Exhibit Section: Air 3.1 General Description:

"Pterosaurs: Adapted for Flight" is a theater video situated near the entrance to the Air section of the American Museum of Natural History exhibit, "Pterosaurs: Flight in the Age of Dinosaurs." The program brings visitors up-to-speed on the basic principles of pterosaur flight and aerodynamics so that they are prepared to explore pterosaur flight for themselves in upcoming interactive exhibits.

Story structure:
Flight is described in the context of adaptations that allowed pterosaurs to fly — to be the first vertebrates to achieve powered flight.

Visitors will learn about pterosaur hollow bones (WEIGHT) that were reinforced allowing for robust flight muscles (THRUST). Their wings had a cambered airfoil shape that generated LIFT. Long narrow wings reduced DRAG for larger pterosaurs, while shorter, wider wings allowed greater maneuverability among lighter-weight pterosaurs.

Final Message:
Although no one will ever see a Pterosaur alive, scientists can apply powerful new techniques for interpreting data and develop new theories about how pterosaurs lived and were adapted for flight.

NARRATION

Long before there were pterosaurs, insects were the only powered flyers on Earth.

Vertebrates — animals with backbones — are much heavier than insects.

Weight is the most obvious challenge to flight.

Over 200 million years ago the first vertebrates to overcome the challenge and achieve powered flight were pterosaurs.

The adaptations that allowed them to fly can help describe how the forces of flight work and interact.

[Title: PTEROSAURS: ADAPTED FOR FLIGHT]

Pterosaur species ranged from swift, small flyers like Jeholopterus ...

to massive creatures like Quetzalcoatlus — the largest known flying creature of all time.
How could *Quetzalcoatlus* — estimated to have stood nearly 16 feet tall — have launched into the air and flown?

One adaptation is in their bones.

Pterosaur bones were hollow, with extremely thin walls.

Internal struts reinforced the bones, so they were lightweight yet strong.

Pterosaurs had another, special adaptation — the way they launched.

Powerful front and hind limbs allowed *Quetzalcoatlus* to take off into the air in an explosive split second.

Perhaps the most important adaptation that allowed pterosaurs to fly is this: the shape of their wings.

Pterosaur wings are thicker in front — the part that faces the direction of travel.

It’s how air flows around this shape that generates lift.

Much later in Earth’s history birds and bats independently evolved this same wing shape.

Aircraft designers call this shape a cambered airfoil.

In a wind tunnel, jets of air allow us to see what’s usually invisible: air as a fluid medium that flows around anything in its path.

The air moves faster over the top of the airfoil compared to the underside.

That’s because the airfoil shape and angle force the air to spin into vortices on the wing.

The spinning air makes the air on top move faster and the air on the underside move slower — creating a pressure difference.

It’s the pressure difference between the upper and lower air that generates lift.

For every airfoil shape and speed, there’s an angle of attack that provides the most effective lift.

Of course, pterosaurs didn’t fly in wind tunnels.

Pterosaurs and other animal flyers flap their wings and adjust their angle of attack during flight.

Most of the resulting lift goes to holding up their weight, but a small portion also helps to thrust themselves forward.
How often would pterosaurs have had to flap their wings?

In part that depends on how much air resistance or drag they encountered.

Large pterosaurs, like large birds today, would tire out after a few minutes of flapping.

Long, narrow wings are an adaptation that reduces drag.

Large birds can take breaks from flapping by soaring on rising thermals of air, or by gliding on strong ocean winds.

By taking advantage of these outside sources of lift, larger pterosaurs could have travelled long distances at high speeds.

Lighter-weight pterosaurs like *Jeholopterus* could afford stouter wings.

They would have flapped more frequently, but they had much greater control over their speed and direction.

In any environment, powered flight has to achieve a balance between weight, lift, thrust and drag.

Flapping wings thrust an animal forward, and counteract drag.

The forward motion displaces air around the wing.

Almost all of the resulting lift goes to counteracting the animal’s weight.

Flying takes a lot of energy.

Why did pterosaurs do it?

Flight provides an escape from predators – new ways to catch prey – flight widens the range for finding food and mates.

As the first vertebrate flyers, pterosaurs were incredibly successful.

They lived for over 150 million years and diversified into many species that were adapted to their unique habitats.

The last pterosaurs became extinct about 66 million years ago.

No one will ever see a pterosaur alive.

But as we find more pterosaur fossils and apply powerful new techniques for interpreting data...
we can develop new theories about how pterosaurs lived and were adapted for flight.
[Page 3:]

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Audio Network

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Footage Research
José Ramos
Rosemary Rotondi

Narration
Melynda Sims
NARRATION

[page 4:]
Exhibition Department of the
American Museum of Natural History

Senior Vice President for Exhibition
David Harvey

Exhibition Interpretation
Senior Director, Lauri Halderman
Margaret Dornfeld
JoAnn Gutin
Sasha Nemecek
Jose Ramos
Martin Schwabacher

Design
Director, Michael Meister
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Media and Interacts
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Joel Sweimler

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Director, Dean Marksian
Jake Adams
Jason Brougham
Jack Cesareo
Tom Doncourt
Tory Ferraro
Brittany Janaszak
NARRATION

Alec Madoff
Karl Matsuda
Genaro Mauricio
Kevin McAllister
Beck Meah
Andrea Raphael

[page 5:]
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