BIOMECHANICAL ASSESSMENT OF MK 12 DIVE SYSTEM

NOAA MODIFICATION FOR ANTI-CONTAMINANT USE IN CONTAMINATED WATEF

Arthur J. Bachrach
Director, Environmental Stress Program Center
Naval Medical Research Institute

Glen H. Egstrom
Professor of Kinesiology and
Director, Underwater Kinesiology Laboratory,
University of California, Los Angeles

J. Morgan Wells
Director, NOAA Diving Program

INTRODUCTION

The history of human factors engineering research in diving equipment is a short history indeed. In 1967, Hugh Bowen and James Miller presented an overview of problems in human factors in underwater performance at an international conference in England, reporting on such aspects as the U.S. Navy SEALAB II experience. In 1969, perhaps the first thorough statement of th range of problems was developed in a Japanese paper by Hori (1969), but actual research conducted in human factors at that time was virtually nonexistent. In 1975, a paper was presented to the Third Joint Meeting of the UJNR reporting the collaborati research comparing the MARK V diving system with the prototype MARK XII (Bachrach 1977). In this paper the collaboration betwe UCLA and the Naval Medical Research Institute was discussed, emphasizing the human factors studies of biomechanical analyses comparing the two diving systems. UCLA, with support from NMRI, developed a set of biomechanical, anthropometric measures (figs. 1, 2), which were used to quantify range of motion measures to

