Countdown to Leadership, Teamwork, & Safety

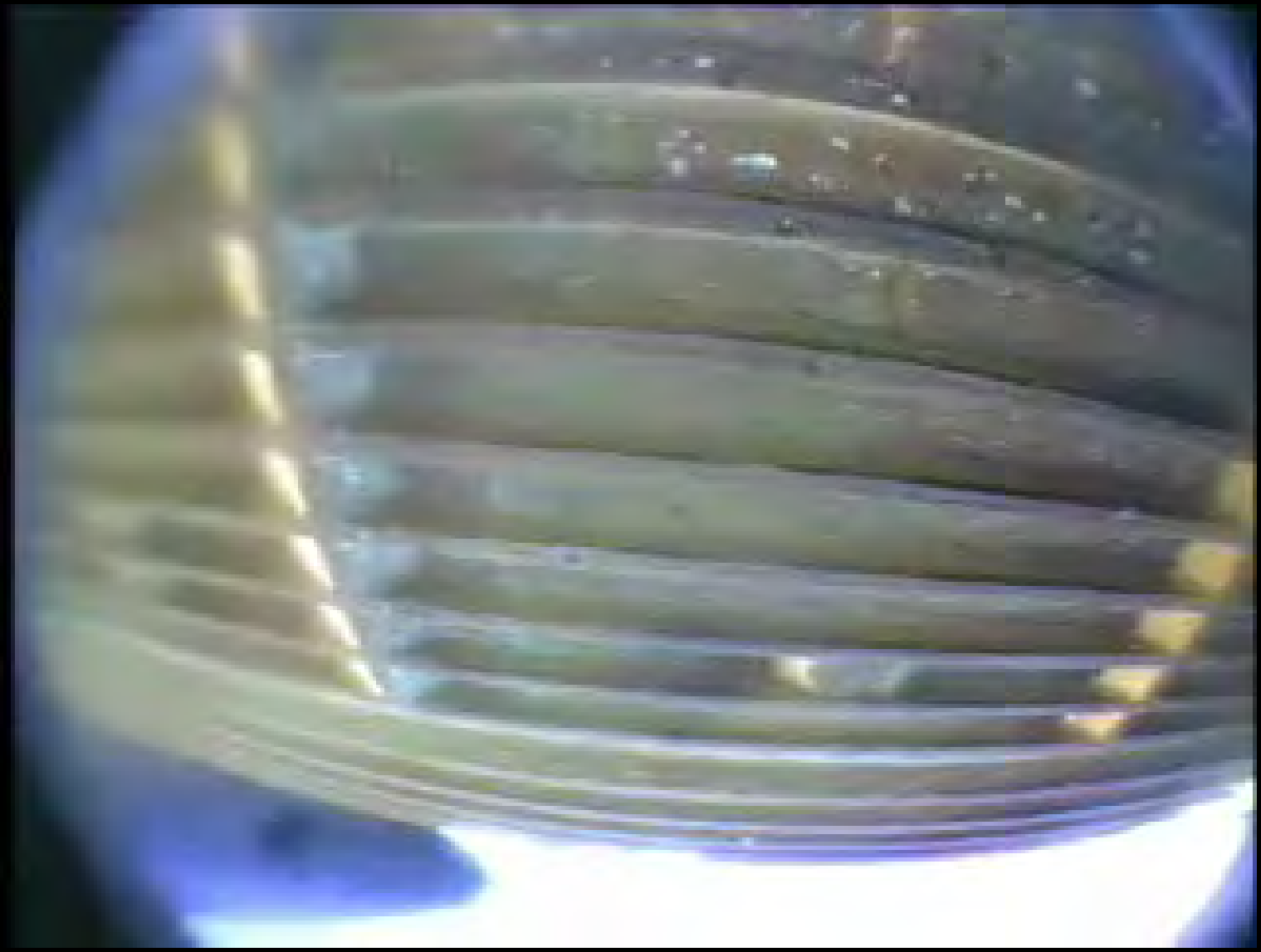
by Astronaut Mike Mullane

www.MikeMullane.com

Author of *'Riding Rockets'*

T-6 seconds

T-0 (zero)



T + 2 min 12 secs

T + 8 min 30 secs

World Class in Safety

World Class in Leadership & Teamwork

Safety Values

Beware of normalization of deviance.

Own your responsibilities.

Be accountable to the ‘good’.

Continuous self-improvement.

Values define who we are.

We don’t live our values because we are <u>told</u> to do so.

We are fiercely <u>self-motivated</u> to live our values.

Safety Values

Beware of normalization of deviance.

Own your responsibilities.

Be accountable to the ‘good’.

Continuous self-improvement.

This is

You are more than a team.
You are a family.

matter.

The families of your team members.

Failure is not an option.

Mission Control

Safety Values

Beware of Normalization of Deviance.

Normalization of Deviance

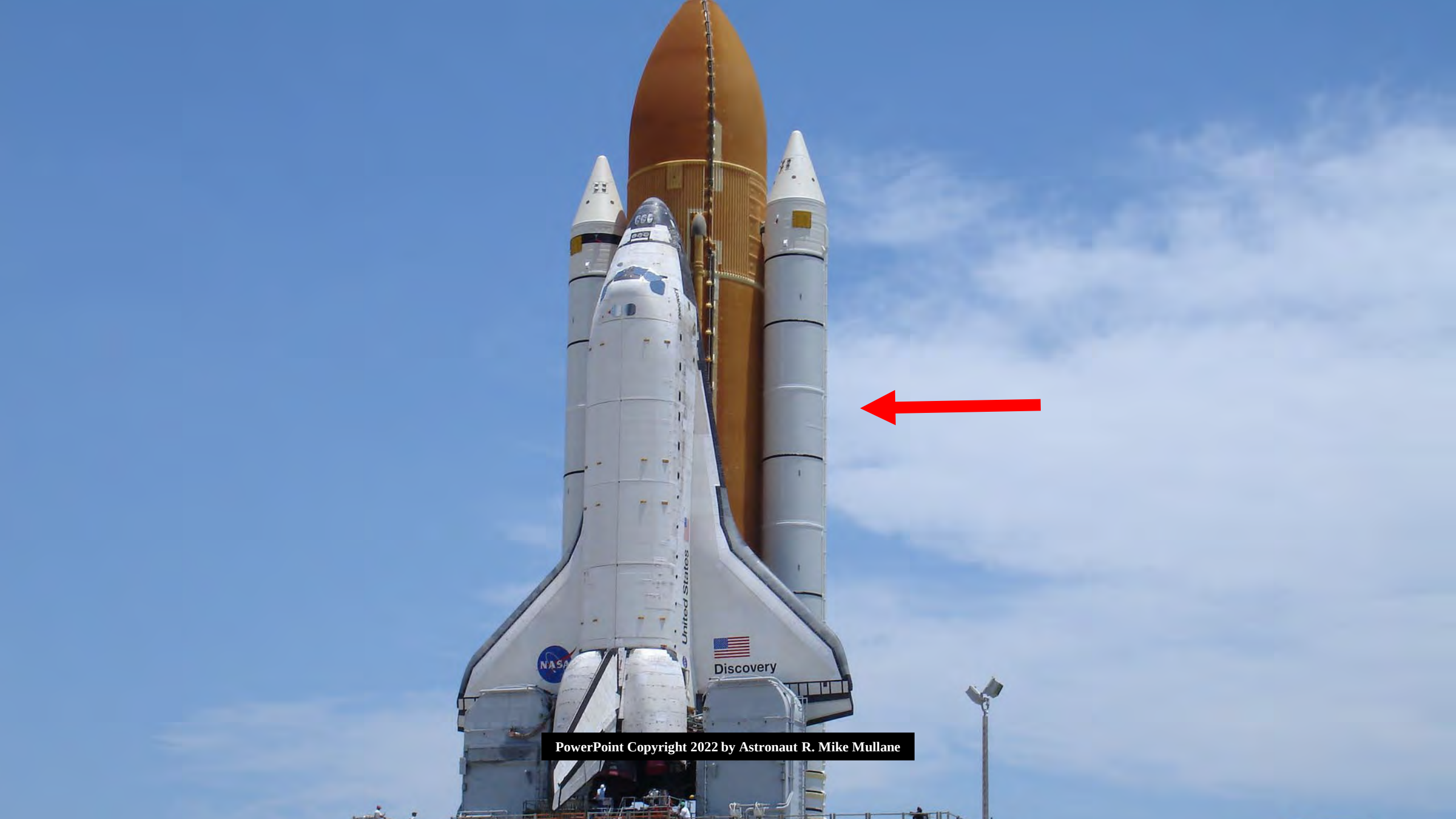
Diane Vaughan, ‘The Challenger Launch Decision’

Repeatedly deviating from best practices until that behavior becomes your new ‘normal’.

