Apr 1st, 8:00 AM

Eternal Tank Design Approach For The Space Shuttle

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EXTERNAL TANK
DESIGN APPROACH
FOR THE
SPACE SHUTTLE
PHYSICAL DIMENSIONS
LENGTH - 157.1 ft (47.841 m)
DIAMETER - 27 ft (8.2296 m)

TYPICAL LO<sub>2</sub> FEEDLINE SUPPORT

TANK/INTERTANK SPICE
(TYPICAL BOTH TANKS)

TYPICAL LO<sub>2</sub> TANK PENETRATIONS
AND NOSE FAIRING INSTALLATIONS

SOLID ROCKET BOOSTER
FWD ATTACHMENT

SOLID ROCKET BOOSTER
AFT SLIDING ATTACHMENT

ELECTRICAL
CONDUIT

GH<sub>2</sub>
PRESSURIZATION
LINE

ORBITER
PFD ATTACH

ORBITER
AFT ATTACH

OUR BASELINE DESIGN
1. Launch

2. SRB Staging
   h ≈ 140K

3. ET Staging, h ≈ 390,000

4. ET Breakup
   h ≈ 210,000

Ground Traces - ETR Launches

Impact
Nose Cover

Pressurization Line
Fwd Ring
Diffuser
Seal
Nose Fairing
Vent Valves

Cover Plate
Cover Assembly

Tank Assembly

Lightning Rod
Lightning Protection Strips

Nose Fairing Assembly

Ogive Skins

32 in.

34 in. Dia
LO₂ TANK

612 R

331 DIA

559.925
INTERTANK

TPS 0.10 Thickness
SLA 561s Ablator

Skin & Stringers
7075T76

Thick Skin
7075T7351

Longerons
7075T73511

Panel End Caps
7075T73511

Diameter
331.0 in.

ET Diameter

270.35 in.
Intermediate Frame (15 Places)

- Dome to Barrel 18-in. Frame
- 1160.25 in.
- 912.0 Barrel
- 331.0 in. Diameter
INTERFACE HARDWARE - ET TO SRB
Sliding Support (Typical 8 Places)

Gimbal Joint

Fixed Support at Disconnect

Flange

Gimbal Joint

Flange

Gimbal Joint

Sliding Support
ET ELECTRICAL SYSTEM

Orbiter

Computers
EPDC & E Events Control
Disp & Control
Main Propulsion System

(All OfI) Hardwire Power, Cmds, Ret
Sig TVC Cmds, Resp

127 Wires (Pins)

Multiplexed Data (DFI Only)
& Responses

Orbiter/ET/SRB Interface

Wires (Pins)

Vent Valve Control
Measurements/ Responses

Propellant Level Sensing

External Tank

11/14/73
All SRB Cable Now
Goes to Aft Attach Point

416 Wires (Pins)
1 SRB via
Aft Strut

Recovery Sequencer
Pwr Transfer

Batteries

SRB Events Control

Measurements Responses
Subsystem

Body Rate Sensors

SRB

NASA-MSFC-M'F
EXTERNAL TANK MAXIMUM HEATING

\[ \dot{q}_{\text{max}} \sim 36 \text{ Staging Plume Impingement (2 sec)} \]

\[ \dot{q}_{\text{max}} \sim 13 \text{ SRB Attach Interference (Add to Convective)} \]

\[ \dot{q} = 11.8 \]

\[ \dot{q} = 7.5 \text{ SSME/SRB Plume } q_{\text{max}} \text{ (Recirculation Plus Radiation)} \]

(Nominal Mission 3A, Ref Appendix 10.11)

CONVECTIVE HEATING

\[ \dot{q}_{\text{max}} \sim 8\text{Btu/ft}^2\text{-sec} @ T_w = 400^\circ R \]

Nose Turbulent

SRB Shock

Orbiter Shock

Orbiter/SRB Interference

\[ \text{X/L Ref} \]

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Ablative SLA 561s

Silicone Seal Coat 92007

2219-T87A Al
(0.141 Taper to 0.080)

- Iridite MP30063
- Primer MP30138
- Adhesive GX-6300

Nose Fairing Cap
- \( t = 0.25 \)
- \( A = 13 \text{ ft}^2 \)

Nose Fairing Barrel
- \( t = 0.05 \)
- \( A = 12 \text{ ft}^2 \)

Ogive
- \( t = 0.15 \)
- \( A = 1050 \text{ ft}^2 \)
Silicone Seal Coat 92007

- Ablative SLA 561s (0.10 in.)
- Iridite MP30063
- Primer MP30138
- Adhesive 6X-6300

55°

95° +Z

55° +Y

-Z

-Y
V-455 Surface Coat

3/4 in. BX-250 (As Sprayed)

1/2 in. BX-250 (Machined Surface)

Iridite 513-707 Primer

DC92-007 Surface Coat

3/4 in. SLA 561s (As Sprayed)

Iridite DC1200 Primer

GX-6300 Adhesive

MICHOU OPERATIONS

LH₂ TANK TPS

CHART NO. 21
DATE
SPEAKER

V-455 Surface Coat

3/4 in. BX-250 (As Sprayed)

1/2 in. BX-250 (Machined Surface)

Iridite 513-707 Primer

DC92-007 Surface Coat

3/4 in. SLA 561s (As Sprayed)

Iridite DC1200 Primer

GX-6300 Adhesive
TPS DESIGN - SPECIAL AREAS

1/2 in. BX-250

BX-250 Closeout

3/4 in. SLA 561s

LH₂ Barrel/Aft Dome Closeout

Aluminum Washers

Foam

Thermal Isolator

Typical Attachment Fitting

LH₂ Barrel/Fwd Dome Closeout
Buy Items!

- Longitudinal Weld of Ogive Panels
- Ogive Body Assembly
- Baffle Assembly
- Barrel Weld Fixture
- Dome Rotation Fixture
- LO₂ Tank Weld Fixture Building 103
- Intertank Assembly
- Proof Test Building 110
- Spray Ablator Building 110
- LO₂ Tank & Intertank Splice
- Installation Position Building 103
- Spray Foam Building 410
- Check Out Building 451 Cell 1
- Pack & Ship

Dome Body Weld Fixture
- Dome Cap Weld Fixture
- Barrel Weld Fixture
- Barrel Weld Fixture
- Dome Cap Weld Fixture
- Aft Dome
- Aft Barrel
- Forward Barrels
- Forward Dome
- Barrel Cap Weld Fixture
- LH₂ Tank Weld Fixture Building 103

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ACTIVITY LOCATIONS

MICHoud OPERATIONS

DATE
SPEAKER

CHART NO. 24

WTR AIR FORCE MISSIONS
HUNTSVILLE
MISSISSIPPI TEST FACILITY
KENNEDY SPACE CENTER LAUNCH
PACK AND SHIP

MICHOUD ASSEMBLY FACILITY

NASA-MSFC-MAF

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