) FY '92 CoF - INCLUDES: INSTALLATION OF ABOVE HARDWARE,
FOUNDATIONS FOR FAN AND MOTOR UNITS, BUILDING
MODIFICATIONS FOR FLOW INLET AND EXIT, REROUTING
EXISTING AIR SUPPLY PIPING.
MODS TO THE JET NOISE LAB RESEARCH REQUIREMENTS

THE HIGH SPEED RESEARCH PROGRAM AT LANGLEY NEEDS TO DEVELOP A DATA BASE OF SUPersonic JET ENGINE NOZZLE SOURCE NOISE TO ALLOW THE DESIGN OF TRANSPORT SIZED SUPersonic ENGINES THAT WILL MEET THE FAA NOISE RESTRICTIONS WITHOUT AN UNACCEPTABLE PERFORMANCE PENALTY.

THE CURRENT ENGINE TECHNOLOGY MUST BE EXPANDED AND A SUPersonic SUPPRESSOR TECHNOLOGY DEVELOPED.

TO DO THIS A FACILITY IS REQUIRED WITH THE FOLLOWING CHARACTERISTICS:
- SIMULATE BOTH ENGINE FLOW STREAMS (CORE & FAN)
- DEVELOP THE FULL ENGINE TEMPERATURE RANGE
- SIMULATE FORWARD FLIGHT TO STUDY PLUME MIXING
- FAR FIELD NOISE MEASUREMENTS
- AERODYNAMIC FLOW MEASUREMENTS
Forward Flight Simulator

- Exhaust Muffler
- Fan
- Eductor
- Collector
- Forward Flight Duct
- Anechoic Test Cell
- Louvers, Damper, Filter
- Muffler
- Fan Drive Motor
Design Codes

American Society for Mechanical Engineers  ASME
American Institute for Steel Construction  AISC
American National Standards Institute  ANSI
American Society for Testing and Material  ASTM
American Welding Society  AWS
American Concrete Institute  ACI
National Fire Protection Association  NFPA
Federal Communication Council  FCC
National Electronic Manufacturers Association  NEMA
National Electric Code  NEC
Electronic Industries Association  EIA
Insulated Powers Cable Engineers Association  IPCEA
Institute of Electrical and Electronic Engineers, Inc.  IEEE
New CMU Building Extension
Design Requirements

Building Size
- 23' 6" Wide
- 99' 0" Long
- 26' 0" High
- 12" CMU Wall

Design Loads
- 500 PSF Floor Live Load
- 60 PSF Roof Live Load
- 30 PSF Wind Load (110 MPH Wind)
New CMU Building Extension
Design Requirements

Additional Considerations
- 12' x 12' Roll Up Door
- 6' x 7' Double Doors
- 12' x 16' Roof Hatch
- 12' x 12' Roof Opening
- Electrical Power
- Lights (50 Foot Candles)
- Steam Space Heat (55°F Interior @ 15°F Ambient)
- Ventilation For Fan Motor (If Required)
NEW ADDITION

16'-0"  16'-3"  17'-9"  17'-0"  17'-0"  15'-0"

SCUPPER, SEE DETAIL

99'-0"

ROOF DRAIN

OPENING 12'-6" SQ.

CRICKET TYP

(3'-0" SQ.) ROOF HATCH

15'-0"

16'-6"

26'-3"

12'-0"

63'-2"

23'-6"

ROOF PLAN, BLDG 1221A EXTENSION

N.T.S.
Process Systems - Work Scope

- Relocate 600 PSI Air Supply Line In Rooms 117 And 117A Including Filter And Motorized Isolation Valve 3106D To The Roof Of Bldg. 1221A

- Relocate Existing Engine Core And Fan Flow Air Systems In Room 117 To The Roof Of Bldg. 1221A

- Replace Existing Mufflers In The Engine Core And Fan Flow Air Systems

- Remove Cooling Water System #1 To The Sue Burner

- Relocate Water Cooling System #2 Supply And Return Manifolds To Accomodate Installation Of Forward Flight Duct
Process Systems - Work Scope

- Relocate the existing Propane/Hydrogen/Nitorgen supply systems to accommodate the installation of the forward flight duct.