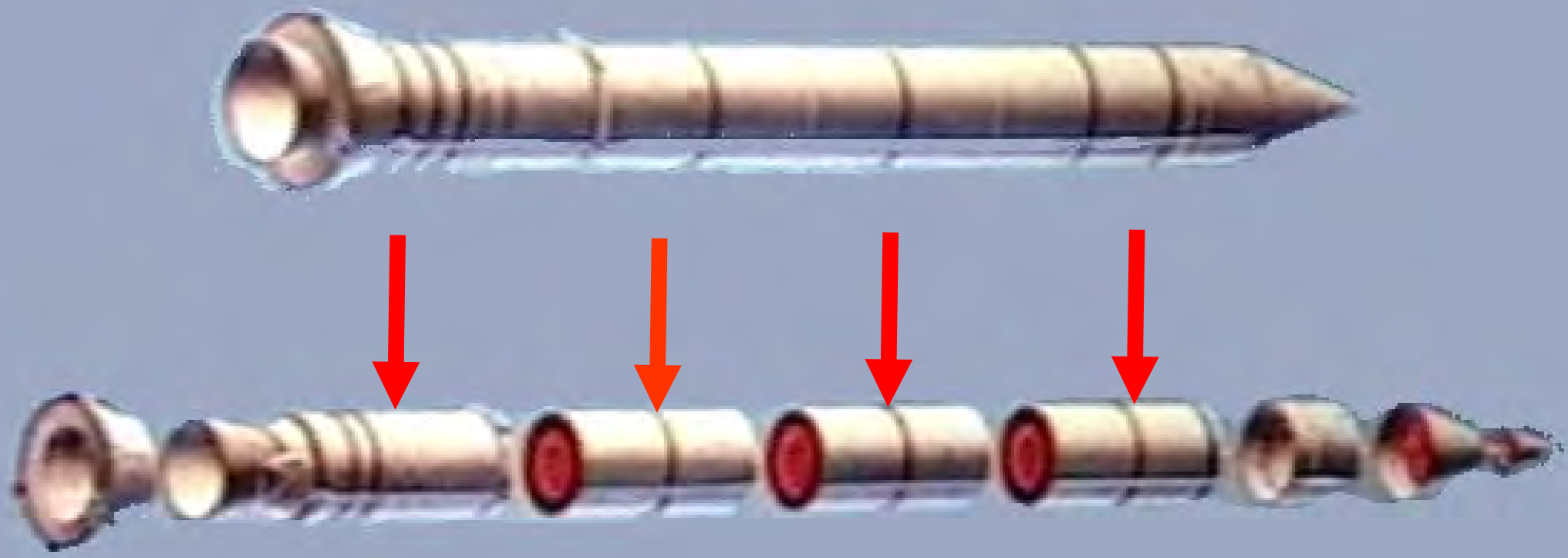
Pressure

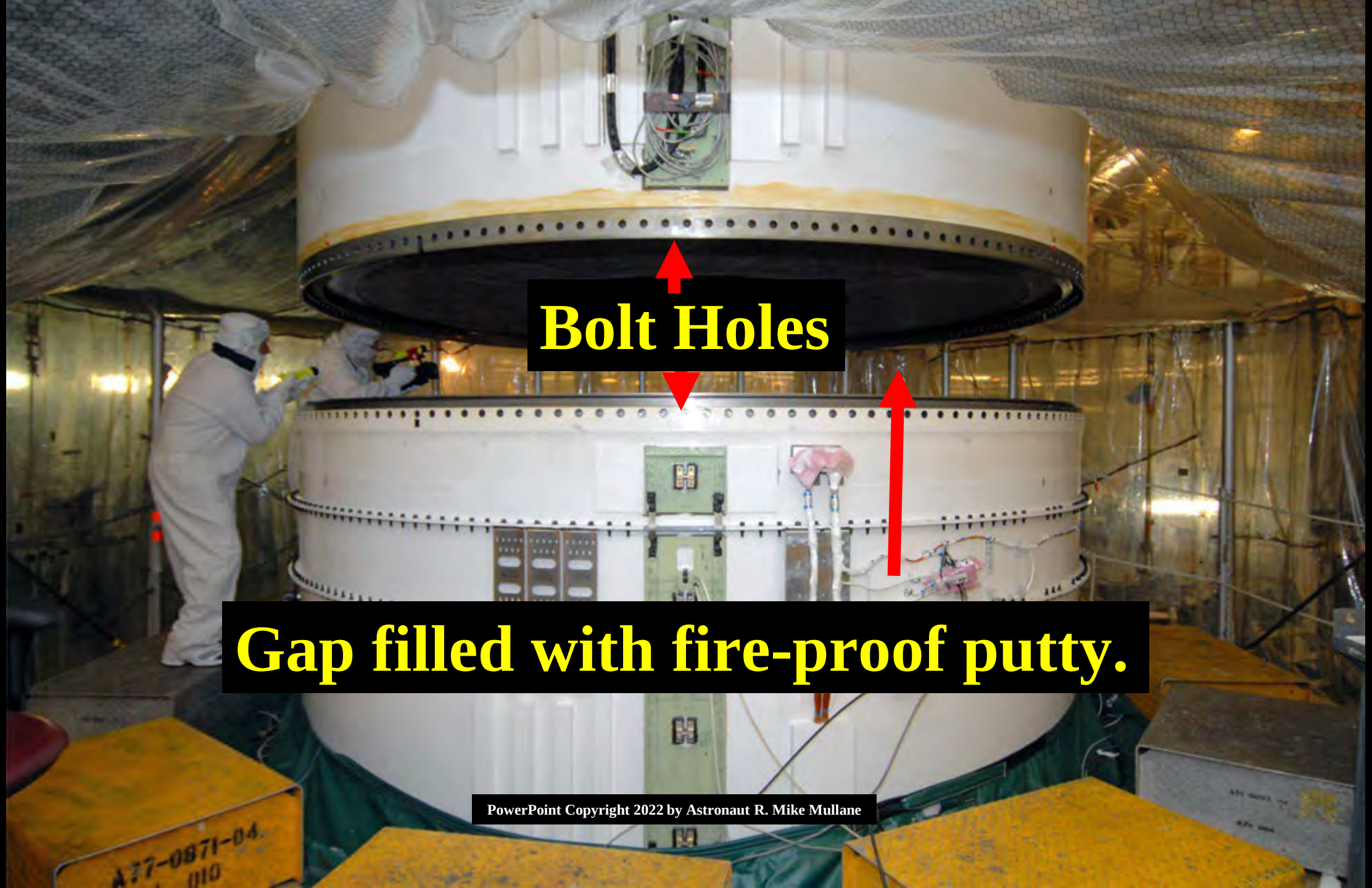
PWorse Nightmare e

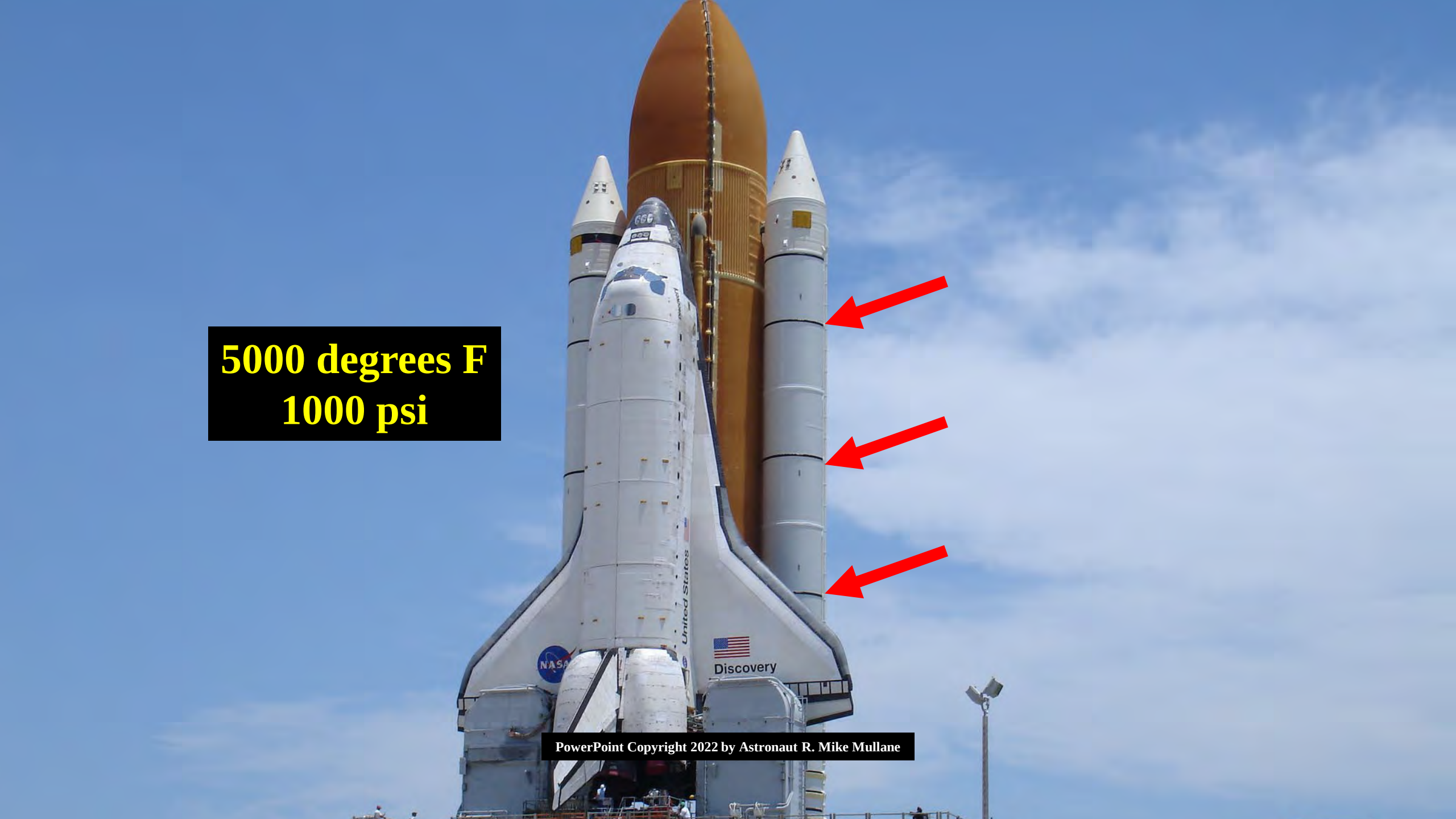

Predictable Surprise
Challenger, Jan 28, 1986

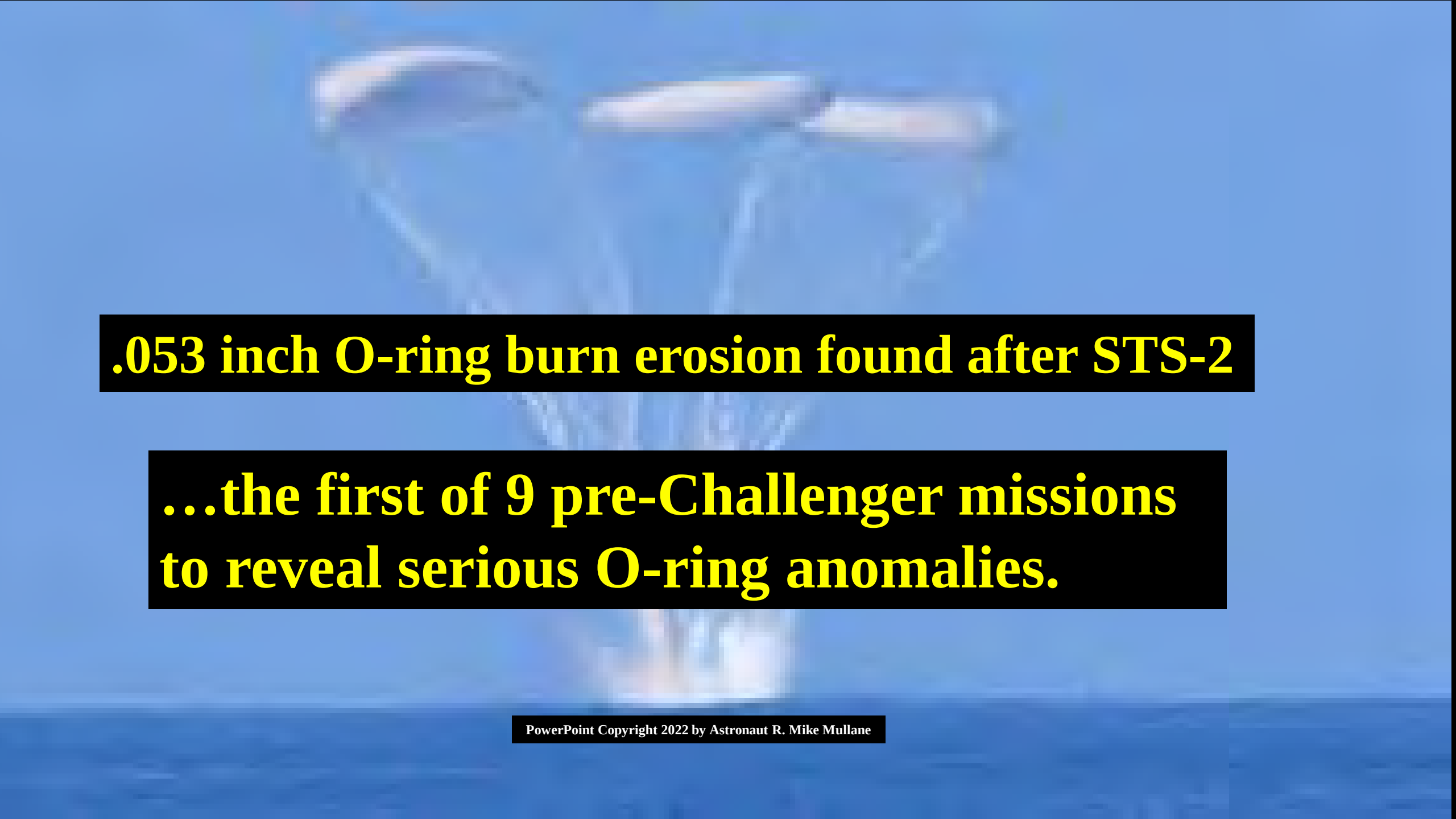


150 ft long **12 ft diameter** **1.3 million pounds**




Bolt Holes
Gap filled with fire-proof putty.
PowerPoint Copyright 2022 by Astronaut R. Mike Mullane


5000 degrees F
1000 psi
United States
Discovery
PowerPoint Copyright 2022 by Astronaut R. Mike Mullane



.053 inch O-ring burn erosion found after STS-2

…the first of 9 pre-Challenger missions to reveal serious O-ring anomalies.

Thiokol memo dated July 31, 1985 (6 months prior to Challenger)

“It is my very real fear, if we do not take immediate action to solve the O-ring problem, we stand in jeopardy of losing a flight, a crew, and all the launch pad facilities.”

Predictable Surprise

O-ring Design Risk Analysis Document

SRB CRITICAL ITEMS LIST

Sheet 1 of 2

Subsystem: SOLID ROCKET BOOSTER

Criticality Category: 1 Reaction Time: immediate to Sec.

Item Code: 10-01-01

Item Name: *Case, P/N (See Retention Rationale) (Joint Assys, Factory P/N 1U50147 Field: 1U50747

No. Required:

FMEA Page No.:

Critical Phases: Boost

Date: December 17, 1982

Analyst: Garber

Approved:

Failure Mode & Causes: Leakage at case assembly joints due to redundant O-ring seal failures or primary seal and leak check port O-ring failure.

NOTE: Leakage of the primary O-ring seal is classified as a single failure point due to possibility of loss of sealing at the secondary O-ring because of joint rotation after motor pressurization.

Failure Effect Summary: Actual Loss - Loss of mission, vehicle, and crew due to metal erosion, burnthrough, and probable case burst resulting in fire and deflagration.

Case, P/N 1U50129, 1U50131, 1U50130, 1U50185, ~~1U501473~~ 1U51473, 1U50715, 1U50716, 1U50717

A. DESIGN

The SRM case joint design is co... ...ses having identical dimensions.
The SRM joint uses centering clips which are installed in the gap between the tang O.D. and the outside ... to gathering and to reduce the total clevis gap

Criticality 1

'...single failure point...'

Loss of mission, vehicle and crew...

O-ring Design Risk Analysis Document

SRB CRITICAL ITEMS LIST

Sheet 1 of 2

Time Immediate to Sec.

Subsystem

Item Code

Item Name (Joint Assys, Factory P/N 1U50147 Field: 1U50747

Revision:

Critical Phases Boost

Failure Mode & Causes Leakage at case assembly joints due to redundant O-ring seal failures or primary seal and leak check port O-ring

NOTE: Leakage of the ... sealing at the second ... ibility of loss of

Failure Effect Summary ... probable case burst ... nthrough, and

Define risk RED LINES

O-ring Damage is Intolerable

Safety Best Practice: Flight Suspension

RATIONALE FOR RETENTION

Case, P/N 1U50129, 1U50131, 1U50130, 1U50185, ~~1U50147~~ 1U50473, 1U50715, 1U50716, 1U50717

A. DESIGN

The SRM case joint design is co... cases having identical dimensions.
The SRM joint uses centering cl... tang O.D. and the outside ... to gathering and to reduce the total clevis gap

4-YEARS

23 MISSIONS

9 missions with O-ring deviances

STS-2

Near Miss

← **Identical Failure Mode** →

STS-25

7 Dead

Pressure

Launch Schedule Pressures

President Nixon, 5 January 1972:

…reliable and versatile…

…replace all present launch vehicles…

…cost to taxpayers one-tenth of current rockets…

The Reality

Aircraft-like qualities:

Launch rate 24 missions/year.

Reuse-ability

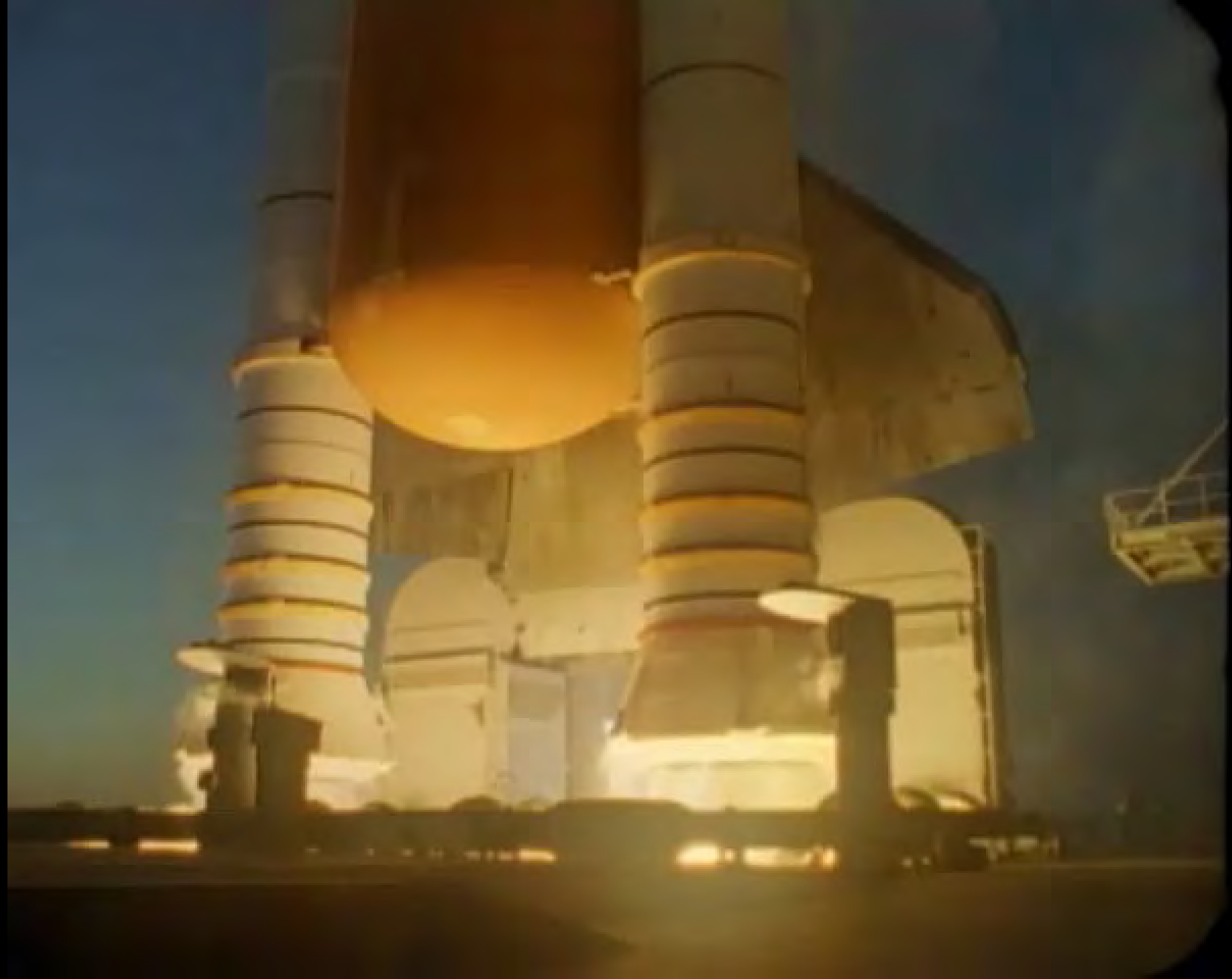
Reliability

Maintain-ability

Turn-ability

Affordability

Safety



Roger's Commission Contractor Testimony:

"The problem was the increasing launch rate. We were just getting buried under all this stuff...The system was about to come down under its own weight..."

