SCUBA REGULATOR PERFORMANCE FOR UNDER-ICE SCIENTIFIC DIVING – PT. 2

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Background

Single-hose scuba regulators dived in very cold water have a probability of experiencing first- or second-stage malfunction yielding complete occlusion of air flow or massive free flow that rapidly expends a diver's air supply.

Both of these conditions are referred to as regulator “freeze-up”.

Second-stage free-flow

Background

Principal factors contributing to ice crystallization in the regulator second stage include manufacturer's design, materials, quality control, exhaled breath of diver, adiabatic gas expansion, mass flow, time, and temperature.

Background

Operational diving safety concerns for exposures in an overhead ceiling environment include availability of independent back-up regulator system, free-flowing regulator shut-off capability, and sufficient air supply to reach exit or safety hole.

2009 Testing

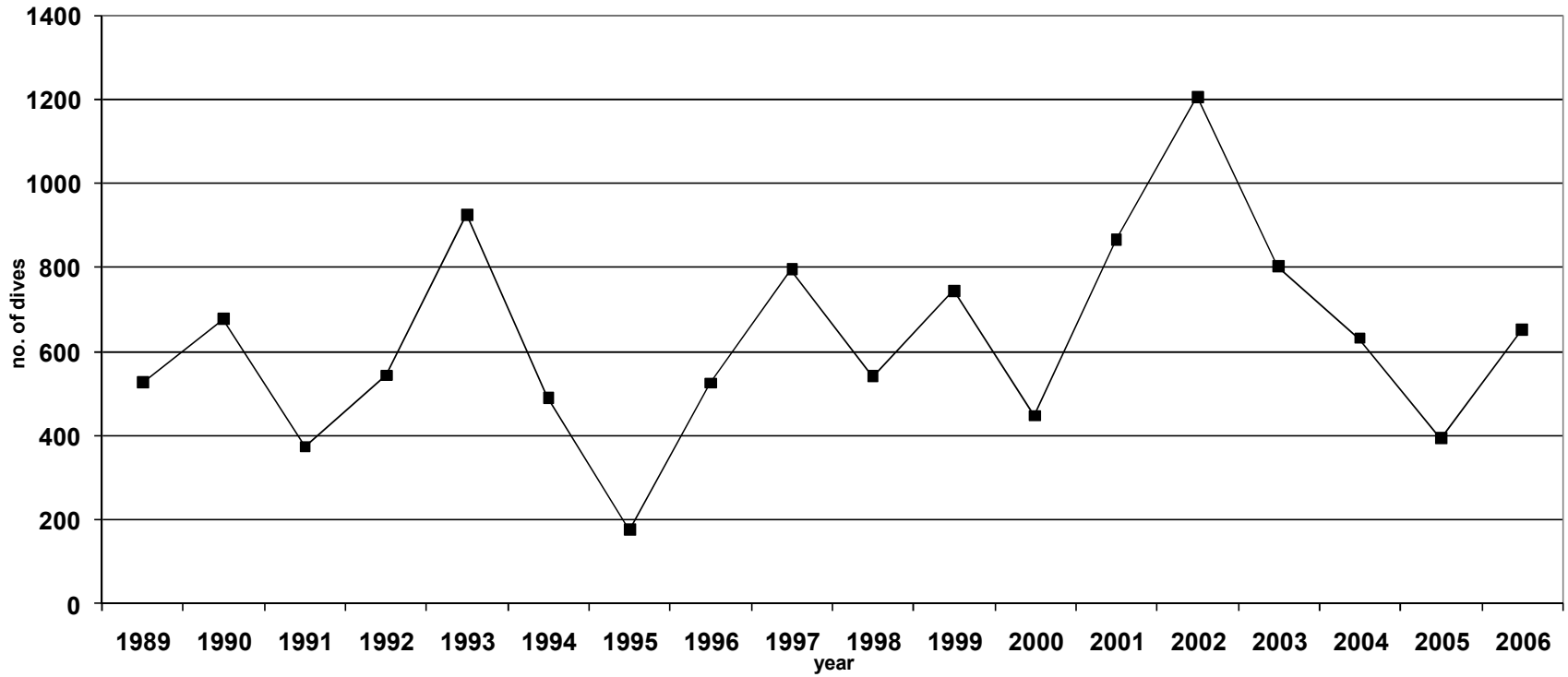
This 2009 dive series continued a Smithsonian Institution funded test of single-hose scuba regulators dived under sea ice in McMurdo, Antarctica for science diving associated with the U.S. Antarctic Program.