- Provide cooling air system to the jet engine simulator.
Jet Engine Simulator - Supply Conditions

- Engine Core Flow
  - Medium: Air
  - Design Pressure: 18 to 140 PSI
  - Design Temperature: Ambient to 2000°F
  - Mass Flow Rate: Up to 11LBM/SEC

- Fan Flow
  - Medium: Air
  - Design Pressure: 18 to 140 PSI
  - Design Temperature: Ambient to 1000°F
  - Mass Flow Rate: Up to 7LBM/SEC
<table>
<thead>
<tr>
<th>Jet Engine Simulator - Supply Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Propane Fuel</strong></td>
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<tr>
<td>Design Pressure: 600 PSI (Liquid)</td>
</tr>
<tr>
<td>Design Temperature: -60°F</td>
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<tr>
<td>Mass Flow Rate: 0 to 0.5 LBM/SEC</td>
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<tr>
<td><strong>Hydrogen Fuel</strong></td>
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<tr>
<td>Design Pressure: 500 PSI</td>
</tr>
<tr>
<td>Design Temperature: 100°F</td>
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<tr>
<td>Mass Flow Rate: 0 to 0.1 LBM/SEC</td>
</tr>
<tr>
<td><strong>Nitrogen Purge Gas</strong></td>
</tr>
<tr>
<td>Design Pressure: 550 PSI</td>
</tr>
<tr>
<td>Design Temperature: 100°F</td>
</tr>
<tr>
<td>Supply Line Size: 1/2&quot; Tube</td>
</tr>
</tbody>
</table>
Jet Engine Simulator - Supply Conditions

- Cooling Air Supply
  - Design Pressure: 350 PSI
  - Design Temperature: 100°F
  - Supply Line Size: 2" Pipe

- Control Air
  - Design Pressure: 100 PSI
  - Design Temperature: 100°F
  - Supply Line Size: 1/2" Pipe
Jet Engine Simulator - Supply Conditions

- Cooling Water

  Design Pressure: 150 PSI
  Design Temperature: 40 to 100°F
  Mass Flow Rate: 300 GPM Max.
Jet Engine Simulator - Supply Sources

- Engine Core Flow/Fan Flow
  - Existing 600 PSI Air Supply
  - Reuse Components From The Existing Sue Burner Engine Core And Fan Flow Air Systems
  - Add Weatherproof Covers For Valve Actuators, Heaters And Other Components Not Rated For Outside Service
- Propane Fuel/Hydrogen Fuel/Nitrogen Purge
  - Reuse Existing Sources And Components From Sue Burner Systems
- Cooling Air
  - Existing 350 PSI Air System
- Control Air
  - Existing Shop Air System
Jet Engine Simulator - Supply Sources

- Cooling Water
  - Use Existing Cooling Water System #2 Pump And Heat Exchanger
  - Relocate Existing Supply And Return Water Manifolds From Cooling Water System #2
Electrical Systems
Electrical Overview

- Demolition
  - Substation
  - Tunnel Circuit Area

- Installation
  - Government Furnished Equipment
  - Power And Controls Jet Engine Simulation
  - Lighting And Power New Bldg's
  - Control Panels

- Variable Frequency Drive

- Interlocks
Electrical Scope

- Remove Existing Abandoned Switchgear And Circuit Breaker 3023
- Remove Existing Substation Fence And Gate
- Remove Existing Valves Disconnect Switches
- Re-route Existing Power And Control Feeders For The Heaters To The Roof
- Remove Power And Control Cables For The Existing Sue Burner Controls
- Re-route Conduits And Wiring On The Existing Walls To Be Removed
- Relocate Existing Panel L-1500A And Transformer
- Re-route Power And Control Wiring And Conduit For The Engine Core And Fan Flow Air System
AMES ROAD SUBSTATION
6.6 KV SWITCHGEAR "W"

3033

3W3
3W3B

EXIST 1-3C, 350 KCMI
7.5 KV, VCL CABLE

EXIST 350 KCMI,
7.5KV, PL CABLE

3023

CIRCUIT BREAKER
AND POthead TO
BE REMOVED.