Max launch rate:
11 missions in a 12-month period.

You are under intense time-critical pressure.

Temptation to shortcut your best practices.

What to do?

Revert to your training.

Invoke best practices.

Stop at your risk red lines.

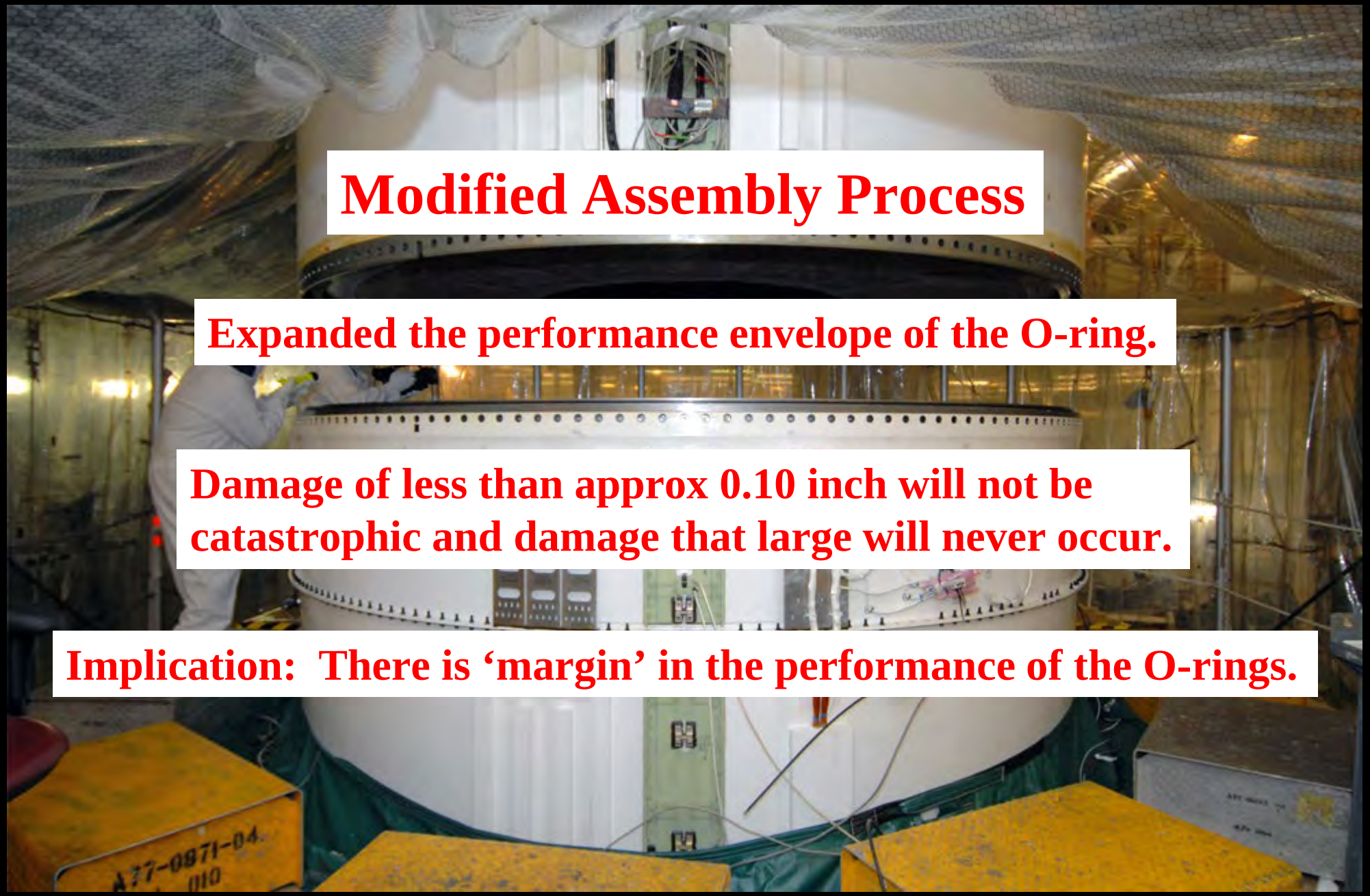
NASA: Shuttle flight suspension.

Accept deviances from best practices to maintain schedule.

The pain of a ‘Stop Work’ call is real and immediate.

The disaster that may result by accepting deviance is hypothetical and distant.

Teams succumb to pressures and step over risk red lines.



Modified Assembly Process

Expanded the performance envelope of the O-ring.

Damage of less than approx 0.10 inch will not be catastrophic and damage that large will never occur.

Implication: There is ‘margin’ in the performance of the O-rings.

O-ring Design Risk Analysis Document

SRB CRITICAL ITEMS LIST

Sheet 1 of 2

Subsystem: SOLID ROCKET BOOSTER

Criticality Category 1 Reaction Time Immediate to Sec.

Item Code: 10-01-01

Item Name: *Case, P/N (See Retention Rationale) (Joint Assys, Factory P/N 1U50147 Field: 1U50747

Page: A-6A

Revision:

No. Required: 1 (11 segments, 3 Field joints, 7 plant joints)

FMEA Page No.: A-4 of MSFC-RPT-724

Critical Phase: Boost

Date: December 17, 1982

Analyst: Garber

Approved:

Failure Mode & Causes: Leakage at case assembly joints due to redundant O-ring seal failures or primary seal and leak check port O-ring failure.

NOTE: Leakage of the primary O-ring seal is classified as a single failure point due to possibility of loss of sealing at the secondary O-ring because of joint rotation after motor pressurization.

Failure Effect Summary: Actual Loss - Loss of mission, vehicle, and crew due to metal erosion, burnthrough, and probable case burst resulting in fire and deflagration.

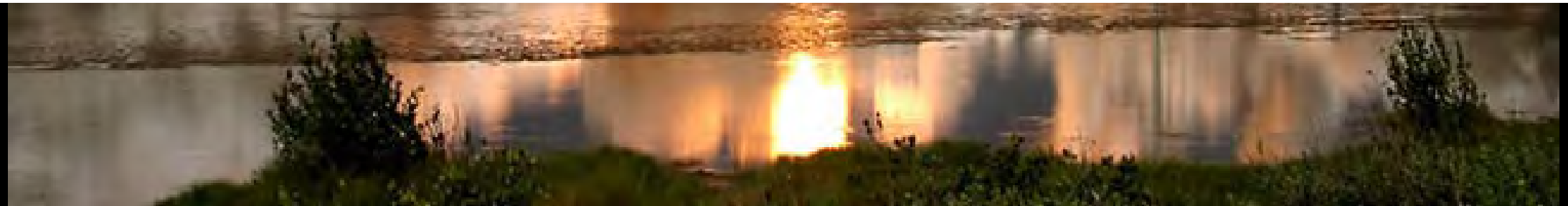
RATIONALE FOR RETENTION

Case, P/N 1U50129, 1U50131, 1U50130, 1U50185, ~~1U50147~~ 1U51473, 1U50715, 1U50716, 1U50717

A. DESIGN

The SRM case joint design is co[illegible] cases having identical dimensions.
The SRM joint uses centering cl[illegible] e tang O.D. and the outside
[illegible] to gathering and to reduce the total clevis gap

O-ring damage is slowly becoming ‘expected’.



In April 1984, Contractor manager recommended to NASA managers:

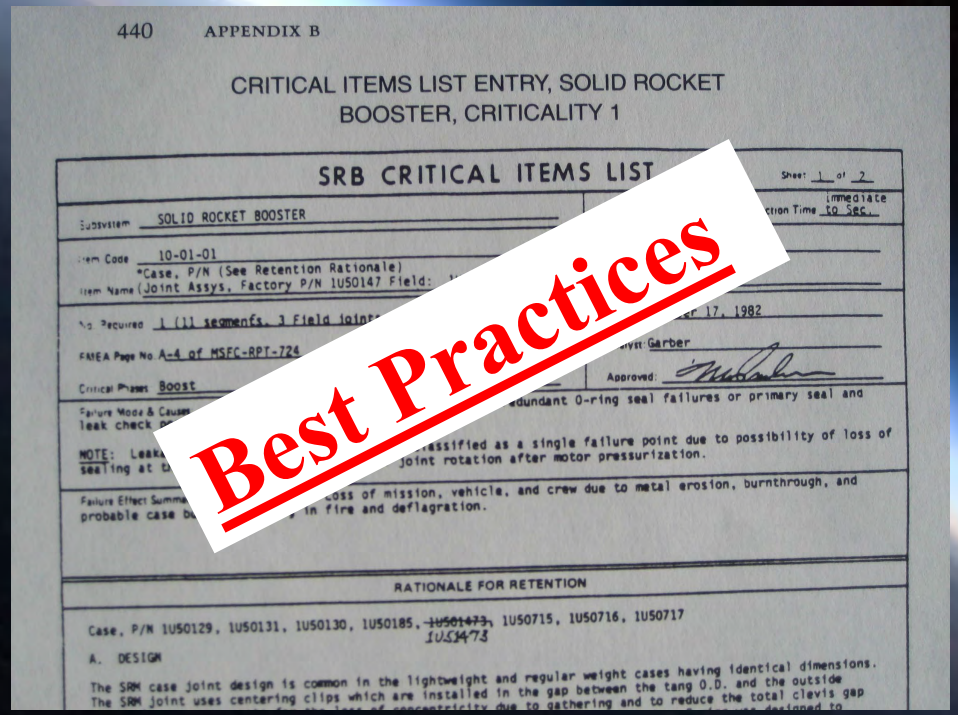
“Fly STS-11, accepting the possibility of some O-ring erosion due to hot gas impingement.”

The Challenger Launch Decision

by Diane Vaughan

“Between 1981 and 1984…Four times, an incident that first was seen as a deviant event was reinterpreted as nondeviant…”

Risk Ceiling



440 APPENDIX B

CRITICAL ITEMS LIST ENTRY, SOLID ROCKET BOOSTER, CRITICALITY 1

SRB CRITICAL ITEMS LIST

Sheet 1 of 2

Subsystem SOLID ROCKET BOOSTER

Item Code 10-01-01

*Case, P/N (See Retention Rationale)

Item Name (Joint Assys, Factory P/N 1U50147 Field:

No. Required 1 (11 segments, 3 Field joint

FMEA Page No. A-4 of MSFC-RPT-724

Critical Phase Boost

Failure Mode & Causes leak check

NOTE: Leak sealing at

Failure Effect Summ probable case

RATIONALE FOR RETENTION

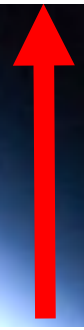
Case, P/N 1U50129, 1U50131, 1U50130, 1U50185, ~~1U50173,~~ 1U50473, 1U50715, 1U50716, 1U50717

A. DESIGN

The SRM case joint design is common in the lightweight and regular weight cases having identical dimensions. The SRM joint uses centering clips which are installed in the gap between the tang O.D. and the outside