Just as in 2008, all regulators selected for testing claimed superior performance in cold water, and held CE EN250 cold-water certification.

First-stage ice formation

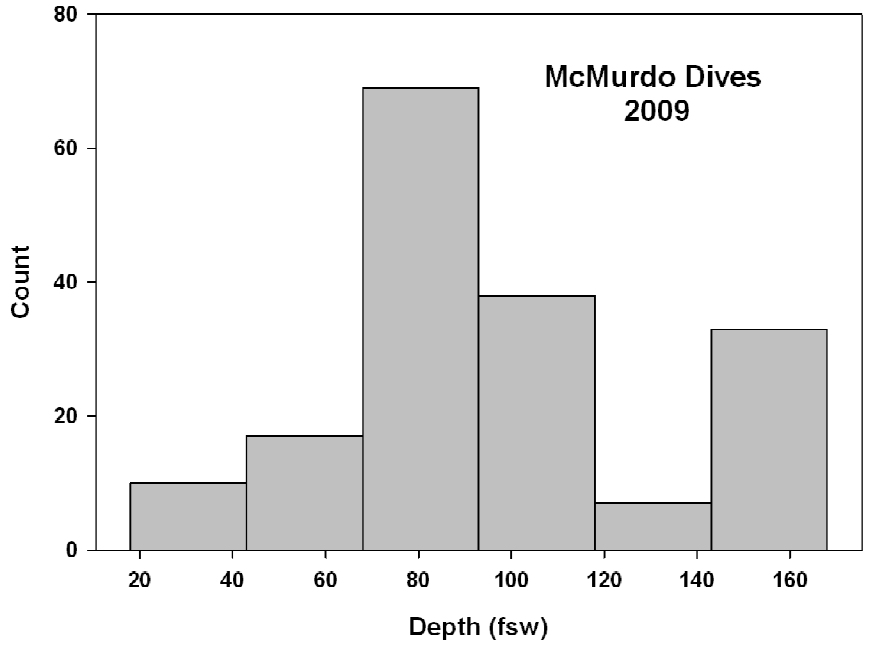
Second-stage Sherwood SRB3600

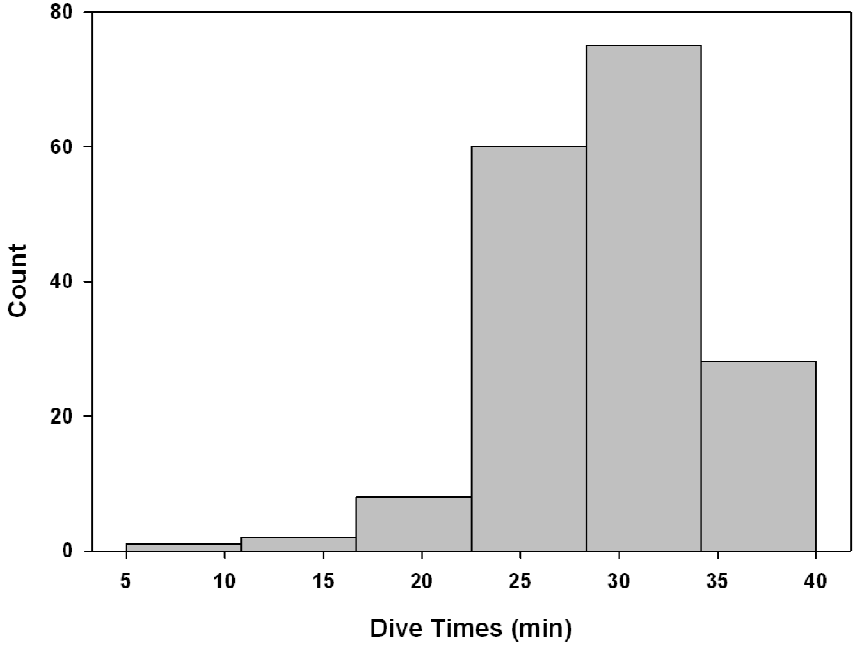
USAP scientific diving



Methods

- **11 divers (6 males, 5 female; mean height 176 ± 10 cm, mean weight 75.8 ± 19.0 kg) logged a total of 170 dives in -1.86°C sea water under 6-m thick Antarctic fast ice. Dive profiles had an average depth of 29 msw and dive time of 29 min, including a 3 min safety stop at 6 msw.**





Methods

Forty-five commercially available, unmodified regulator units from 7 different manufacturers underwent standardized pre-dive regulator care and were randomly assigned to divers. Depths and times of onset of second-stage regulator free-flow were recorded.