TO
SWITCHGEAR
"W3B"
BLDG 1247D

EXISTING SINGLE LINE DIAGRAM
Electrical Scope - Continued

- Installation Of The Government Furnished Equipment (GFE)
  - Unit Substation (4000 KVA)
  - Variable Frequency Drive
  - 4000 Horsepower Motor

- Provide Power And Control Cables For The GFE

- Provide Power And Control For The Jet Engine Simulator

- Provide Lighting And Power Outlets For The New Tunnel Circuit And Drive Buildings

- Provide Power And Control For The Motorized Louvers

- Provide Remote Control Panel In Control Room
NEW SINGLE LINE DIAGRAM

AMS ROAD SUBSTATION
6.6 KV SWITCHGEAR "W"

EXIST 1-3/C, 350 KCMIL
7.5 KV, PL CABLE

SW3

TO SWITCHGEAR "W3F"
BLDG 12470

EXIST 1-3/C, 350 KCMIL
7.5 KV, PL CABLE

NEW OUTDOOR TYPE
4000 KVA UNIT SUBSTATION
(GFC)

HIGH VOLTAGE
AIR SWITCH

4000 KVA
8.6 KV/4.16 KV

MAIN
1200 AC
1200 AT

COMPARTMENT A
CUBICLE 1A & 2A

COMPARTMENT B
CUBICLE 1B & 2B

SWITCHGEAR SERVICE
(RECEPTACLES, HEATERS AND
CB CONTROLS)

NEW CONDUIT & PULL WIRE
TO TELEPHONE TERMINAL CABINET
IN BLDG 1221

1200 AC
800 AT

SWITCHGEAR
SERVICING

CLF

CT

PT

CLF

VOLTOMETER

AMMETER

WATT TRANSUCER

0-1 MA
TO TTC

REMOTE CONTROL PANEL

LOCAL CONTROL PANEL

2 SETS OF
(500 KCMIL A)
1/4"/O GND)

REMOTE FACILITY COMPUTER

EXISTING FACILITY COMPUTER
RS232

VARIABLE
FREQUENCY DRIVE

(GFC)

SW

AIR VELOCITY TRANSUCER

4000 HP

(NEW IND MOTOR (GFC)

FAN

DRIVE SYSTEM
Remote Control Panel

- Start - Stop Push Buttons
- Motor RPM Digital Display
- Motor Voltage Digital Display
- Motor Current Digital Display
- Air Velocity Digital Display
- Drive Cooling System Temperature Digital Display
- Manual Speed Control
- Tunnel Lock/Release Switch
- Alarm Trip Indication of VFD
- Vibration Monitor Alarm/Trip Information
- 4 - 20 Ma Speed Signal From Existing Computer
Local Control Panel (GFE)

- Start - Stop Push Buttons
- Motor Voltage Digital Display
- Motor Current Digital Display
- Motor RPM Digital Display
- Manual Speed Control
- Alarm Trip Indication Of VFD
Variable Frequency Drive (GFE)

- AC Line Fused Disconnect Switch
- Filter
- Microprocessor Based Digital Control Panel
- Output Frequency 0.5 to 70 hz
- Speed Regulation 0.5%
- Maximum Ambient Operating Temperature 104°F
- RS-232 Interface
Interlocks

- Tunnel Circuit Doors
- Motor Winding Temperature
- Variable Frequency Drive Doors
- Motorized Louvers
- Switchgear And Drive System
- Supply Systems For Jet Engine Simulator
SAFETY, RELIABILITY, AND QUALITY ASSURANCE

MODIFICATIONS TO JET NOISE LABORATORY FOR FORWARD FLIGHT SYSTEM PRELIMINARY DESIGN REVIEW

DAN FOLTA
JULY 12, 1991
SR & QA
AGENDA

- OVERVIEW OF SR & QA APPROACH DURING DESIGN/ACQUISITION/CONSTRUCTION/CHECKOUT
- SYSTEM SAFETY FEATURES INCLUDED IN DESIGN
- HAZARD ANALYSES RESULTS AND PRELIMINARY CRITICAL ITEM LIST
- FIELD VERIFICATION STATUS OF INTERFACE DRAWINGS TO BE REFERENCED IN ACQUISITION PACKAGE
- POTENTIAL REVISIONS AND ADDITIONS TO EXISTING FACILITY BASELINE LIST
- AREAS OF CONCERN OR UNCERTAINTY
OVERVIEW OF SR & QA APPROACH