Best Practices

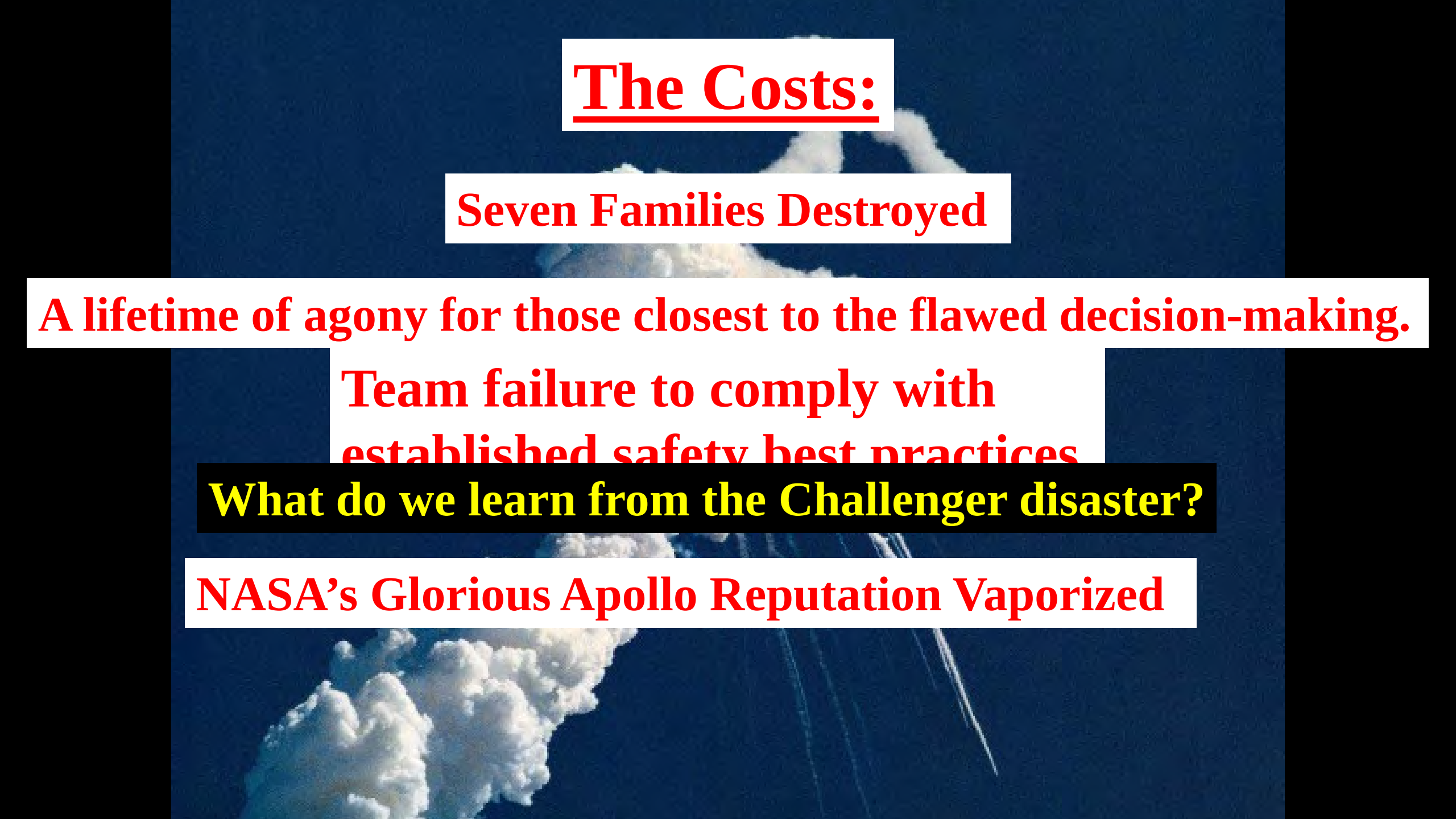
Future Risk Justification



Past Success with Risk Taking

Experience Base

Normalization of Deviance



The Costs:

Seven Families Destroyed

A lifetime of agony for those closest to the flawed decision-making.

Team failure to comply with established safety best practices

What do we learn from the Challenger disaster?

NASA's Glorious Apollo Reputation Vaporized

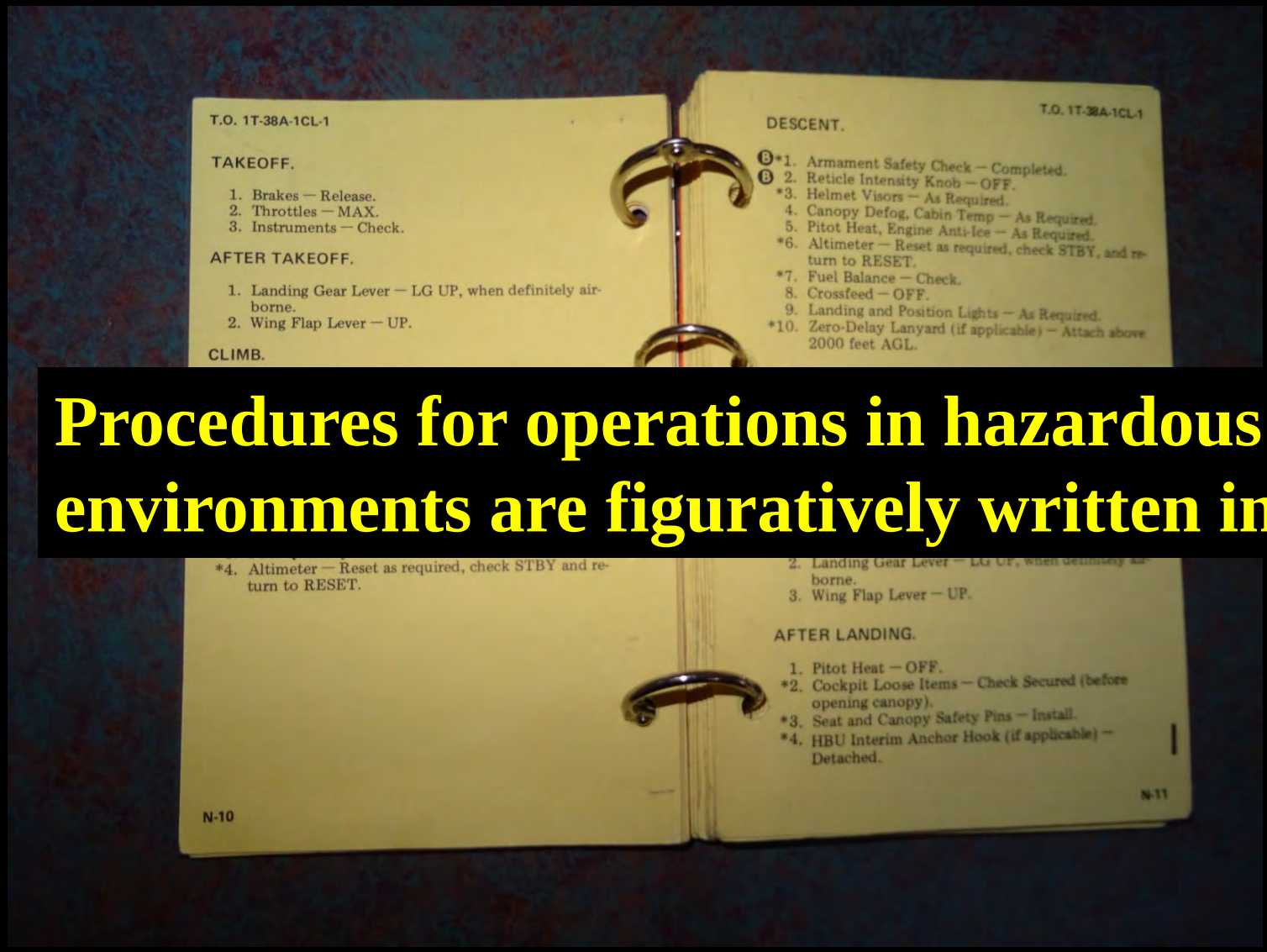
LESSON 1:

Risk has no memory.

Risk is not diminished as a function of your success in repeatedly taking a risk.

LESSON 2:

Procedural compliance should be a religion.



Procedures for operations in hazardous environments are figuratively written in blood.

Procedures for your operations
are figuratively written in blood.

LESSON 3:

There is never a ‘one-and-done’ when it comes to deviance from best practices.

You can’t ‘un-experience’ your success at taking a risk.

Risk Ceiling

440 APPENDIX B

CRITICAL ITEMS LIST ENTRY, SOLID ROCKET BOOSTER, CRITICALITY 1

SRB CRITICAL ITEMS

Subsystem SOLID ROCKET BOOSTER

Item Code 10-01-01

*Case, P/N (See Retention Rationale)

Item Name (Joint Assys, Factory P/N 1U50147

No. Required 1 (1) segments, 3 Fie

FMEA Page No. A-4 of MSFC-

Critical Phase Boos

December 17, 1982

Analyst: Garber

Approved:

ue to redundant O-ring seal failures or primary seal and

al is classified as a single failure point due to possibility of loss of

ause of joint rotation after motor pressurization.

Loss - Loss of mission, vehicle, and crew due to metal erosion, burnthrough, and

sulting in fire and deflagration.

RATIONALE FOR RETENTION

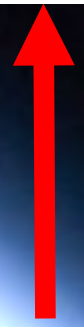
Case, P/N 1U50129, 1U50131, 1U50130, 1U50185, ~~1U50173,~~ 1U50473 1U50715, 1U50716, 1U50717

A. DESIGN

The SRM case joint design is common in the lightweight and regular weight cases having identical dimensions. The SRM joint uses centering clips which are installed in the gap between the tang O.D. and the outside

Your Best Practices

Future Risk Justification



Past Success with Risk Taking

Experience Base

Normalization of Deviance

LESSON 4:

Capitalize on Near-Misses.

Look beyond the obvious.

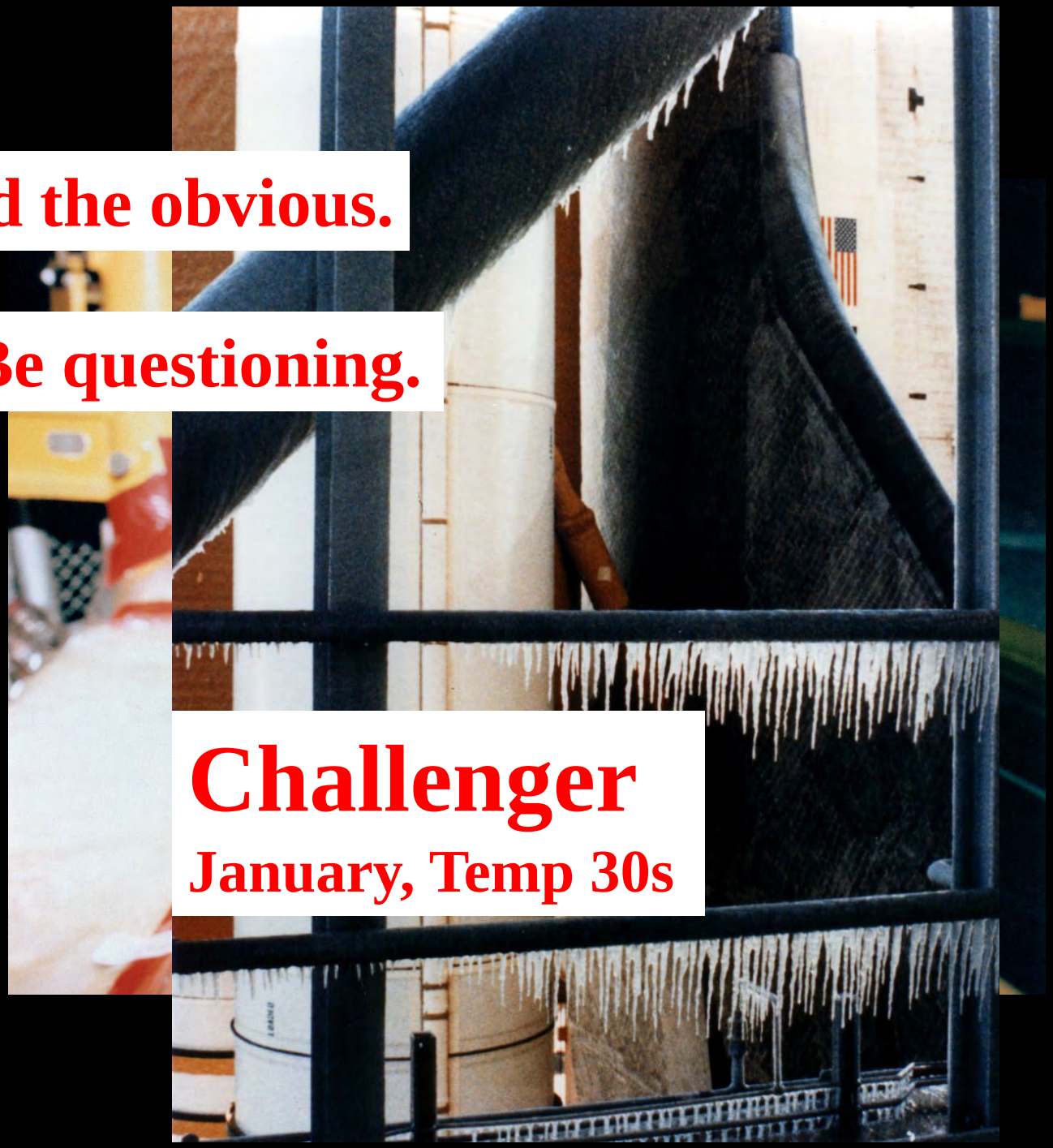
Be curious. Be questioning.

Look beyond the obvious.

Be curious. Be questioning.

STS-12 August, Temp 80s

STS-12
1984



Challenger
January, Temp 30s

LESSON 5:

Maintain a strong sense of vulnerability.

The 20-20 clarity that comes in the study of past disasters can erode our sense of vulnerably.

Normalization of Deviance…..
It can happen to you!