Methods

The regulator models tested were

- DiveRite Jetstream
- DiveRite Hurricane
- Mares Abyss
- SI TECH S40 Forever
- Atomic Aquatics M1
- Scubapro A700/MK17
- Hollis D212
- Sherwood U (an undetuned Sherwood Maximus).

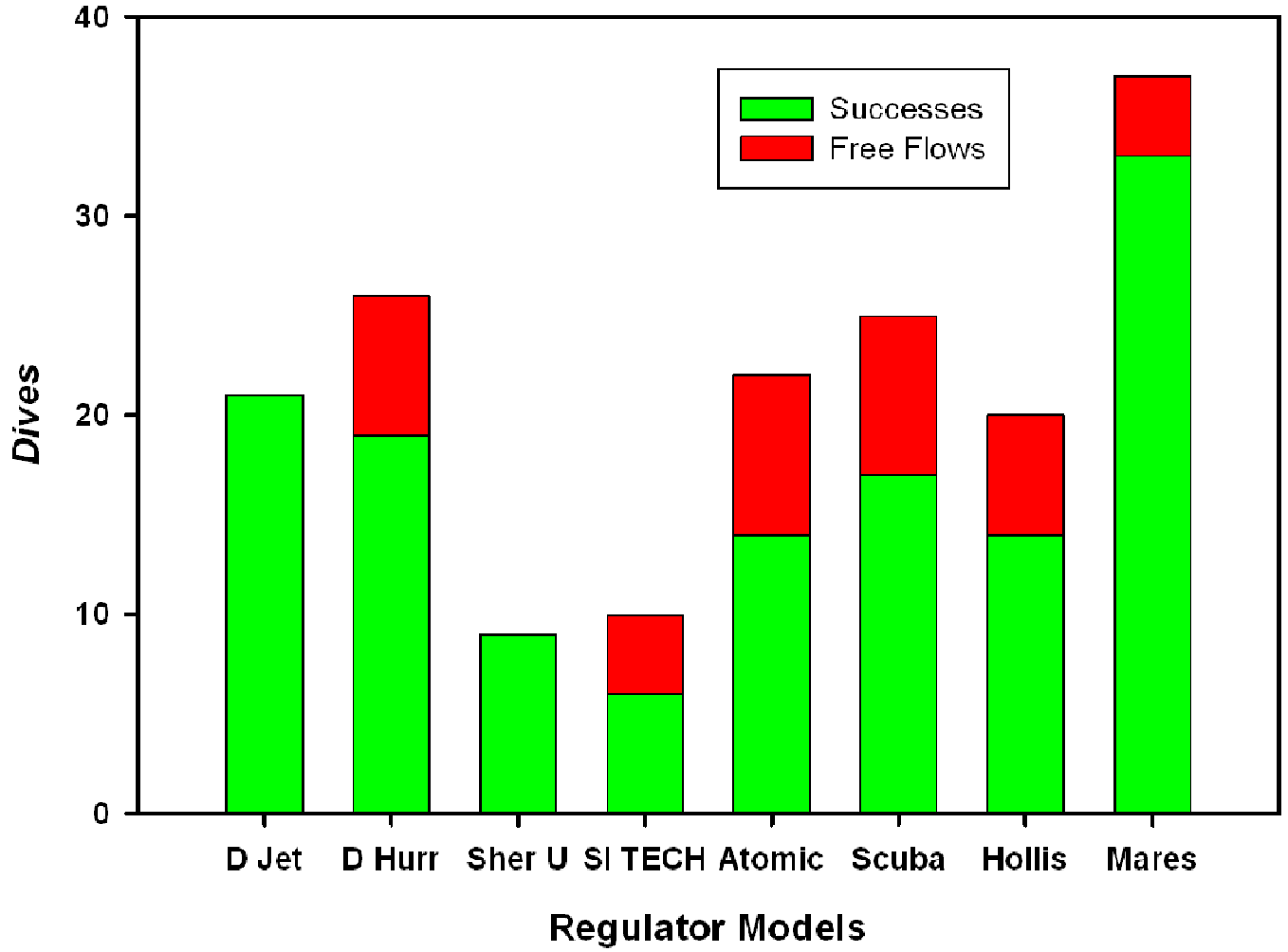
Results

- In 170 dives, there were 37 free flows.
- The regulators classified as “better” suffered 11 free-flows (FF) out of 93 exposures (12% combined incidence).
- The others suffered 23 FF out of 77 exposures (36% incidence).

