

**DTO IN-FLIGHT MEASUREMENTS OF THE SHUTTLE MK-I
TREADMILL**

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PURPOSE/OBJECTIVES:

The following measurements and derivations will be used to generate procedures and limits for the proper use of the Shuttle treadmill.

1. To evaluate the treadmill performance in-flight by:
measurement of:
 - a) subject equivalent weight load
 - b) elevation of the treadmill
 - c) treadmill speed, and subject pace
 - d) foot-ground forces
 - e) subject motion, especially leg, and trunk
 - f) subject metabolic response (when possible)
 - g) EMG recordings (when possible)
2. To derive mechanical work loads.
3. To relate mechanical work loads to subject work (metabolism).

JUSTIFICATION

A good theoretical basis exist for assuming that treadmill locomotion in space will closely approximate 1-g locomotion in terms of biomechanics, kinematics, and metabolic response. However, this has never been systematically demonstrated. Essential baseline performance studies on the Shuttle treadmill have not been done. After uncontrolled in-flight use of the Shuttle treadmill (MK-I*) there were reports of inadequate performance. This illustrates the need to gather baseline treadmill performance data to allow for preparation of operational manuals and adequate experiment planning.

A phased program is proposed to start as soon as possible with the current instrumentation available. Studies will be added as hardware and schedules allow for completion of the evaluation. Phase 1 will consist of measurements of speed, subject pace, weight equivalent load (WEL) and equivalent elevation of the treadmill. Phase 1-A will be introduced when foot/ground force hardware and other instrumentation become available. Phase 2 would consist of using the MK-II treadmill equipped with integral force and grade instrumentation. The MK-II is scheduled for availability in a year.

* MK-I developed by William Thornton and Henry Whitmore 1974

A minimum of 3 flights for each phase is requested. A second crewmember is required for filming and recording at each exercise level. Information from Phase 1 will contribute to later phases of development of the hardware.

SUPPORT REQUIREMENTS:

The Shuttle treadmill will be calibrated as specified by NASA (Boeing). The Human Performance Lab and/or the Mid-deck of the Shuttle Mock-Up will be the site of the familiarization and data sessions preflight.

EQUIPMENT REQUIRED:

GROUND SUPPORT EQUIPMENT:

1. Phase 1

Shuttle MK-1 Treadmill (Orbiter hardware
and training bungees) in ground
support test fixture
Cameras (motion pictures)
Cardiotachometer (calibrated)

2. Phase 1-A

Shuttle MK-1 Treadmill (Orbiter hardware)
in ground support test fixture
Cameras (motion pictures)
Cardiotachometer (calibrated)
Foot/Ground Force Measurement Apparatus
Respiratory Gas Analysis System *
EMG Recording Equipment *

CERTIFICATION: Unique hardware to support this test is classified as Non-Critical, Class D-DSO per NMI 8010.1, and will be certified for safety and compatability per NSTS 21096, "Program Requirements Document for Non-Critical DSO/DTO Hardware".

FLIGHT HARDWARE:

1. Phase 1A

Mechanical Scale
Harness and electrodes
EMG amplifiers and Recorder *
Respiratory Gas Analysis System *

2. Phase 1

Mechanical Scale
Harness and electrodes
Foot/Ground Force Measurement In Treadmill
EMG amplifiers and Recorder *
Respiratory Gas Analysis System *

* When available and stowage schedule allows.

WEIGHT OF FLIGHT HARDWARE: 2 pounds - scale
35 pounds - Gas Analysis System*
3 pounds - EMG System *

* When available and stowage schedule allows.

VOLUME OF FLIGHT HARDWARE: .25 locker minimum
1.5 locker maximum

STOWAGE: Locker stowed for launch and entry.

DATA AND PHOTO REQUIREMENTS: In-flight documentary
35mm still photos (six photos) and five minutes of 16 mm
footage are requested.

**ORBITER POWER, SPECIAL LIGHTING, WATER, WASTE
DISPOSAL, etc.:** 100 Watts, 110 Volt, 400 Hz **

** When the EMG System and the Respiratory Gas
Analysis System is available. Otherwise the
usage will be NONE.

TEST CONDITIONS/ACTIVITY REQUIRED

Preflight:

The subjects will be exercise on the MK-I flight treadmill with characteristics equivalent to the in-flight unit. One familiarization session will be held. A second session will involve the DSO protocol for exercise using the MK-I treadmill. Baseline measurements will be recorded for force loads, EMG responses, and metabolic loads during the exercise session on the MK-I treadmill.

In-Flight:

The calibrated treadmill will be configured for usage. The bungee cords will be adjusted to the desired equivalent weight which will be measured by the mechanical scale and recorded. At each treadmill speed the following measurements will be recorded: belt speed, subject pace (steps counted for one minute), indicated speed, locomotion mode (walk, jog, run) and a lateral filming for 10-15 seconds taken with the Arriflex 24 FPS and still photos using a 5 mm lens. Comments regarding the hardware will be recorded. Data for single speed indicator calibration will be taken by timing ten belt revolutions.

Postflight:

A thirty minute debrief session will be held to document the comments of the operators. The in-flight treadmill will be calibrated.

PREFLIGHT: ACTIVITY	DURATION	SCHEDULE	PERFORMANCE CONSTRAINTS
FAM Session	60 min	L-60	N/A
Training	60 min	L-15 to 30	N/A
INFLIGHT:			
Hardware Set Up and Test	10 min	FD3	N/A
Hardware Test	30 min	FD3	N/A
Photos	5 min	FD3	N/A
POSTFLIGHT:			
Debrief	30 min	R+2	N/A