13 years

My Missions

Maiden flight of Orbiter Discovery

STS-12
1984

August 30, 1984

STS-27
1988

December 2, 1988


MULLANE ROSS SHEPHERD
GIBSON GARDNER


PER BOWL
XII

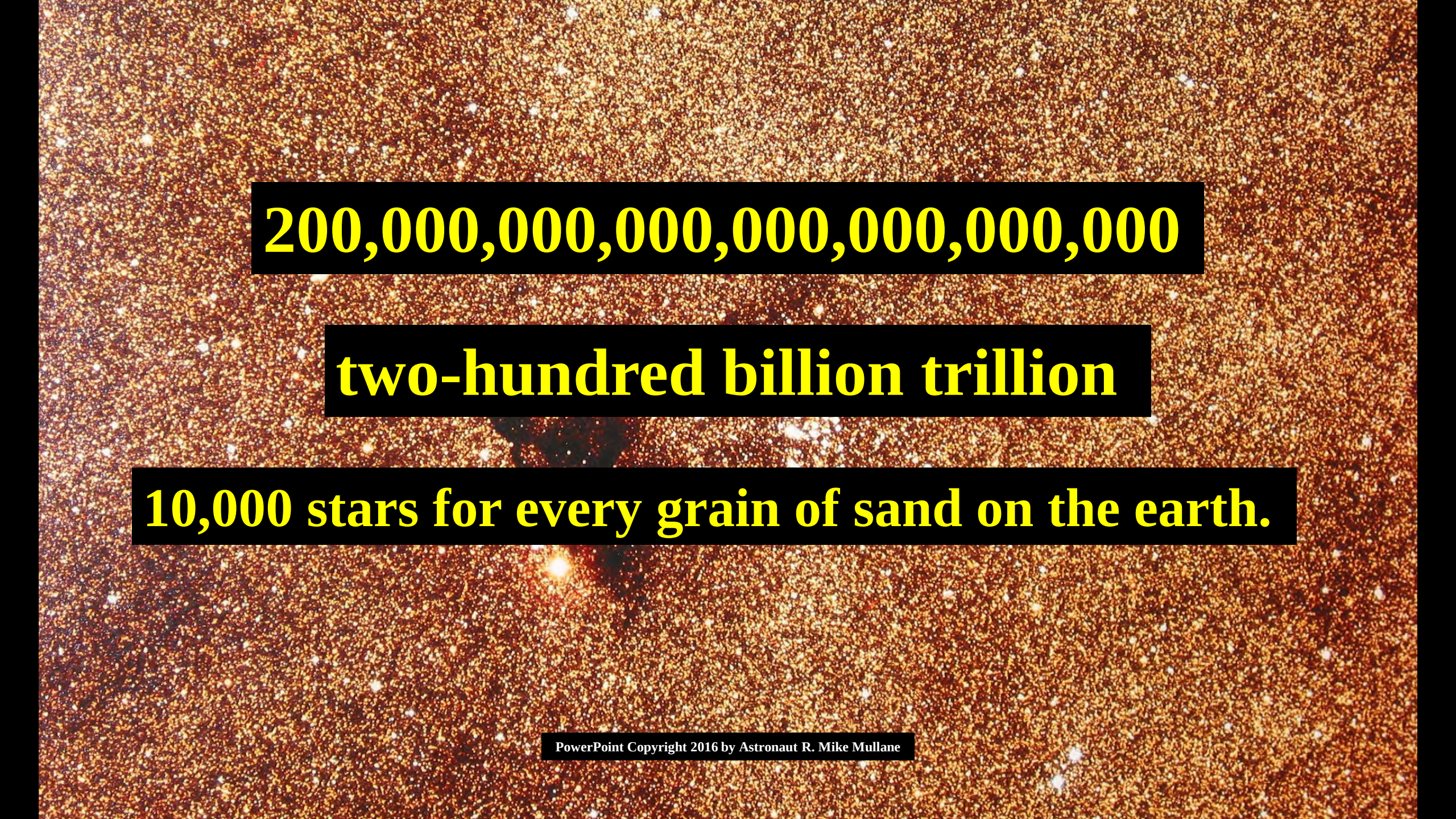

Billy Joel


Christie Brinkley

STS-36
1990

February 28, 1990

UFOs and Aliens



Safety Values

Own your responsibilities...

…because you will be accountable for your ownership.

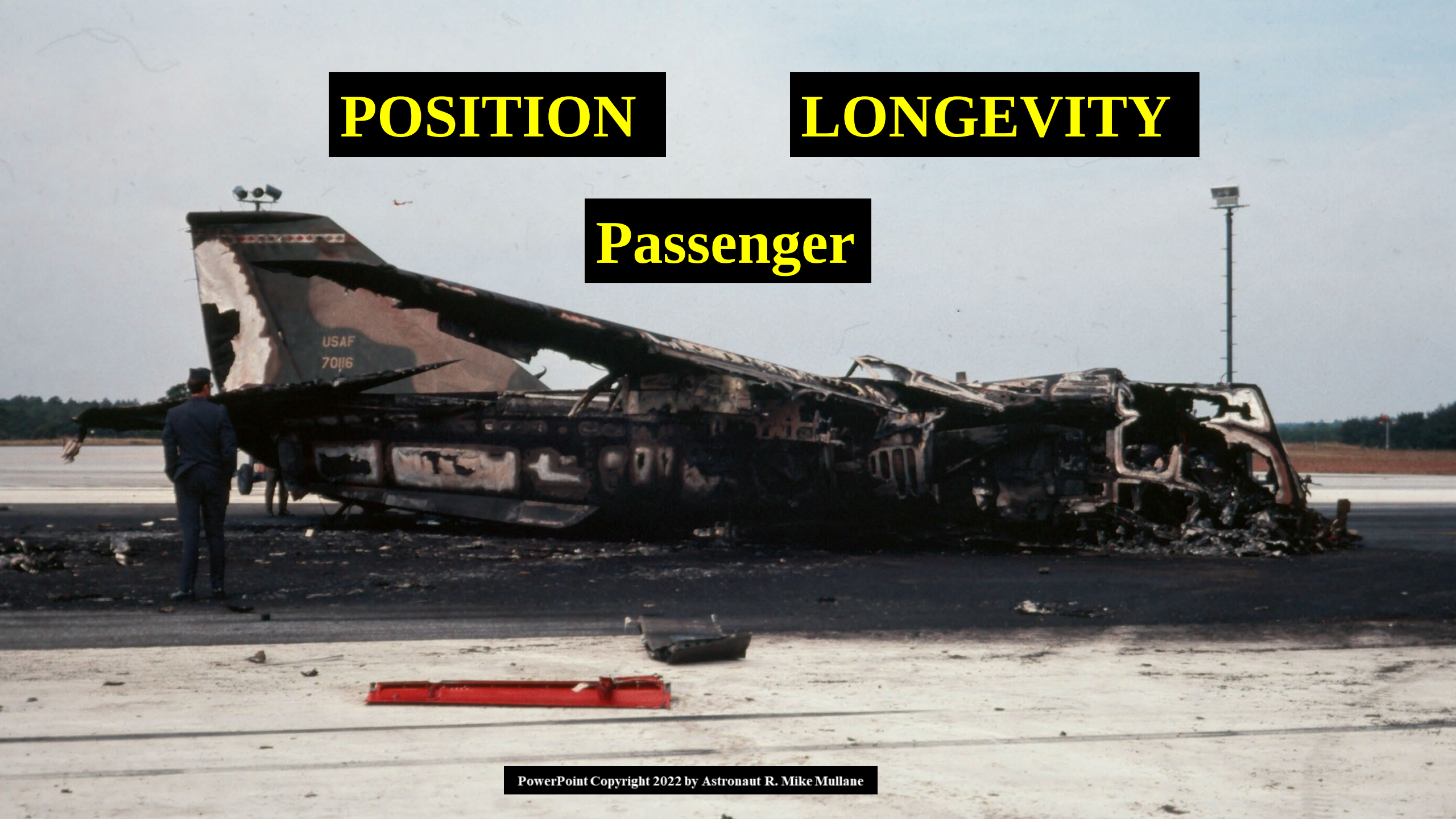
Meg Ryan

Goose

1500 ‘Goose’ hours in F-4 Phantom

First flight in F-111

‘Bingo Fuel’



LESSON 1:

Our safety responsibilities are non-transferable.

The rank or seniority of other team members does not minimize our own safety responsibilities.

Don’t be a passenger.

See something…Say something…Do something.

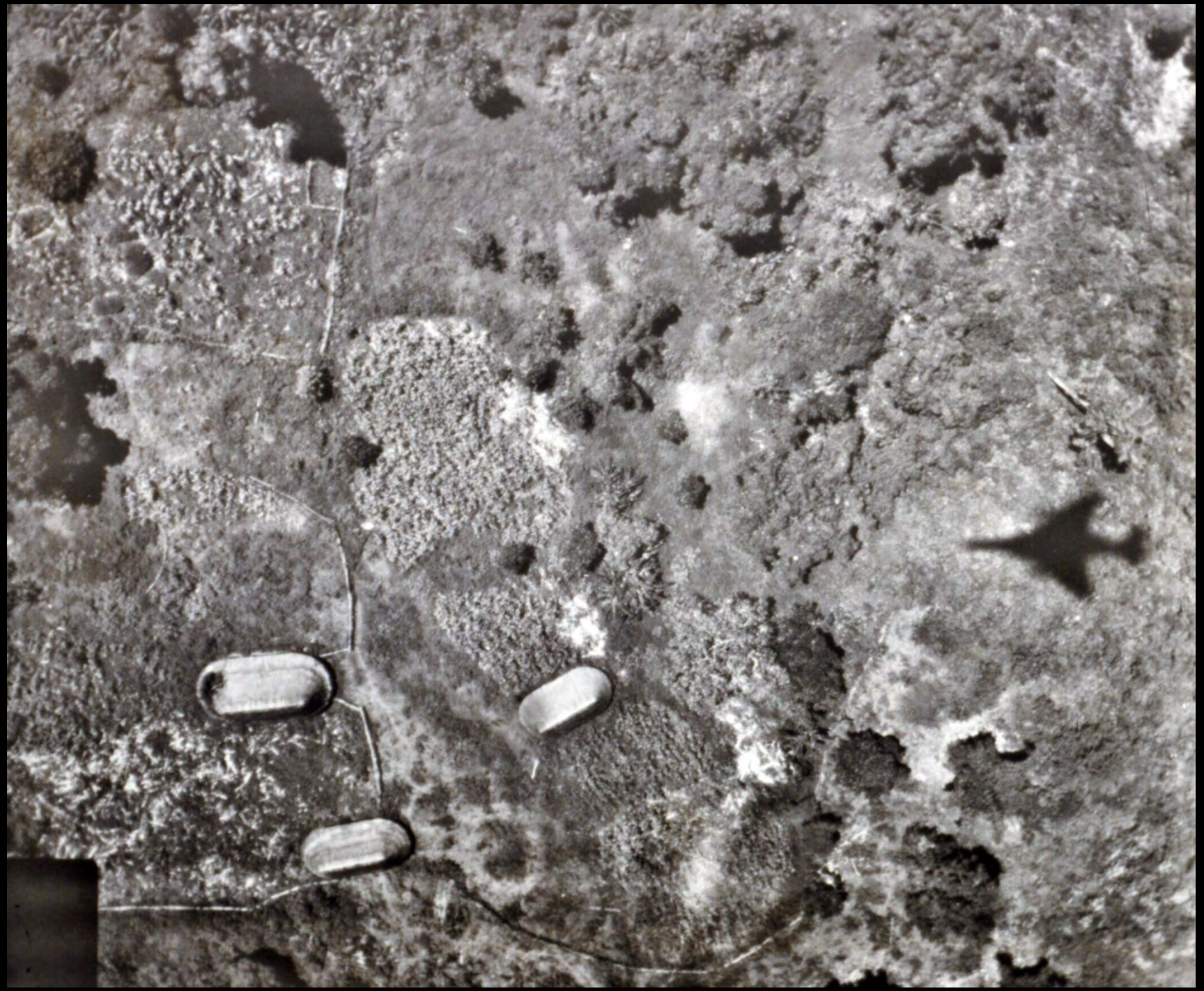
LESSON 2:

Leaders:
Empower your team members so they do count!

Foster an environment for ‘Courageous Conversations.’

Leadership Empowerment

RF-4C: Reconnaissance version of F-4 Phantom



Empowering me to engage in courageous conversations.

He wanted me to COUNT!

A Lesson in ‘Counting’

Shuttle had no ‘bailout’ option.

Aircraft-like qualities:

- Reuse-ability
- Reliability
- Maintain-ability
- Turn-ability
- Affordability
- Safety


Cockpit


413

That’s the way we’ve always done it.


Mock-up of Shuttle Side Hatch

Flight Surgeon Idea

Be curious. Be questioning.

See something, say something, do something.

Everybody Counts!

That’s the way we’ve always done it.

Safety Values

Be accountable to the ‘good’.


Accountability Nightmare


NASA
EL ONIZUKA
MIKE SMITH
DICK
RON McNAIR


NASA
NASA
NASA


ARDVARKS
1

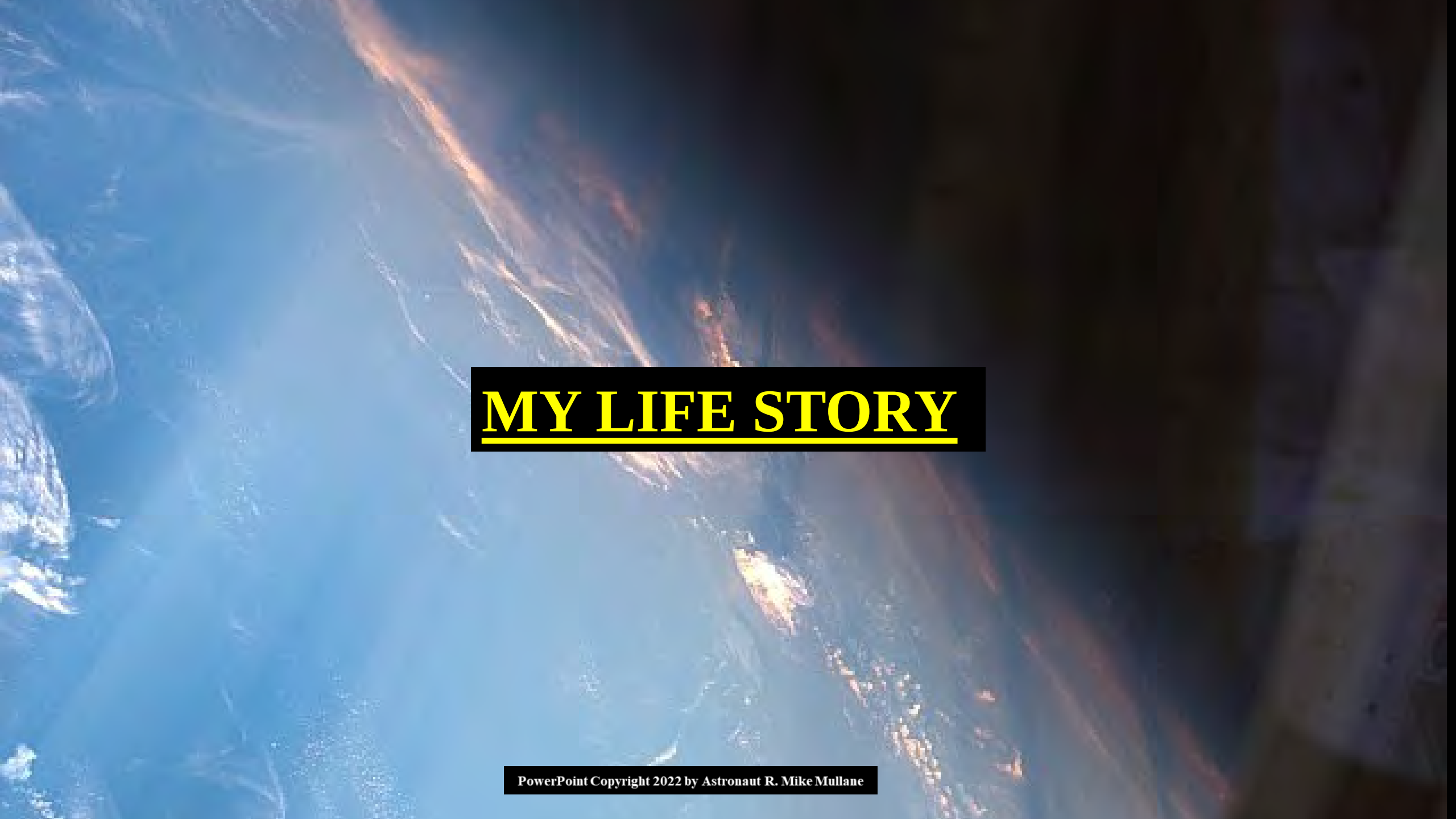
You can’t take back your ripples.

