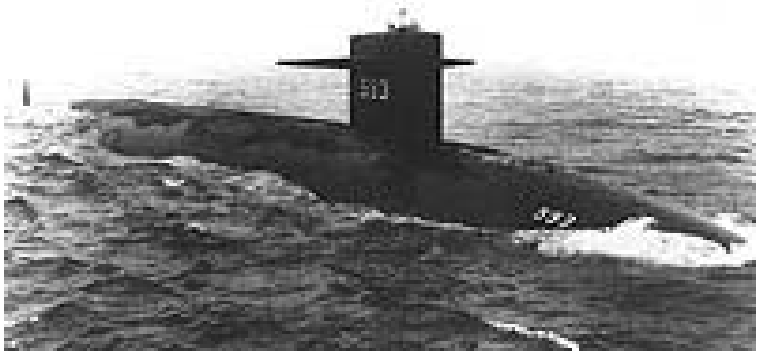
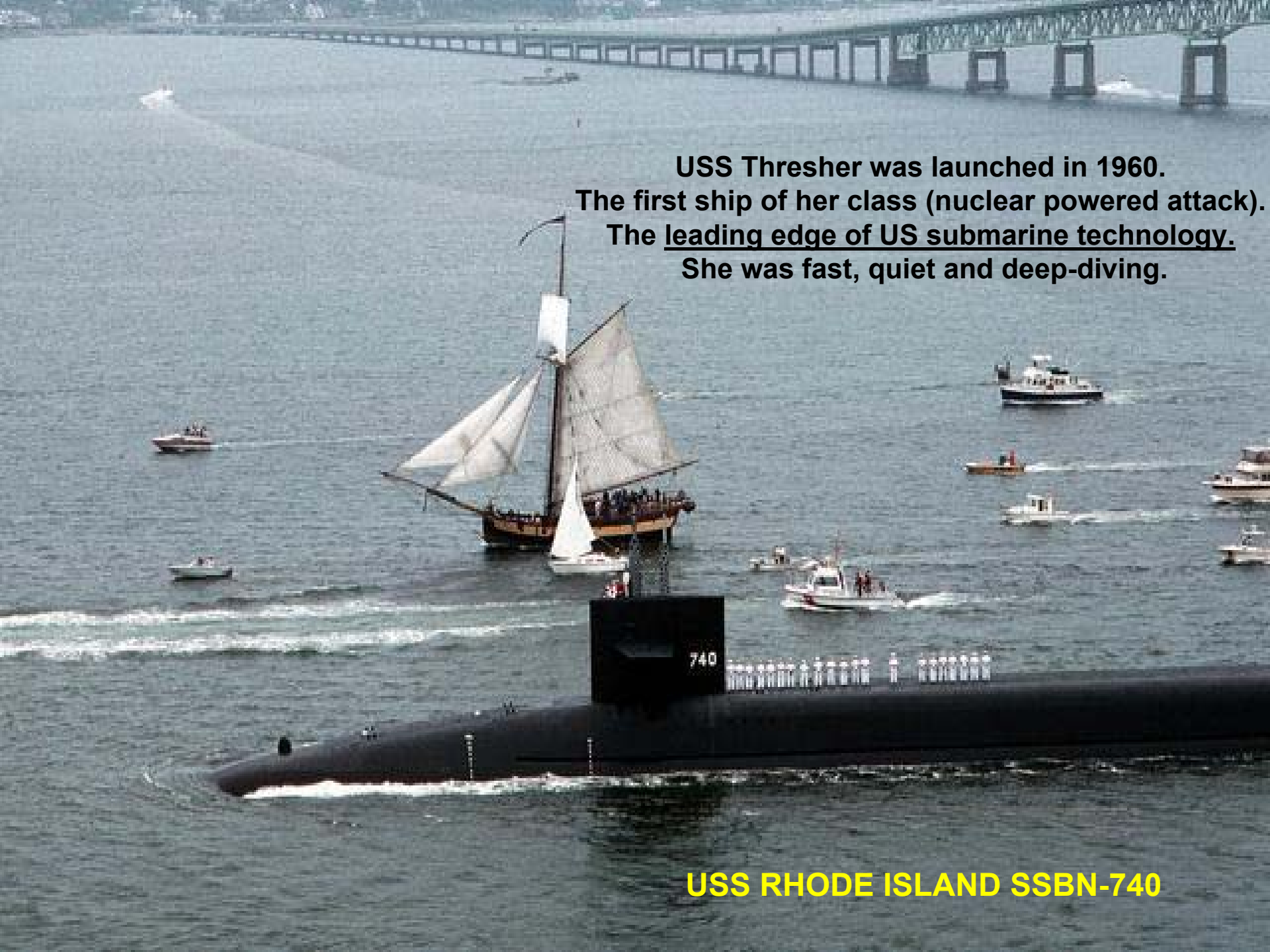
SUBSAFE –



USS Thresher, SSN 593, Lesson Learned

Leadership ViTS Meeting
June 5, 2006

Jim Lloyd
Deputy Chief, Safety and Mission Assurance



USS Thresher was launched in 1960.
The first ship of her class (nuclear powered attack).
The leading edge of US submarine technology.
She was fast, quiet and deep-diving.