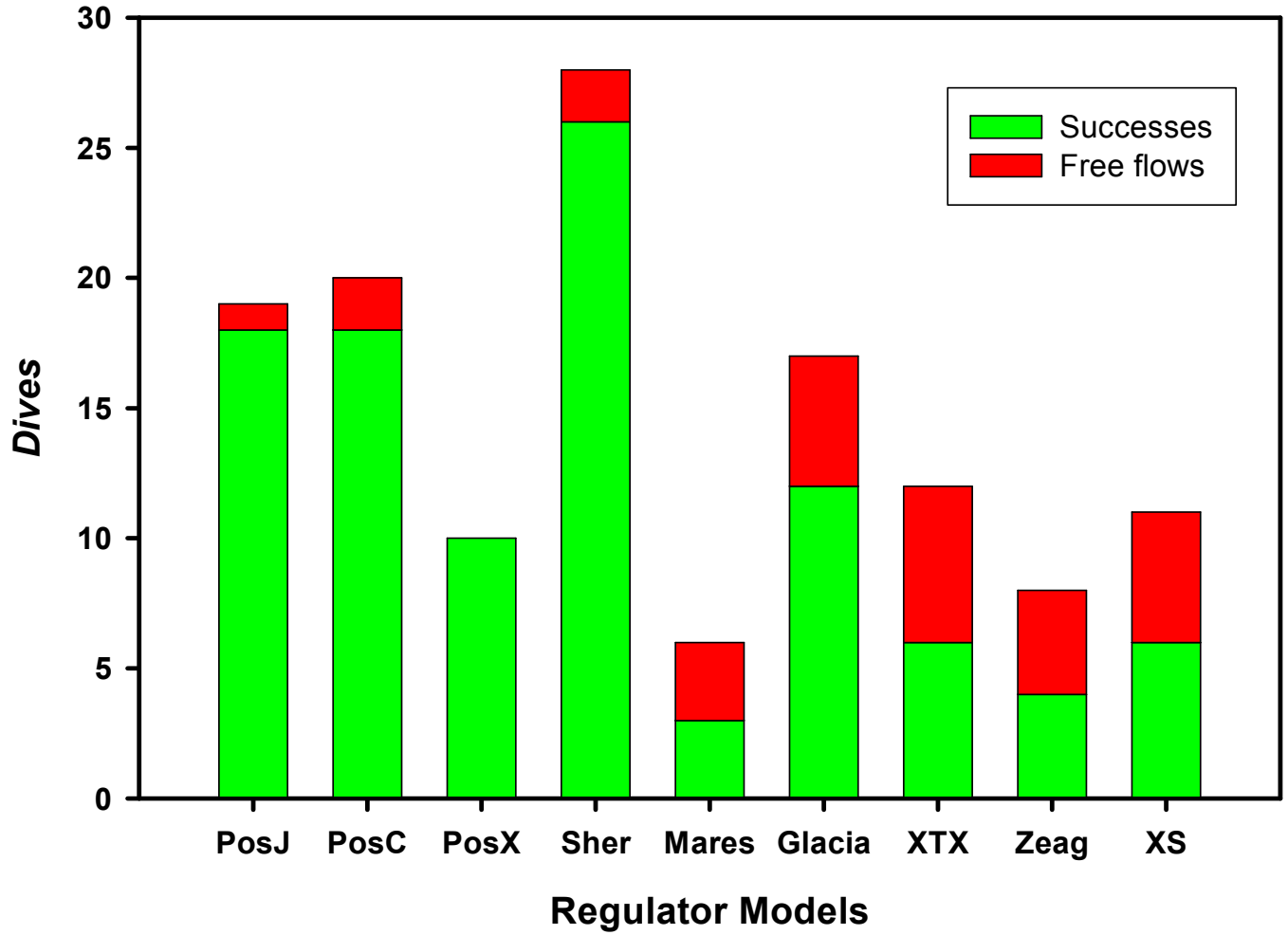
Results

- Testing on one regulator was aborted when free flow incidence reached 40%.
- Differences between regulator free-flow incidences were tested by the Chi-square test.
- The pooled incidences for the four best performing regulators were compared to the four remaining regulators. The differences between the groupings was significant at $P<0.001$.