Be accountable to the ‘good’.

Safety Values

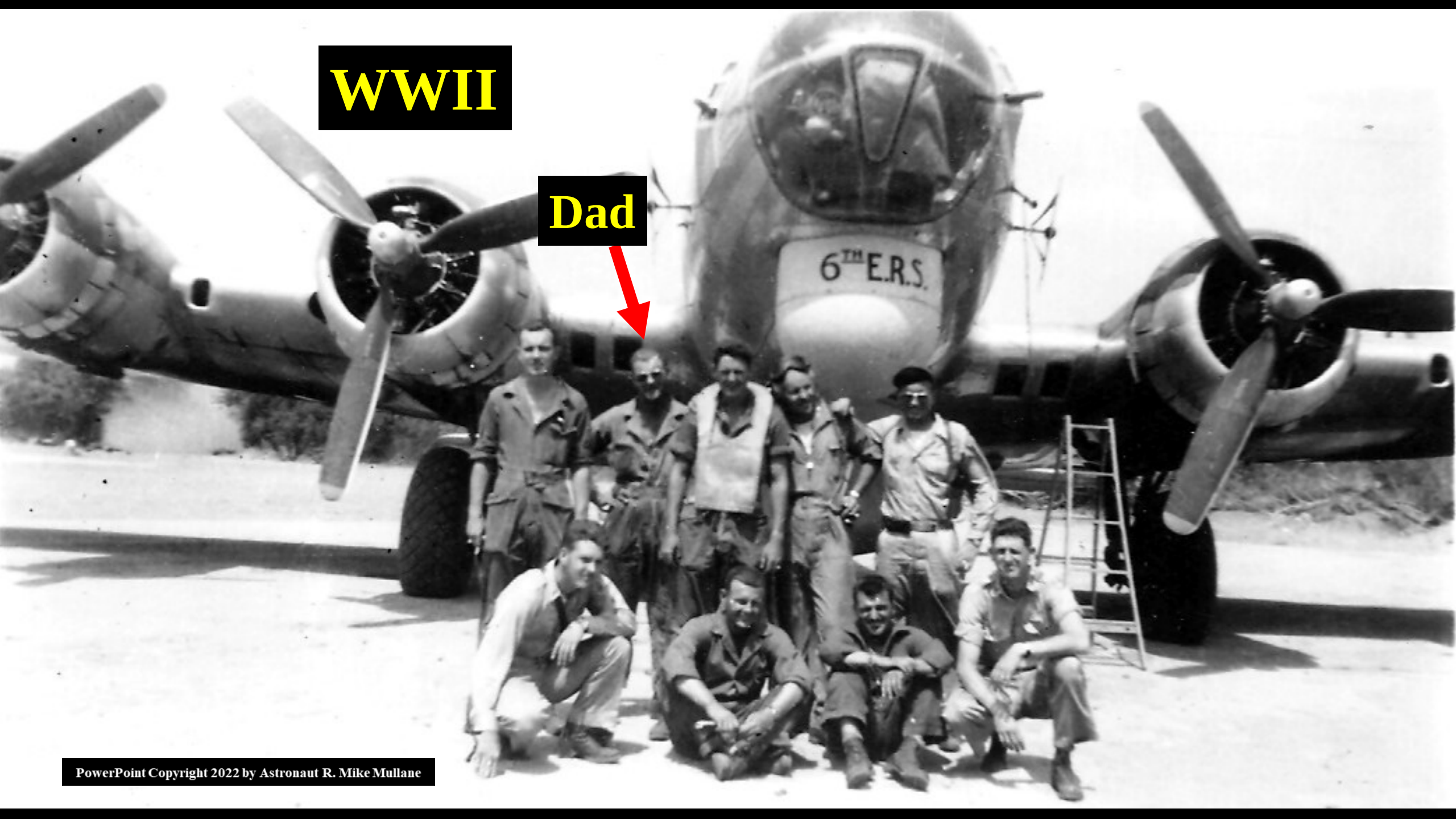
Continuous self-improvement.

A lifetime quest to build a better version of ourselves.



MY LIFE STORY

Born 3 weeks after WWII ended.



Hollywood significantly influenced my youth.

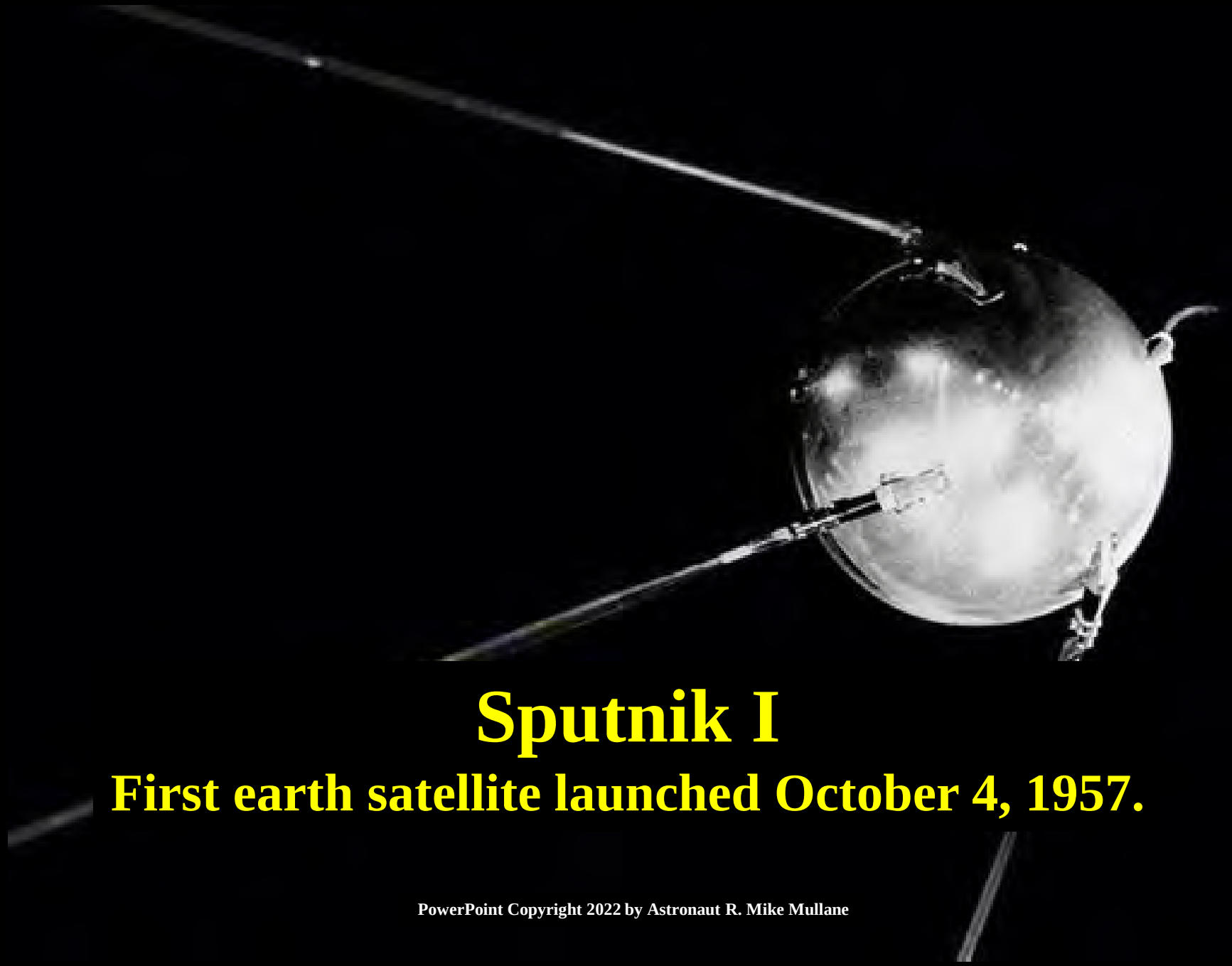
1949 1951 1952

When Worlds Collide

1950

1951

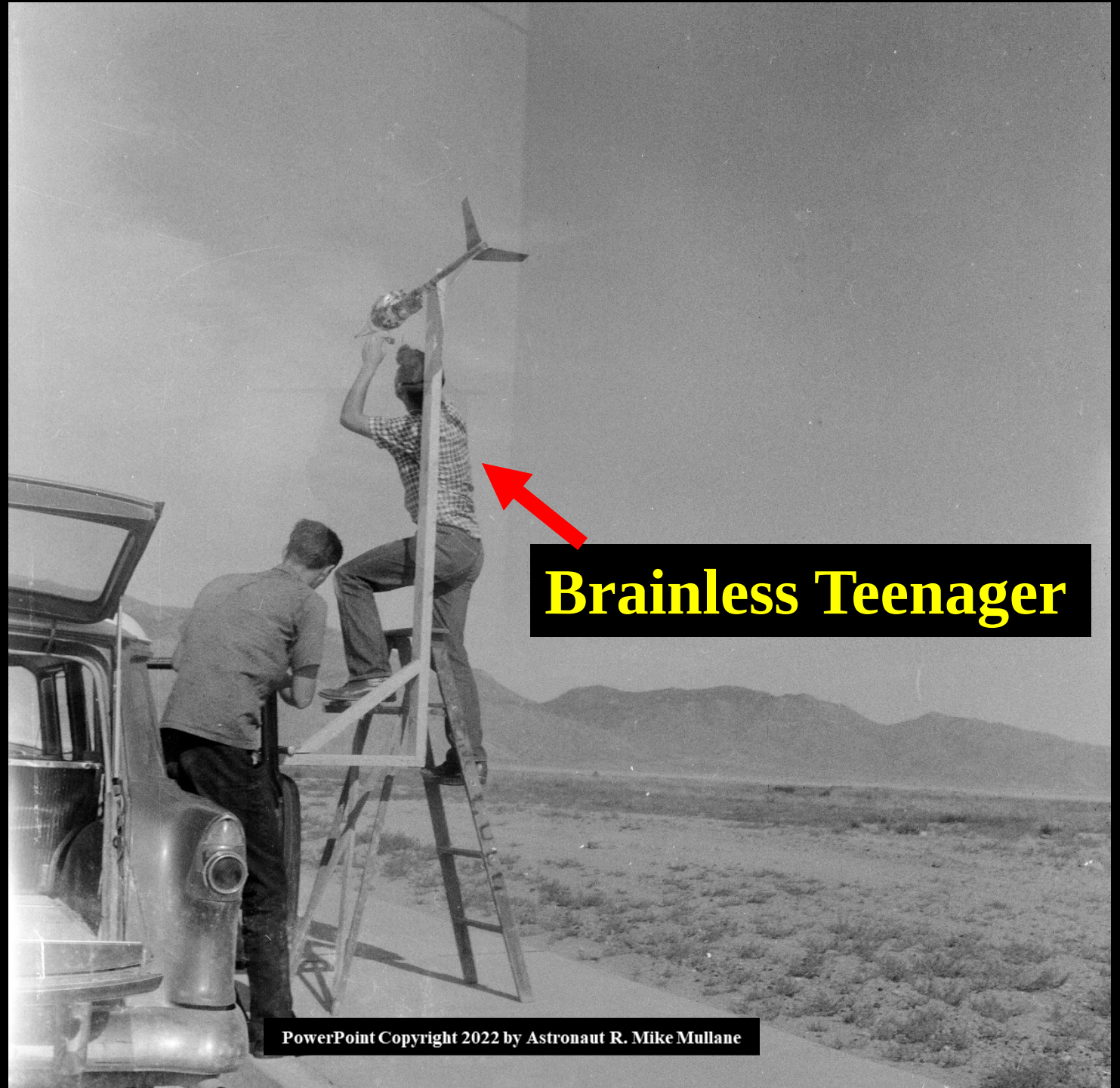
1956



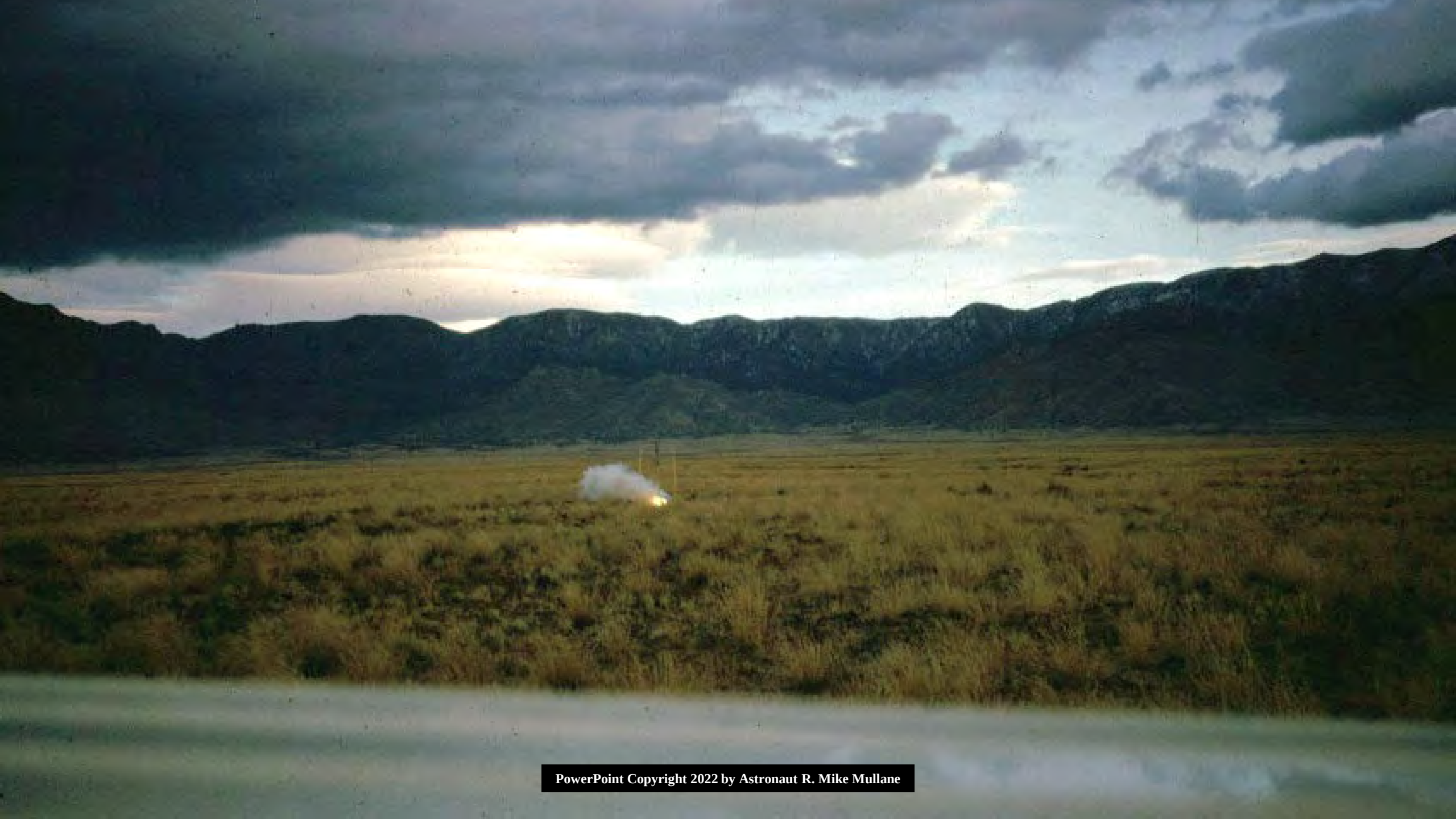
Sputnik I

First earth satellite launched October 4, 1957.