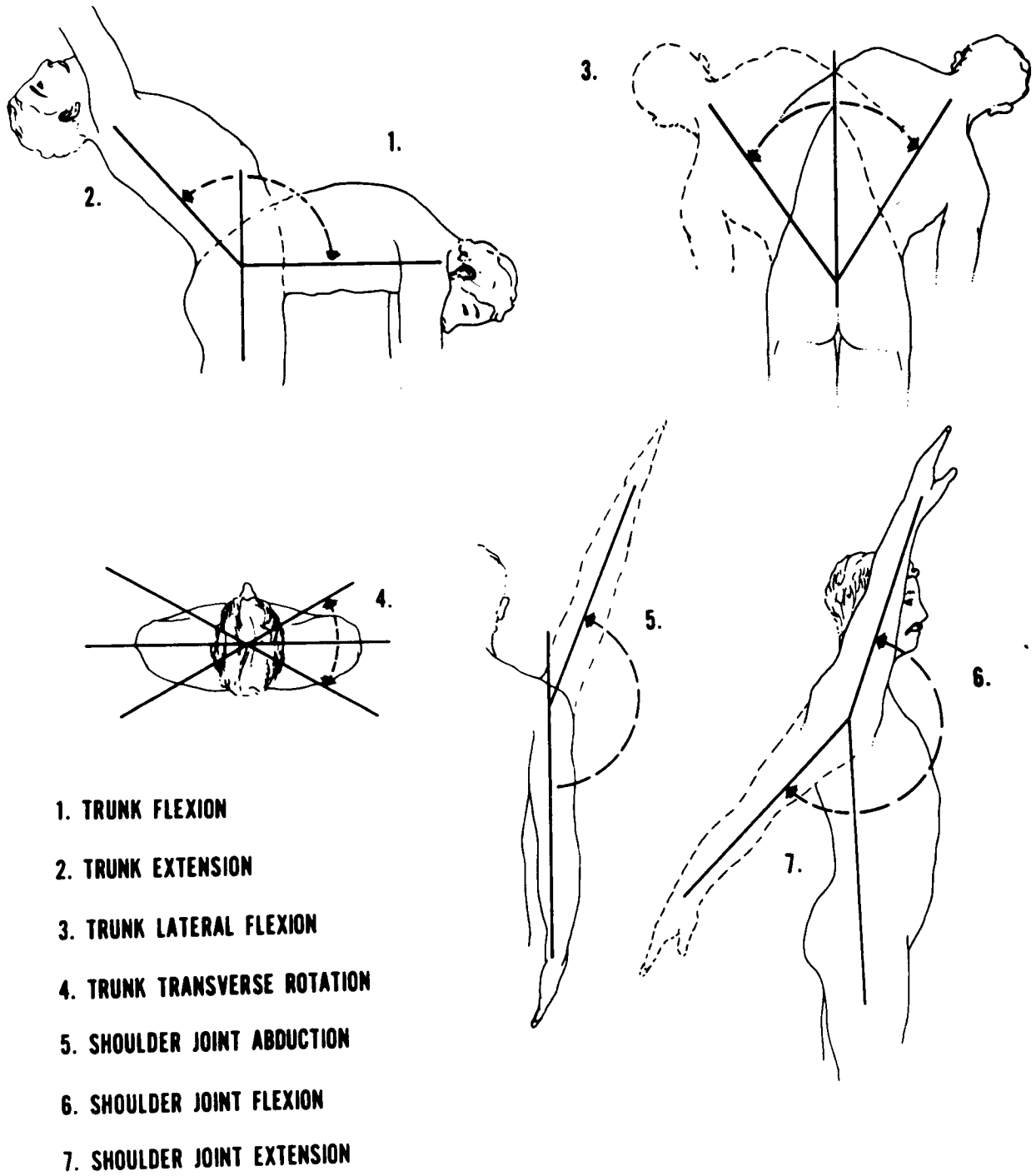

Figure 1.--Biomechanical anthropometric measures

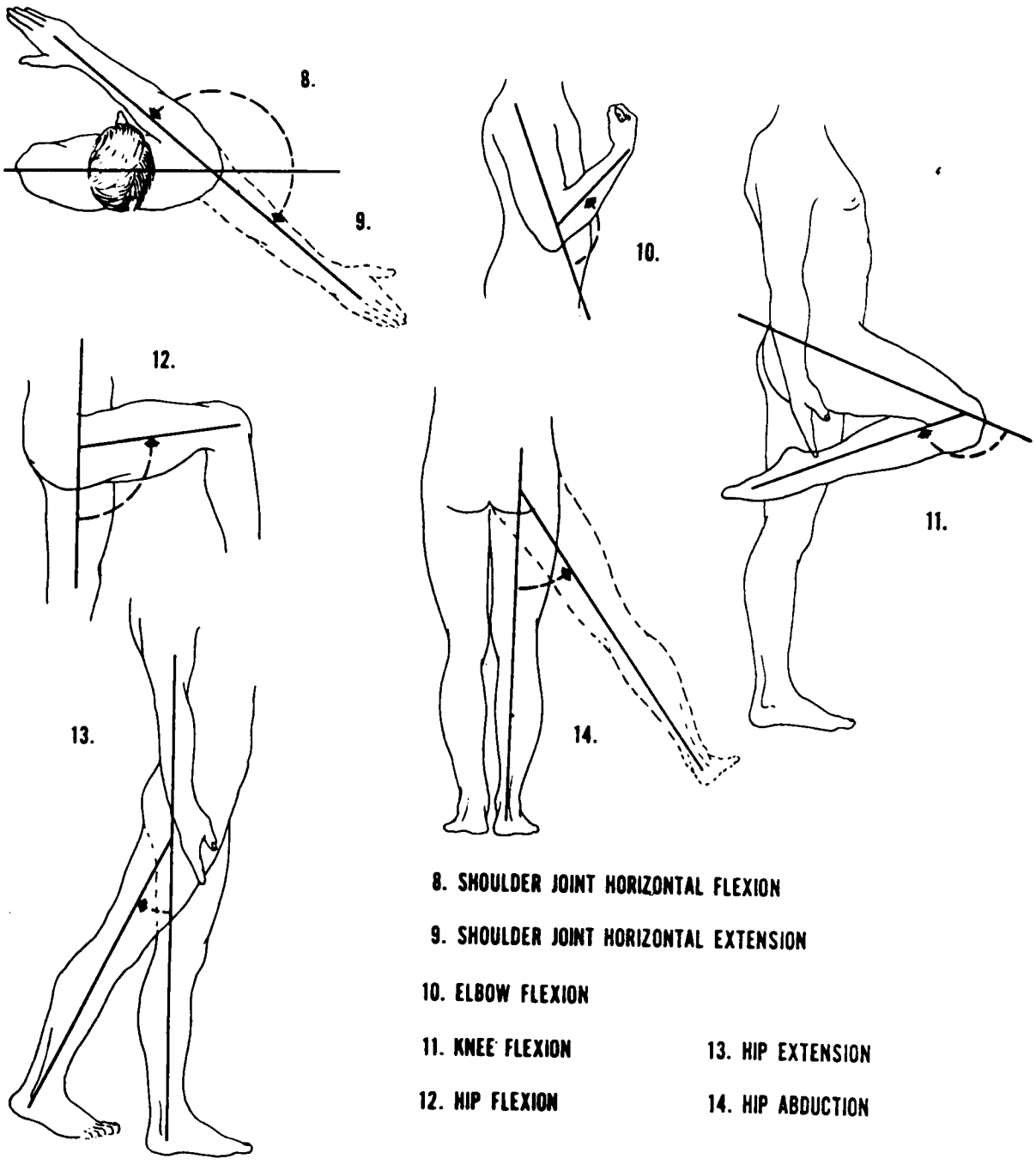

Figure 2.--Biomechanical anthropometric measures

Figure 3.--Biomechanical measure operator in JIM-4

assess the impact of the diving gear itself on movement and performance (Bachrach et al. 1975). The measures shown in figures 1 and 2 were taken in swimsuits (as baselines) in each system, and then in water wearing the MARK V and the MARK XII, respectively. The divers also performed tasks such as the UCLA pipe assembly, and physiological measures were taken (primarily heart rate to assess the physiological cost of working in the gear). The results of the series of studies completed showed an overall superiority of the MARK XII over the MARK V in range of motion and in lowered physiological cost (Bachrach et al. 1975).

These measures have since become standard in many research projects in which biomechanical assessment is important. In the

Navy biomedical assessment (Bachrach 1981) of JIM-4, the one-atmosphere diving system, measures appropriate to the performance of JIM in the water were taken, also after a swimsuit baseline series (fig. 3). The U.S. Navy Coastal Systems Center used the measures in studies of the development of thermal protection for divers (Nuckols 1980). When the Naval Medical Research Institute, UCLA, and NOAA's Diving Program Office embarked on a collaborative project to assess the NOAA modification of the MARK XII for use in contaminated waters, use of these biomechanical measures was clearly indicated.

All measures were taken in swimsuit baselines. Figure 4 illustrates a diver performing Trunk Flexion in surface baseline; figure 5 shows a diver performing the same movement under water in the MARK XII. A similar comparison, this time of Trunk Extension, is illustrated in figures 6 and 7. The use of the grid and the floor radial plot allowed for reasonable quantification of the measures. Recording of the movements was accomplished by video and still photography. The water measures were taken at 30 feet of seawater in the Tower test facility at the Naval Surface Weapons Laboratory, White Oak, as were the surface baselines. A report of the preliminary analysis was presnted at the Oceans '85 Conference (Egstrom et al. 1985). Results indicated that there were no significant decrements in range of motion when the diving system was used, compared with swimsuit baseline measures. Losses were in the range of less than 20%, indicating that the decrements resulting from the diving dress did not appear to be of a magnitude

