Material requested for the record on pages 198 and 199 during the hearing before the Senate Committee on Aeronautical and Space Sciences on February 3, 1976.

Question: In your prepared statement you mention space motion sickness as perhaps the most pressing and difficult of the issues to be resolved for Shuttle passengers, and you note that should such illness occur in either a Shuttle passenger or crew member, it would take a significant portion of a seven-day Shuttle mission.

How do you propose to solve that problem?

Answer: Our research approach to the space motion sickness problem is a multiple one, and ranges from applied to basic. In general, the research tasks within the area can be categorized by their orientation to the following component problem areas and requirements, all of which are mutually supportive:

1. The development of criteria for the determination of individual susceptibility to space motion sickness for use in medical selection.

2. The development of training techniques to diminish susceptibility.

3. The development of improved countermeasures for the prevention and alleviation of symptoms.

4. Elucidation of the causes and mechanisms of space motion sickness.

5. Bioinstrumentation and methodology development.

6. Preparation of flight experiments in the interest of all of the above objectives.

Material requested for the record on pages 198 and 199 during the hearing before the Senate Committee on Aeronautical and Space Sciences on February 3, 1976.

Question: Is it possible to determine before selection whether or not a person will suffer space motion sickness? Would that be a criterion for the selection of Shuttle astronauts and non-astronaut Shuttle passengers?

Answer: With respect to the determination of predisposition of individuals to space motion sickness (category 1.), it is not possible at the present time to make this prediction, but the importance of such predictive criteria to medical selection is recognized and research to establish them is being vigorously pursued. A numerical index which was derived for that purpose was tested throughout Skylab. It was based on a precisely scored motion sickness history, coupled with very carefully measured and graded responses to specific patterns of head movements performed in a rotating chair turning at controlled rates. Despite its precision and fundamental rationality, the index proved to be invalid as a predictor of susceptibility to motion sickness in space, although quite valid as a predictor of predisposition to air sickness during aviation aerobatics. This finding clearly suggests that there is something different about the genesis of space motion sickness as opposed to earth based types. One prominent theory, which is currently being investigated, proposes a causative relationship with the persistent headward fluid shifts which occur during weightlessness, but not during aircraft flight (unless flown on zero G trajectories).

In further pursuit of this objective, the same researchers at the Naval Aerospace Medical Institute, Pensacola, and in-house investigators at NASA JSC, Houston, are attempting to modify older concepts and

derive new data correlations working with individuals flown aboard KC 135 flights on zero G trajectories, as well as subjects on the rotating room. A promising correlation which appears to be emerging at the present time is an inverse relationship between susceptibility and speed of adaptation to the noxious motion environment.

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Question: Can an individual be trained or treated so that he or she will not get space motion sickness?

Answer: Investigations of preventive training procedures (category 2, above) are also being carried out at JSC, Houston, and NAMI, Pensacola, as well as at NASA ARC, Moffett Field, California. While there is evidence that vestibular responses can be improved by training, it is not yet clear that modification of these responses to the space environment can be affected by training, nor have specific training procedures and schedules yet been established for this purpose. Skylab experience demonstrated that tolerance to head movements in a rotating chair could be considerably enhanced by the performance of programmed head movements during certain aerobatic maneuvers in aircraft, such as aileron rolls, but this did not seem to affect tolerance to space motion sickness. Further exploration of this apparent anomaly is in progress with the aim of determining what alterations of these training procedures might prove to be effective toward preventing space motion sickness. In addition, a preliminary study of biofeedback at ARC has shown some promise as a candidate training technique and is being further evaluated.

The medications used in Skylab as countermeasures against the symptoms of space motion sickness were selected on the basis of extensive ground based comparative testing which was carried out at NAMI, Pensacola, and at Louisiana State University Medical School. Although these drug combinations did control Skylab symptomatology to a fair extent, control was neither as complete nor sustained as desired. Our current research efforts are continuing to evaluate new pharmaceuticals, new combinations, and alternative dosage schedules. Procedural countermeasures, such as specific head movement routines, are also being investigated.