1960 Science Fair Rocket Project.


Brainless Teenager
PowerPoint Copyright 2022 by Astronaut R. Mike Mullane

Hazard Mitigation...teenager style.



1960 Science Fair Rocket Project.

Preliminary Report

1960 Science Project

Development of Biological Rocketsonde

Michael Mullane
St. Pius X High School

FORWARD

Today, this country and many others throughout the world are steadily working towards the conquest of space. Someday, I also plan to participate in this great undertaking. At present, I am trying to familiarize myself with the basic principles of rocketry and to gain as much knowledge and practical "know-how" in this field as possible. To do this, I have been working on a series of scientific projects. The first of these was the development of a capsule and a reliable recovery system. This project, "Instrument Recovery From High Altitude" was entered in the 1959 Science Fair. With the data collected from this project it is now possible for me to expand my 1960 project into the development of a monitoring and telementry system.

FORWARD

Today (1960), this country and many others throughout the world, are steadily working toward the conquest of space.

Someday, I also plan to participate in this great undertaking.

Mike Mullane, age 14

MICHAEL
MULLANE
Nickname: Mike; Baseball 2; Science Fair 1,3; 1st School; 1st Regional; 2nd State; Physics Club 4; Ambition: Attend Air Force Academy

Attend Air Force Academy

West Point

REPORT OF UNITED STATES MILITARY ACADEMY ENTRANCE EXAMINATION

FROM:

The Adjutant General
Department of the Army
Washington 25, D. C.
Attn: Military Academy Section (AGPB-M)

DATE

22 APRIL 1963

TO:

MR RICHARD M MULLANE
8602 LA SALA GRANDE NE
ALBUQUERQUE N M

SOURCE AND TYPE OF NOMINATION

THIRD ALTERNATE
N M AT LARGE
REP MONTOYA

RESULTS OF EXAMINATION WITH RESPECT TO QUALIFICATION

ACADEMIC	PHYSICAL APTITUDE	MEDICAL
QUALIFIED	QUALIFIED	QUALIFIED

YOUR STATUS, WITH RESPECT TO ADMISSION TO THE UNITED STATES MILITARY ACADEMY IS SHOWN BELOW

THIRD ALTERNATE

2. DISQUALIFIED FOR ADMISSION, as shown above **(See Note 1 on Reverse Side).**

3. QUALIFIED - NO VACANCY. You are fully qualified but there is no vacancy for your admission under the terms of your nomination. If your status changes for any reason, **YOU WILL BE NOTIFIED PROMPTLY.**

4. QUALIFIED - STATUS PENDING. You are fully qualified but your right to admission under the terms of your appointment depends upon the outcome of the presently undetermined status of the candidate, or candidates, ahead of you. **YOU WILL BE NOTIFIED AS SOON AS FINAL DETERMINATION IS MADE.**

5. MEDICAL RE-EXAMINATION AUTHORIZED. **(Read Note 2 on Reverse Side)** Should you desire a medical re-examination you are authorized to report as early as possible, **AND NOT LATER THAN**

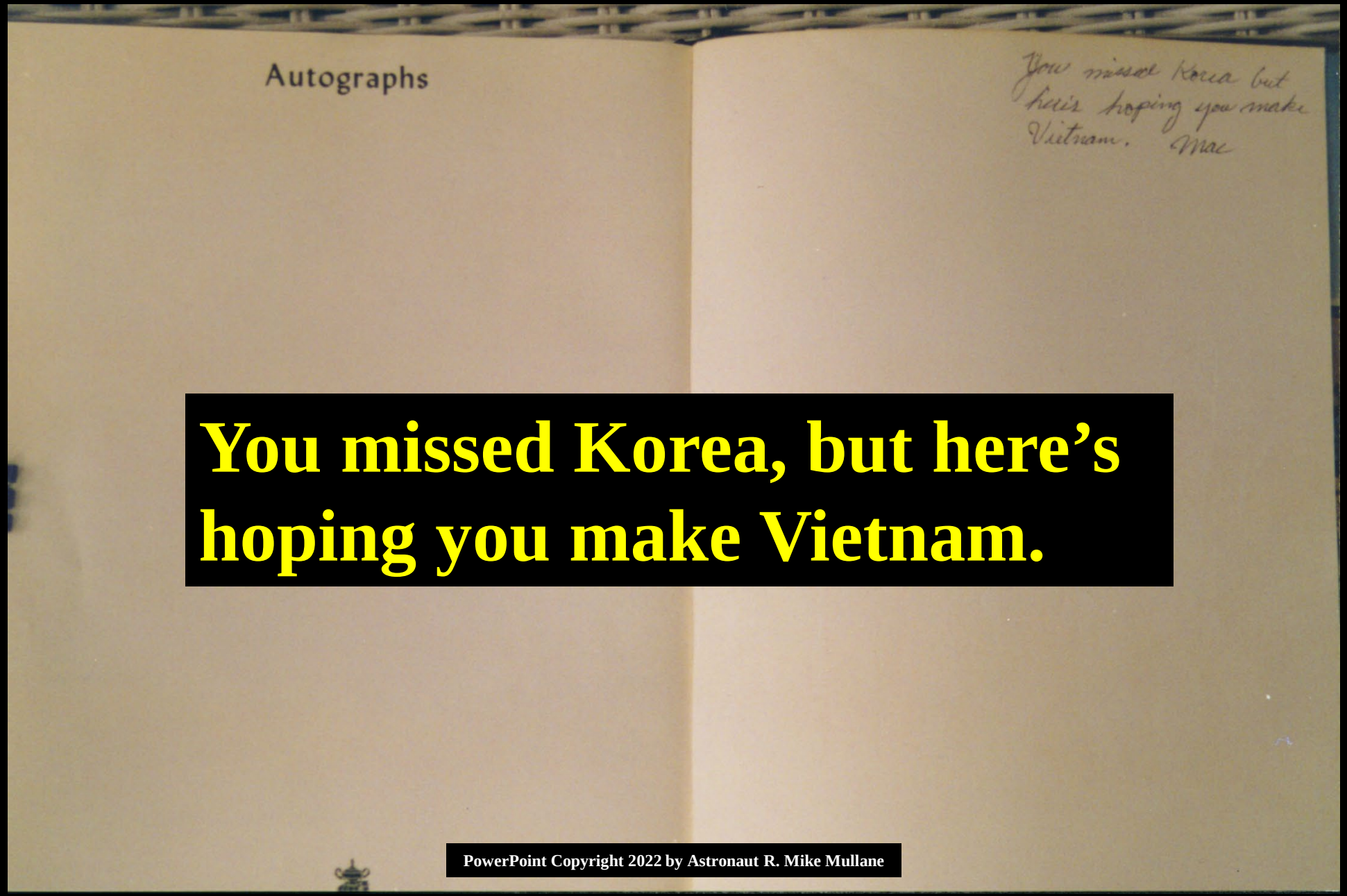
Please fill out and return the attached form. Prior to reporting for re-examination, it is suggested you communicate with the hospital for an early appointment. Present indications a... ect to admission will then be as shown in par. above.

PLEASE EXHIBIT **(BUT DO NOT RELINQUISH)** THIS FORM ... HEN YOU REPORT FOR RE-EXAMINATION.

Varsity Club

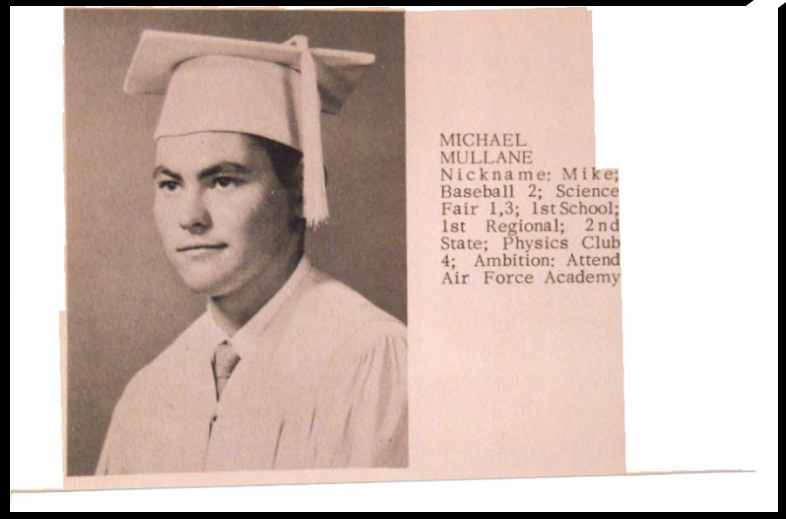
T TO RIGHT: Joseph Bowen, treasurer; Sandra Herron, vice-president; Mary L
tary; Ben Jojola, president.

Senior Class Officers



You missed Korea, but here's hoping you make Vietnam.

?

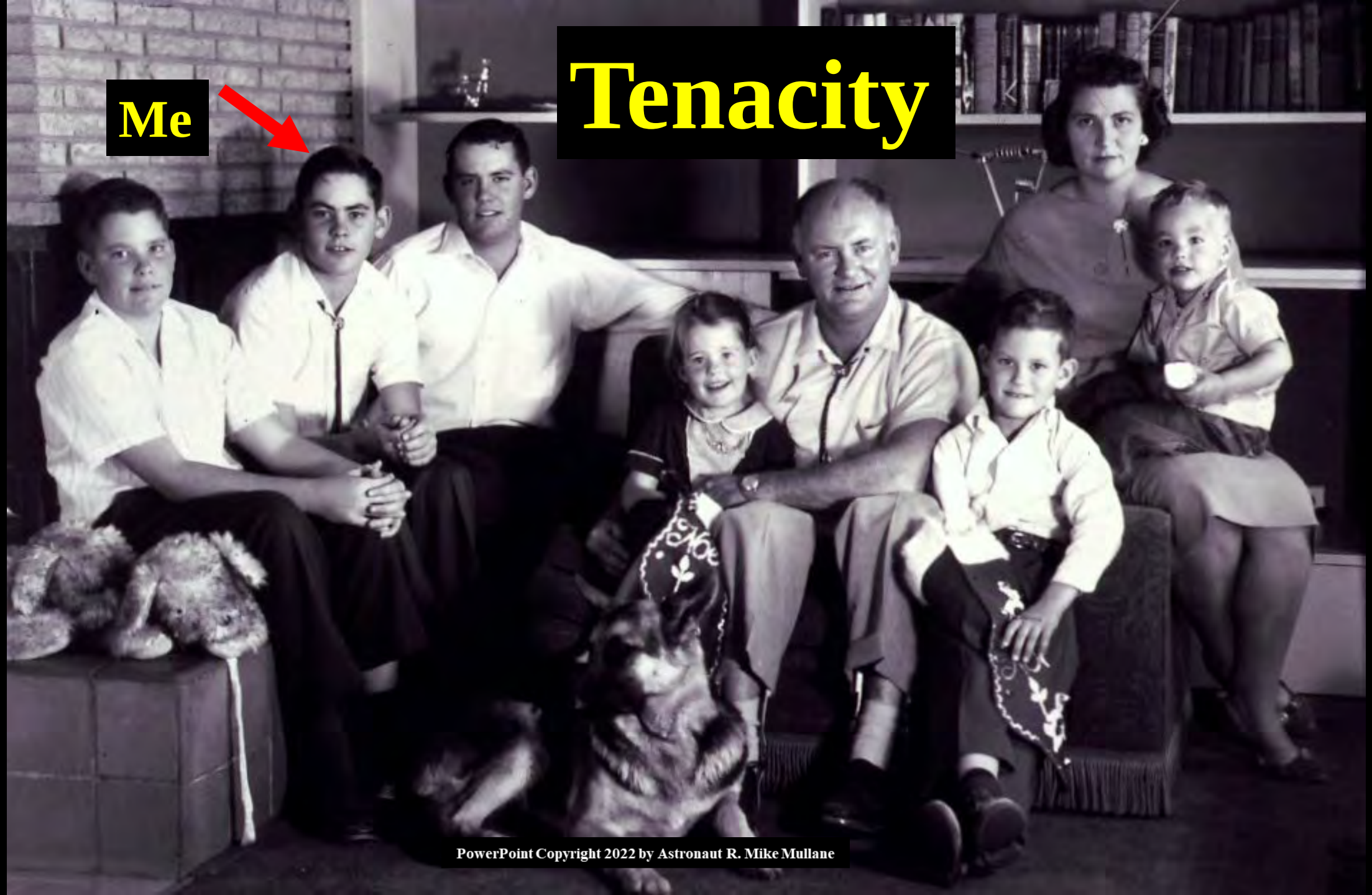


From a very early age my interests were laser-focused on aviation & space.