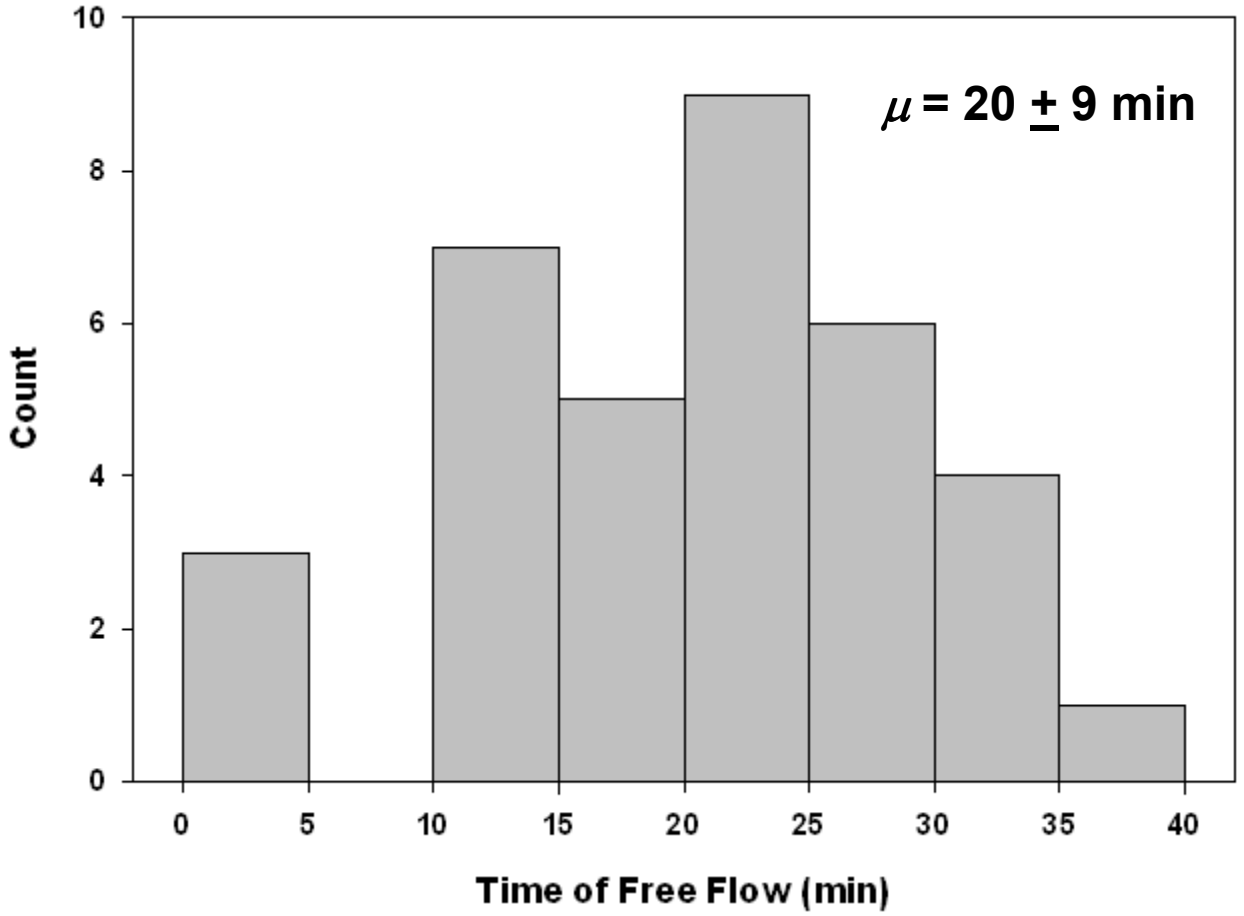
2009 Regulator exposures



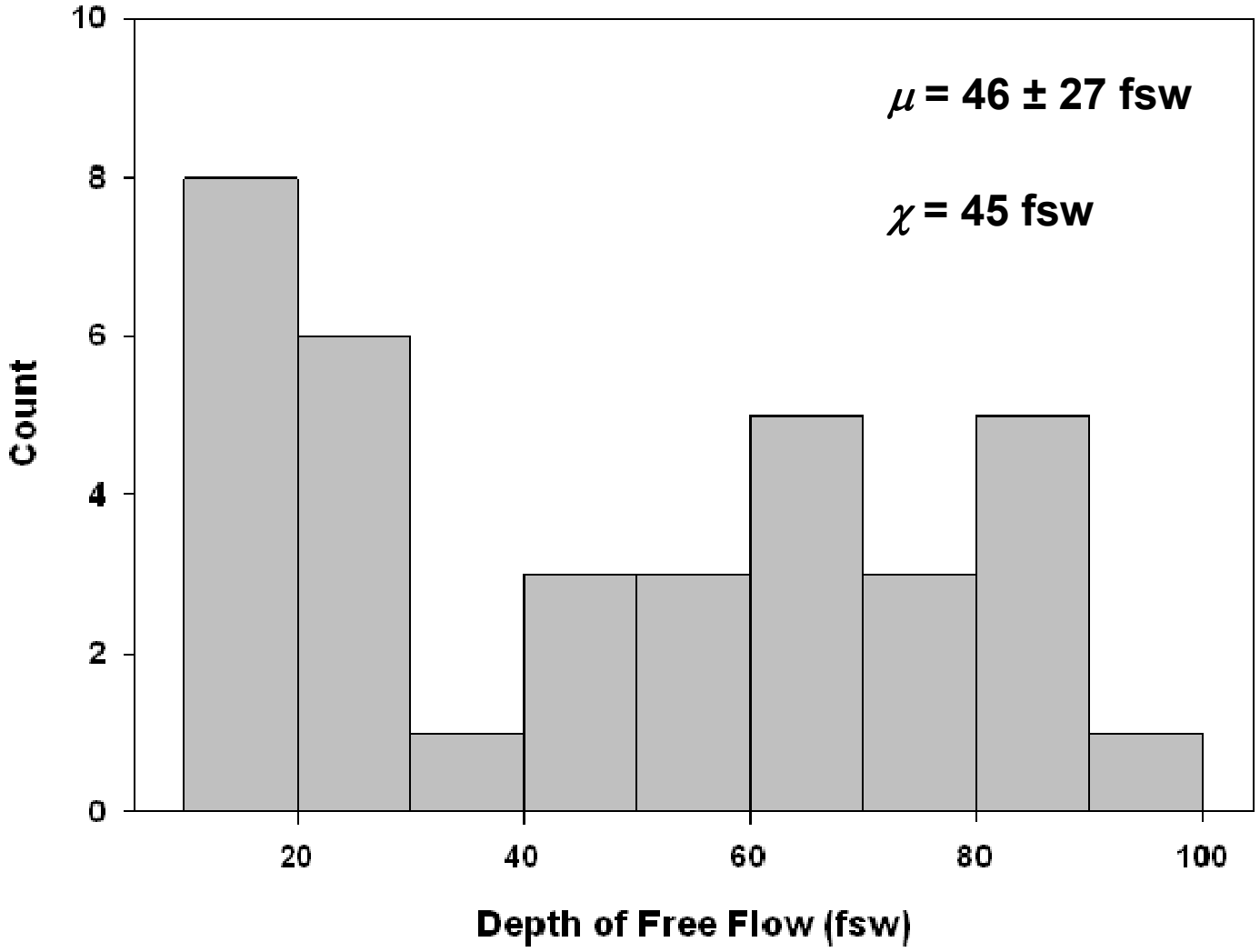
2008 Regulator exposures



2009 free-flow onset time



2009 free-flow onset depth



Discussion/Conclusion

- During the 2008 and 2009 seasons, the Smithsonian Regulator Test Divers tested 17 regulator models from 13 manufacturers.

- Very few regulator models had an acceptable failure rate for science diving in under-ice polar conditions.

Discussion/Conclusion

The European testing standard EN250:2000*, for which the CE mark is given for cold water (<10°C) regulators, does not adequately replicate the harsh conditions (-2°C) of polar diving.

(EN 250:2000: Respiratory equipment. Open-circuit self-contained compressed air diving apparatus. Requirements, testing, marking.

The Smithsonian Institution Scientific Diving Program has selected the Mares Abyss regulator as a replacement for the two decades old, modified Sherwood regulator for use in the U.S. Antarctic Program.

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