• PARTICIPATION IN DESIGN REVIEW PROCESS
• PERFORM NECESSARY SAFETY ANALYSES
• DEVELOPE CRITICAL ITEM LIST
• PARTICIPATE IN DEVELOPMENT OF FACILITY BASELINE LIST (NEW, EXISTING)
• PARTICIPATE IN DEVELOPMENT OF DESIGN SPECIFICATIONS (QA, INSPECTION REQUIREMENTS)

• FINAL SPECIFICATION AND DRAWING REVIEW
• SUBMITTAL REVIEW OF HARDWARE SELECTION, INSPECTION PROCEDURES, WELDING QUALIFICATION AND PROCEDURES, SAFETY AND QUALITY ASSURANCE PLAN
• SQRD INSPECTION SUPPORT DURING CONSTRUCTION
• SQRD SAFETY BRIEFINGS TO CONTRACTORS
• REVIEW SHAKEDOWN PLANS, CONDUCT PROCEDURE DEMONSTRATIONS
• PROVIDE FINAL RISK ASSESSMENT IN SUPPORT OF THE PROJECT REVIEWS
SYSTEM SAFETY FEATURES INCLUDED IN DESIGN

- SYSTEMS WILL BE DESIGNED, FABRICATED AND INSPECTED IN ACCORDANCE WITH APPLICABLE CODES, STANDARDS, SPECIFICATIONS AND DRAWINGS.

- SYSTEMS INTERLOCKED/KIRK LOCKED TO AFFORD MAXIMUM PROTECTION FOR PERSONNEL AND EQUIPMENT.

- PROPANE/HYDROGEN DETECTORS WITH ALARMS INCORPORATED FOR PERSONNEL PROTECTION AND TO PROTECT AGAINST DEFLAGRATION AND/OR DETONATION.

- MUFFLERS TO BE INCORPORATED TO ELIMINATE NOISE HAZARDS TO PERSONNEL.
HAZARD ANALYSIS RESULTS AND PRELIMINARY CRITICAL ITEM LIST

- NO RAC 1 OR RAC 2 RISKS ANTICIPATED BY THIS C OF F PROJECT.

- NO CRITICAL ITEMS GENERATED BY THIS C OF F PROJECT, CONSIDERING THE CURRENT GUIDELINES. CRITICAL ITEMS AND INTERLOCKS IDENTIFIED IN CURRENT SAFETY ANALYSIS REPORT WILL BE UPDATED WHEN NEW STRUT AND MODEL INCORPORATED.

- JET NOISE APPARATUS SAFETY ANALYSIS REPORT WILL BE REWRITTEN IN ITS ENTIRETY AND OVERALL FACILITY RISK ASSESSMENT WILL BE PRESENTED AT THE ISR.
FIELD VERIFICATION STATUS OF INTERFACE DRAWINGS TO BE REFEENCED IN ACQUISITION PACKAGE

• REFERENCE DRAWINGS HAVE BEEN IDENTIFIED. CNT'S 36-46.
• DRAWINGS EITHER FIELD VERIFIED OR IN PROCESS OF FIELD VERIFICATION.

POTENTIAL REVISIONS AND ADDITIONS TO EXISTING FACILITY BASELINE LIST

• NEW DRAWINGS WILL BE ADDED TO FACILITY BASELINE LIST AS CCD OR SFD (SUPPORTING FACILITY DOCUMENTS) AT ISR.
• CHANGES TO APPROXIMATELY 90% OF EXISTING DRAWINGS.
• FACILITY NUMBER OF CCD DRAWINGS IS 43. DRAWINGS FOR EFFORT CODES 35, 37, AND 71 ALSO AFFECTED.

DELETION OF "TBD" OBSOLETE DRAWINGS.