Focus

I had an abundance of tenacity.

Polio



FOCUS

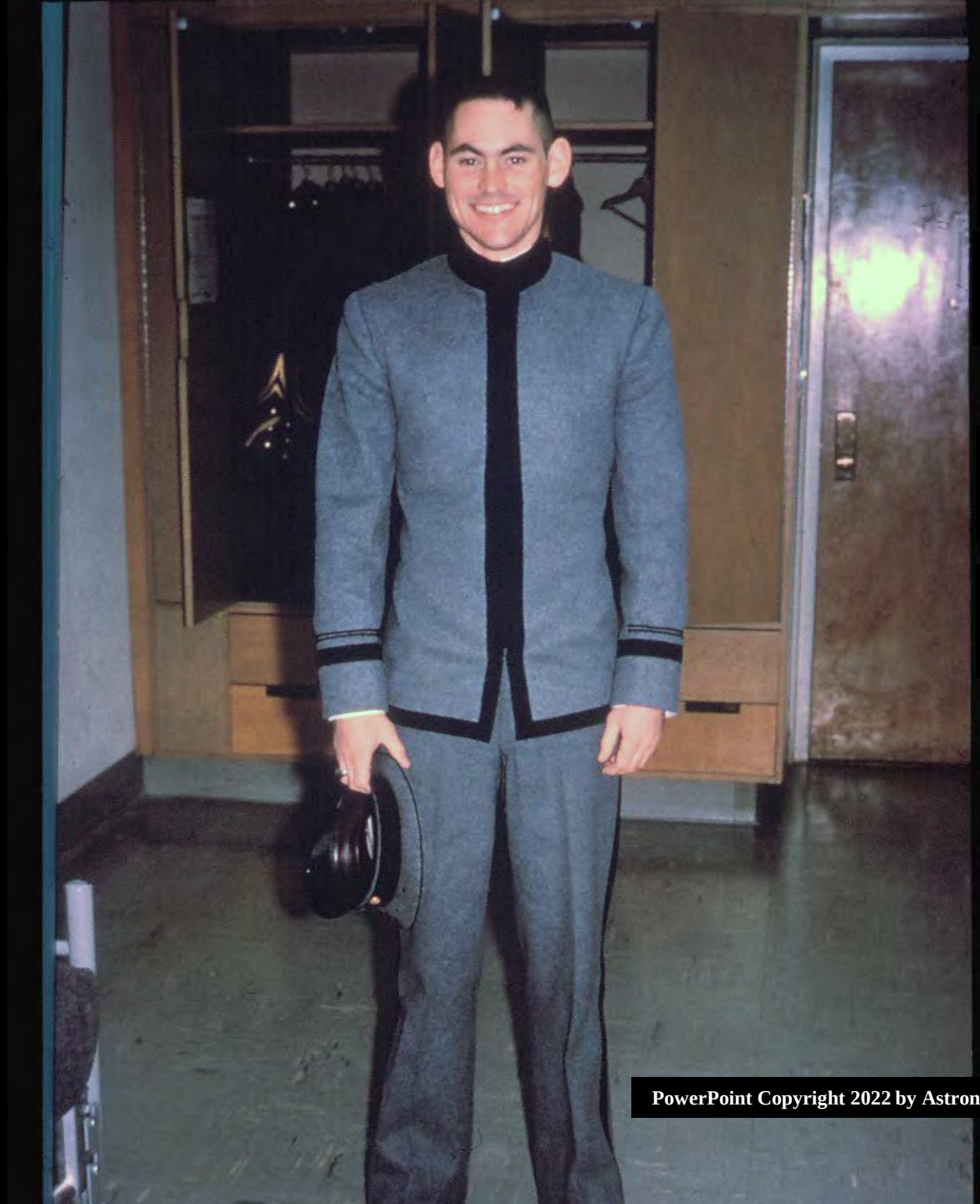
TENACITY

I did not possess this value:

A belief in myself.


TO RIGHT: Joseph Bowen, treasurer; Sandra Herron, vice-president; Mary L
tary; Ben Jojola, president.

Terrified of failure.



West Point
1963- 1967

I can’t.

I’ll fail.

It’s too hard.

I’m afraid.

A gift: A knowledge that my limits were far beyond anything I had previously imagined.

Focus

Tenacity

Continuous Self-Improvement.

Strangers getting married.


1968
Pat
Amy
PowerPoint Copyright 2022 by Astronaut R. Mike Mullane


Laura 1971
PowerPoint Copyright 2022 by Astronaut R. Mike Mullane

You are more than a team.

You are an extended family.

Flight Training 1968

1969: Vietnam

Cold War NATO forces 1970-1973

Graduate School
1974-75

Test Pilot School (back-seater course)
1975-1976


NASA announces opening of Astronaut selection for the Space Shuttle program.
Eglin AFB
1976-1977
Mission Specialist crew position does NOT require applicant to be a pilot.

Focus

Tenacity

Continuous Self-Improvement

Astronaut
1978-1990

Life Lessons

- Do your best. It always counts.
- Set lofty goals.
- Be tenacious.

- Don’t be afraid of failure.

SpaceX


FALCON HEAVY TEST FLIGHT
STARTUP
LIFTOFF
MAX-Q
BOOSTER ENGINE CUTOFF
MAIN ENGINE CUTOFF
FAIRING DEPLOY
BOOSTERS LAND
STAGE 2 SHI


FALCON HEAVY TEST FLIGHT
STARTUP
LIFTOFF
MAX-Q
BOOSTER ENGINE CUTOFF
MAIN ENGINE CUTOFF
FAIRING DEPLOY
BOOSTERS LAND
STAGE 2 SHI

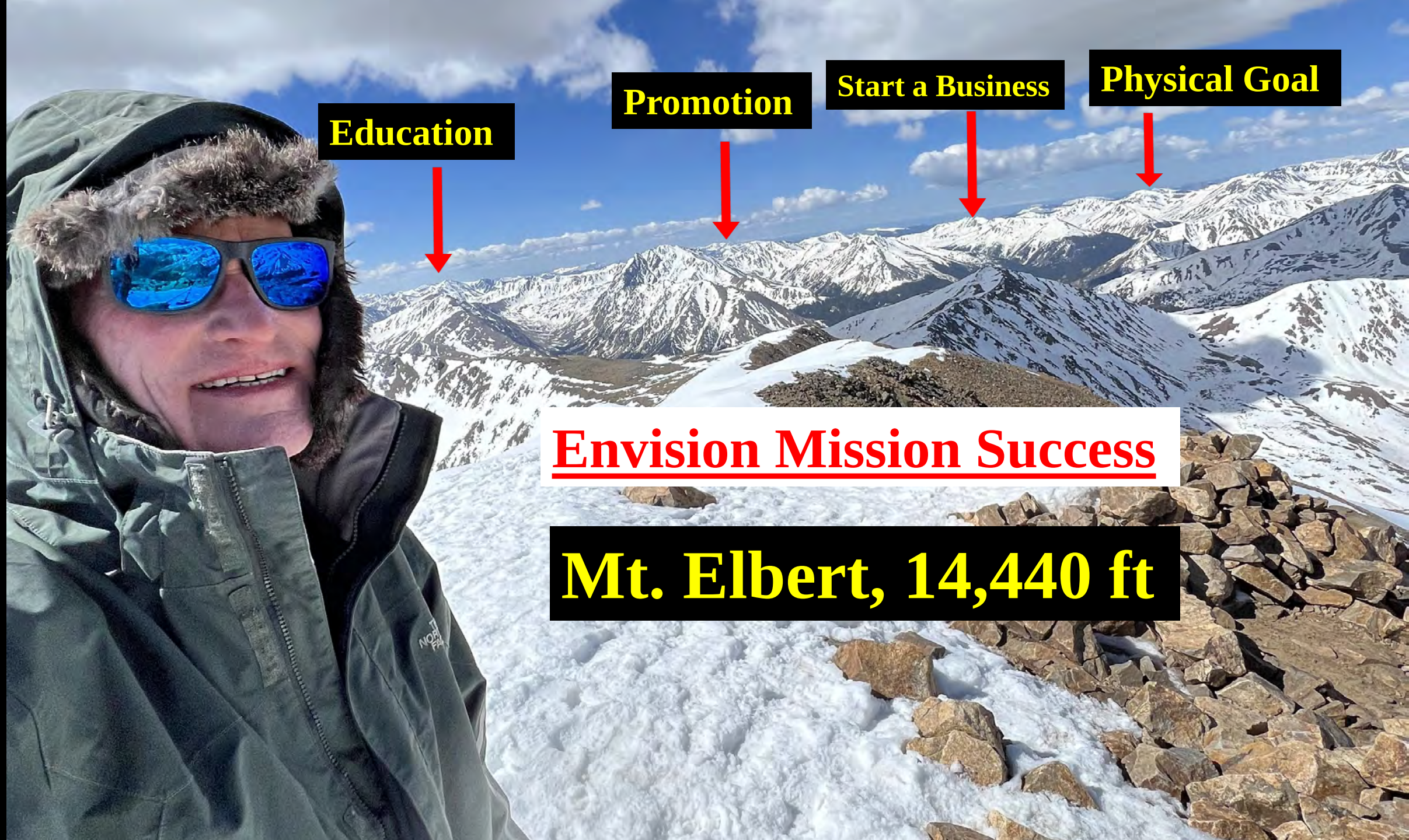
Fail Fast. Learn Faster.

Life Lessons

- Do your best. It always counts.
- Set lofty goals.
- Be tenacious.

- Don’t be afraid of failure.
- Advance your education.
- Advance your team and leadership skills.
- Envision mission success.


Trail
Envision Mission Success


Education
Promotion
Start a Business
Physical Goal
Envision Mission Success
Mt. Elbert, 14,440 ft

You don’t have to be extraordinary to achieve extraordinary personal results.

Safety Values

Beware of normalization of deviance.

Own your responsibilities.

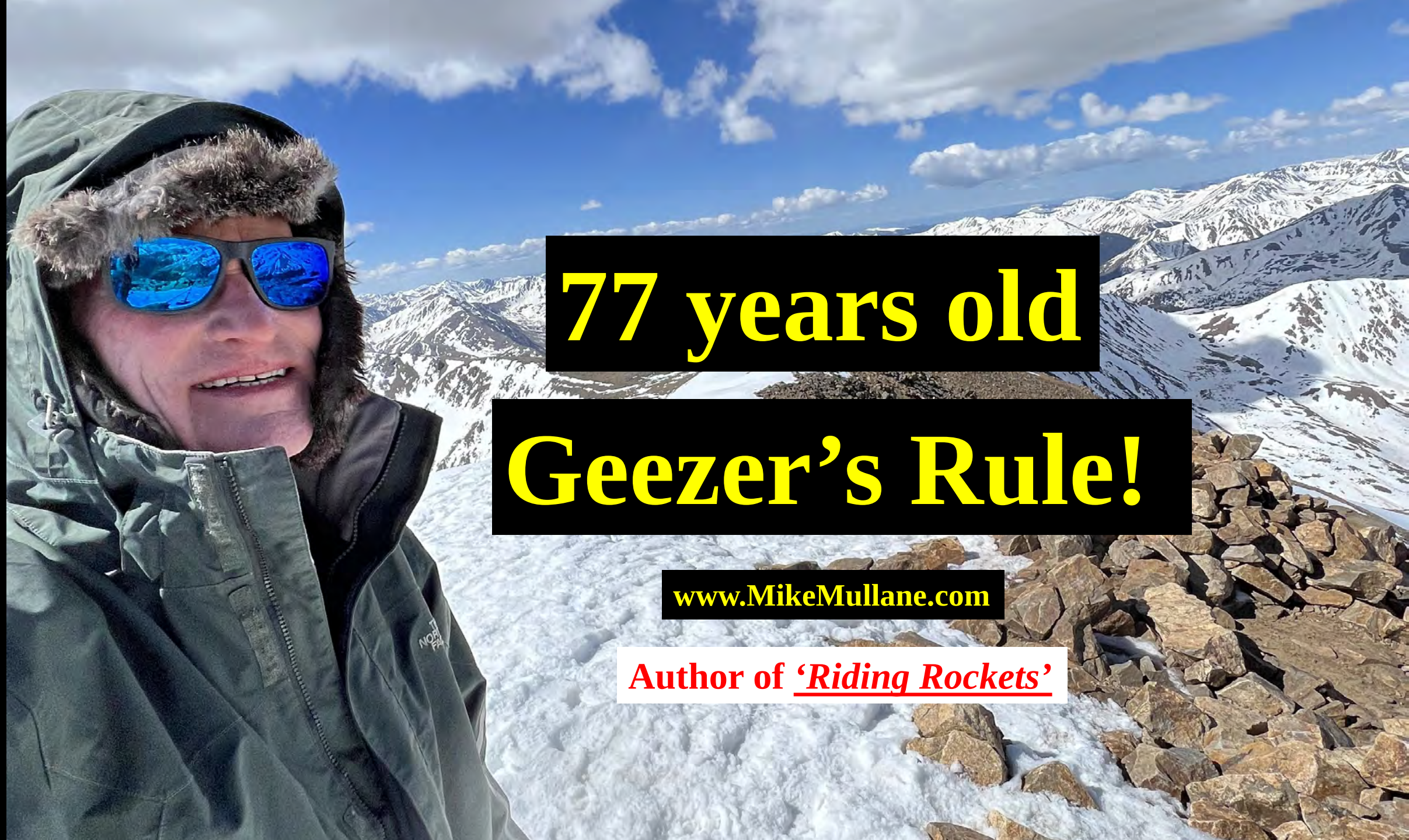
Be accountable to the ‘good’.

Continuous self-improvement.

Life Lessons

- Do your best. It always counts.
- Set lofty goals.
- Be tenacious.

- Don’t be afraid of failure.
- Advance your education.
- Advance your team and leadership skills.
- Envision mission success.


77 years old
Geezer's Rule!
www.MikeMullane.com
Author of 'Riding Rockets'