USS RHODE ISLAND SSBN-740

On April 10, 1963:

While engaged in a deep test dive
220 miles east of Cape Cod, MA,

The USS Thresher, *SSN 593, was lost at sea*
settling at a depth of 8400 feet with all aboard

The crew of 112 Naval Officers
and Enlisted personnel and
17 civilians
died

Proximate Cause and Ensuing Chain of Events

(Postulated)

Ruptured Piping System (brazed) Joint

Engine room flooding

Seawater spray on switchboards causing loss of propulsion power

Unable to secure flooding

Unable to blow ballast tanks

Unable to drive to surface

Unable to Surface

Investigation Conclusions

- Deficient **Design**

  (Ballast tank blow failure)

- Deficient **Fabrication Practices**

  (Insufficient brazed joint bonding)

- Deficient **Quality Assurance**

  (Inadequate ultrasonic inspections)

- Deficient **Operational Procedure**

  (Difficult access to vital and damage susceptibility of equipment under emergency conditions)

SUBSAFE Certification Program

- SUBSAFE Certification performed for material, work and testing within the SUBSAFE Boundary

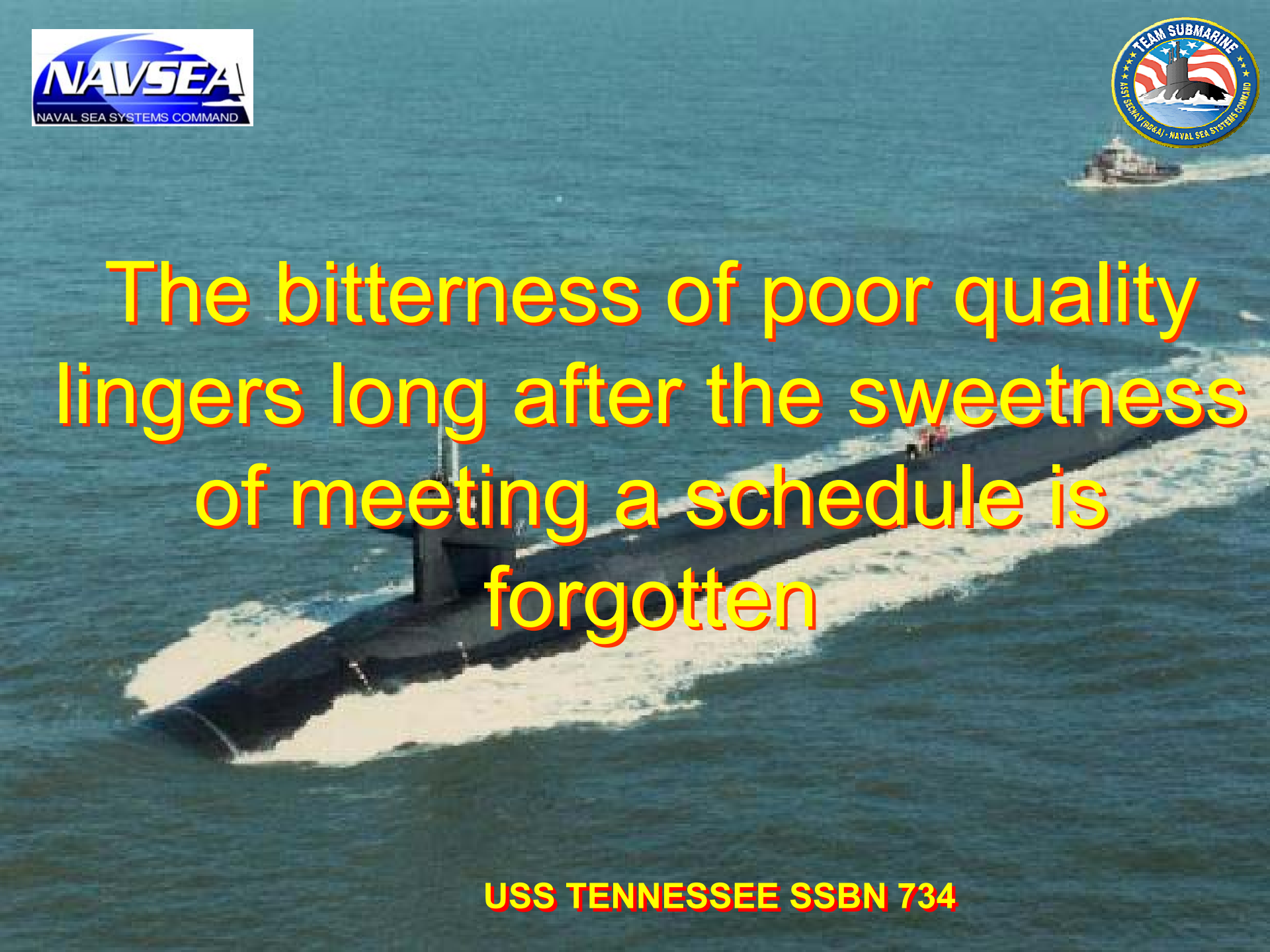
$$SSCB \equiv structure_{.critical} + systems_{.critical} + components_{.critical}$$