AREAS OF CONCERN OR UNCERTAINTY

• FUTURE MODIFICATIONS TO STRUT AND MODEL WILL BE EVALUATED AND COMPARED WITH CURRENT MODEL (SUB BURNER) TO ENSURE THE SAME/LIKE HAZARD CONTROLS ARE INCORPORATED.
Critical Items

An item the failure of which would likely result in death, or damage to equipment/property equal to or greater than $1.0M, or in a facility downtown of 3 months or greater. Facility downtime is defined as the inability of the facility to be used for research or normal operation. Critical Items are to be listed in the Safety Analysis Report, tracked throughout their lifetime and supported by documentation to include; installation requirements or instructions, maintenance and inspection criteria and requirements, and drawings, specifications and design calculations.

Design calculations for critical items which are part of a standard product line of a company, designed to industry consensus codes, for which a history of acceptable operation of same or similar products is available, or where design is considered to be proprietary will not be required. These critical items are generally associated with the large rotating machinery which comprise wind tunnel compressor and drive systems.

Further, standard product line pressure components built and installed to consensus national codes and standards for which there is an operational history for the same or similar products at the Center are by definition not considered Critical Items. However, these items shall be covered under the Center's Pressure System Recertification Program to assure system integrity.
<table>
<thead>
<tr>
<th>Description</th>
<th>PER Coff</th>
<th>Present Coff</th>
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<tbody>
<tr>
<td>Inlet (Louvers, Damper, Filter)</td>
<td>17,000</td>
<td>24,900</td>
</tr>
<tr>
<td>Duct (Bellmouth, Screens, Nozzle)</td>
<td>24,000</td>
<td>50,800</td>
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<tr>
<td>Relocating Process Systems Piping</td>
<td>30,000</td>
<td>79,300</td>
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<tr>
<td>Modify Anechoic Test Chamber</td>
<td>5,000</td>
<td>32,400</td>
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<tr>
<td>Jet Engine Simulator</td>
<td>47,800</td>
<td>18,600</td>
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<tr>
<td>Collector</td>
<td>N/A</td>
<td>3,400</td>
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<tr>
<td>Eductor</td>
<td>---</td>
<td>52,800</td>
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<tr>
<td>Muffler</td>
<td>8,000</td>
<td>5,000</td>
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<tr>
<td>Fan &amp; Fan Motor</td>
<td>95,000</td>
<td>152,600</td>
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<tr>
<td>Exhaust Muffler</td>
<td>12,000</td>
<td>6,400</td>
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<tr>
<td>Installation Of Variable Speed</td>
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<tr>
<td>Driver With Transformer And Variable Speed Driver Enclosure</td>
<td>70,500</td>
<td>280,300</td>
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<tr>
<td>Bldg 1221-A Extension</td>
<td>210,200</td>
<td>152,300</td>
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<tr>
<td>Bypass Damper Installation</td>
<td>3,000</td>
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<tr>
<td>Remove Lab Room To Shop Area</td>
<td>20,000</td>
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<tr>
<td>Honey Comb Curtain</td>
<td>28,000</td>
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<tr>
<td><strong>Engineering Total</strong></td>
<td><strong>561,500</strong></td>
<td><strong>858,800</strong></td>
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## Project Cost Estimate, Sheet 2 of 2

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<tr>
<th>Description</th>
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<tbody>
<tr>
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<td>R&amp;D</td>
<td>CofF</td>
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<tr>
<td>Engineering Total</td>
<td>1,555,100</td>
<td>561,500</td>
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<tr>
<td>25% Profit And Overhead</td>
<td>3,888,800</td>
<td>140,400</td>
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<tr>
<td>Total</td>
<td>1,943,900</td>
<td>701,900</td>
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<tr>
<td>Escalation 5%</td>
<td>97,200</td>
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<tr>
<td>Contingency 10%</td>
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<td>70,200</td>
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<tr>
<td>Grand Total</td>
<td>2,041,100</td>
<td>807,200</td>
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<tr>
<td>Current Budget</td>
<td>2,500,000</td>
<td>900,000</td>
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**Note:**
1) Fan Horsepower Requirement Increased From 3000 To 4000 HP
2) Tunnel Component Designs Changed From Stress Base To Deflection Base
3) Major Reconfiguration Of Facility