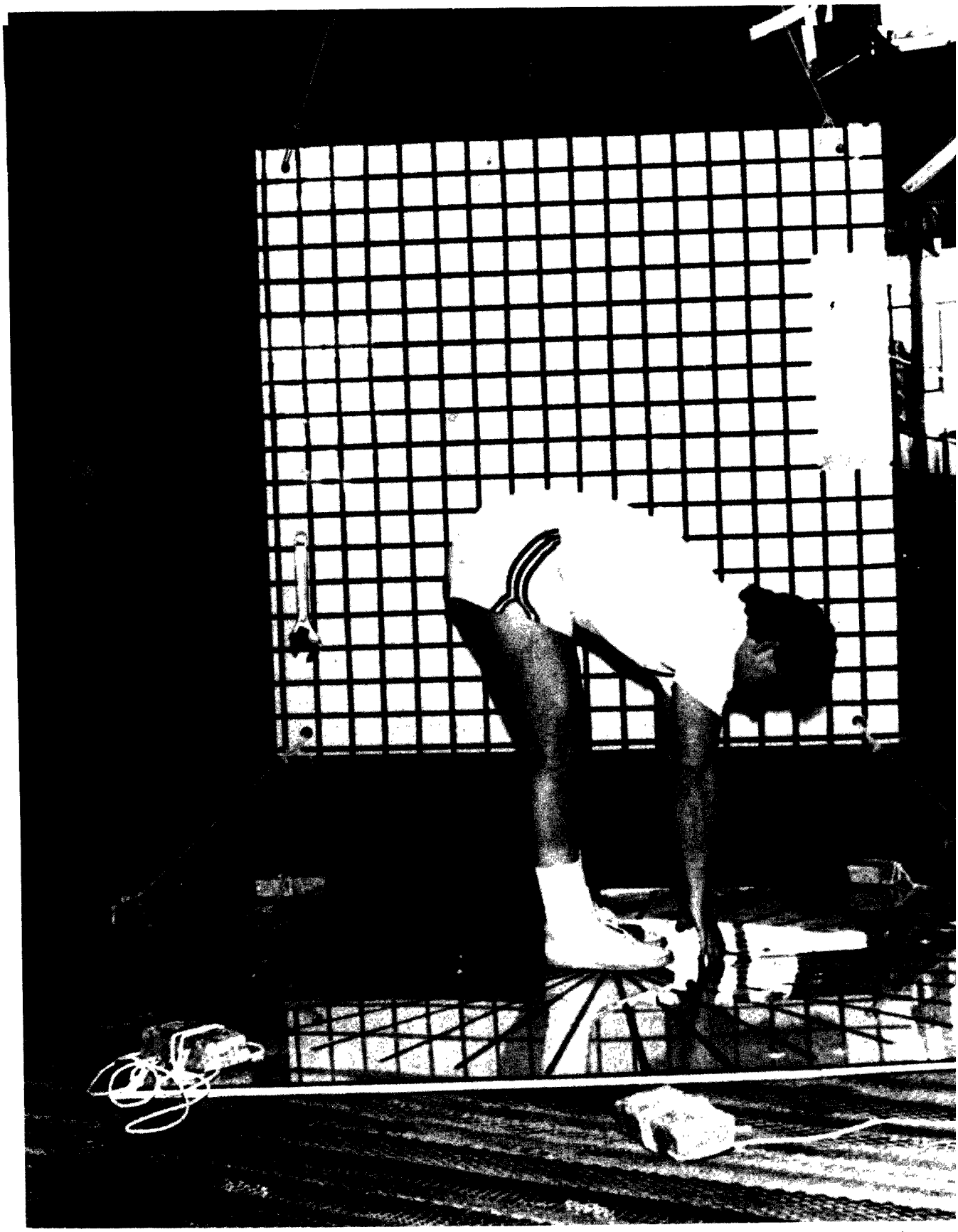

Figure 4.--Diver performing Trunk Flexion in surface baseline

Figure 5.--Diver performing Trunk Flexion under water in the MARK XII

Figure 6.--Diver performing Trunk Extension in surface baseline

Figure 7.--Diver performing Trunk Extension under water in the MARK XII

that would limit routine underwater work. One finding of interes was that the shortest of the three NOAA divers showed the greates flexibility in range of motion, suggesting that the sizing of suits and the selection of divers for specific tasks needs full consideration.

It is our firm belief that the various studies briefly noted in this discussion, along with related research, support the importance of human factors analyses of diving equipment. In his excellent review of human factors applications related to underwater activities, Hori stresses that it is important to stud research related to "the protection of the body and maintenance of posture underwater, posture and movement at time of work, methods of supporting the body, the assessment of protective tools, clothing, gloves and shoes at time of work" (Hori 1969). The methods described for biomechanical and physiological assessments can contribute significantly to such a goal.

ACKNOWLEDGMENT

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