- SSCB ≡ structure, systems, and components that are critical to the watertight integrity and recovery capability of the submarine
  - Defined in the SUBSAFE Manual
  - Depicted in SUBSAFE Certification Boundary (SSCB) Books

Establishing and Maintaining SUBSAFE Certification

- *Maximum reasonable assurance* achieved through establishing the initial certification near the end of 5 year construction cycle
  - built upon a solid base of well-documented SUBSAFE Technical Requirements
- And, then, by maintaining it through the life of the submarine using a triad of tools for maintaining certification:
  - Audits
  - Re-Entry Control
  - URO/MRC Program [added in 1969]

(URO MRC ≡ Unrestricted Operations Maintenance Requirement Card Program)


NAVSEA
NAVAL SEA SYSTEMS COMMAND
TEAM SUBMARINE
The bitterness of poor quality lingers long after the sweetness of meeting a schedule is forgotten
USS TENNESSEE SSBN 734

SUBSAFE Program Success

1915 – 1963

16 submarines lost to non-combat causes

1915:	USS F-4 (SS-23)
1917:	USS F-4 (SS-20)
1920:	USS H-1 (SS-28)
	USS S-5 (SS-110)
1923:	USS O-5 (SS-66)
1926:	USS S-51 (SS-162)
1927:	USS S-4 (SS-109)
1939:	USS SQUALUS (SS-192)
1941:	USS O-9 (SS-70)
1942:	USS S-26 (SS-131)
	USS R-19 (SS-96)
1943:	USS R-12 (SS-89)
1944:	USS S-28 (SS-133)
1949:	USS COCHINO (SS-345)
1958:	USS STICKLEBACK (SS-415)
1963:	USS THRESHER (SSN-593)

SUBSAFE Program inception after THRESHER sunk

1963 - Present

1 submarine lost to non-combat causes

1968: USS SCORPION (SSN-598)

- SCORPION was **not** SUBSAFE certified
- Loss would not have been prevented by the SUBSAFE Program

NO SUBSAFE-CERTIFIED SUBMARINE HAS EVER BEEN LOST

Some Submarine & Space Vehicle Similarities

- Extreme environments.
- High energy systems.
- Critical systems whose failure or lack of proper function can have catastrophic consequences.
- Integration of complex subsystems in highly complex vehicles.
- Must maintain conformance with critical requirements (safety & reliability) over extended periods of operating time and away from maintenance facilities.
- Design, testing, operation, and maintenance of the craft require firm technical basis, followed by rigid process for compliance verification.

Back-Up
&
Additional Resource:

NASA/Navy Benchmarking Exchange (NNBE) Program Profile

http://pbma.nasa.gov/index.php?fuseaction=casestudies.main&cid=498

The Audit Program

- Verification is part of the work process:
  - Functional Audits; (processes, procedures, & practices)
    - Specific for an Organization
    - Functional Areas Reviewed:

      - Management
      - Technical
      - In-Process Work
      - Re-Entry Control
      - Quality Assurance
      - Material Control

  - Certification Audits; (accomplished work)
    - Ship-specific
- The audit as a Constructive Experience
  - Assembling the Audit Team
  - P**eer review** during SUBSAFE Functional Audits
  - Teaming effort - **Synergistic**
  - Auditor and audited **attitude**
  - Deficiency documentation & adjudication
    - Contentious issues sometimes arise
  - Certification findings
  - X-pollination & process improvements shared across submarine fleet

Re-Entry Control (REC)

- Control of work & testing performed within the SUBSAFE boundary. Heightened attention to:
  - Technical authorization.
  - Configuration management.
  - Documentation.
  - Quality assurance.
- REC is a tool that helps:
  - Maintain work discipline
  - Establish personal accountability
  - Establish and verify Objective Quality Evidence

URO MRC Program

URO MRC ≡ Unrestricted Operations Maintenance Requirement Card

- The URO MRC Program originated in 1969 with a request to extend the USS Queenfish's SSN 651 Operating Cycle for an additional 1 year prior to overhaul
  - Testing & inspection results were surprisingly poor, indicating SUBSAFE controls were not sufficiently robust and the URO MRC program was added

- The URO MRC Program provides the technical basis for continued SUBSAFE Certification for unrestricted operations at sea.