

We do feel that these two materials can be developed and applied to meet most of the requirements for low or zero flammability materials in the spacecraft.

We are also considering new materials for fasteners. Some type of fastener must be available for crew convenience while operating in the weightless environment. Otherwise, it could be most cumbersome keeping everything "tied down." In the past, the fastener material has been Nylon Velcro which supports combustion in a pure oxygen atmosphere. We are considering several possibilities for replacing this material. One is a steel Velcro, which has excellent fire protection properties, but has been judged to be too abrasive for our use when fabricated as a hook and pile fastener using the currently available techniques. Another material being considered is teflon. This material is self-extinguishing in terms of its burning characteristics, but fabrication techniques have not been developed. We do know, however, that using more conventional fasteners such as snaps and hooks and eyes will meet the need for fire resistant fasteners in the spacecraft. In the meantime we are continuing to explore the use of new materials for this application.

Films are used in the spacecraft cabin in the form of bags for containing food, for fecal collection and for containing various small articles of equipment. Here again we are considering teflon as a possible replacement material, but for this application the oxygen permeability of the material as a film must be verified. Other new materials are also being considered.

Foams are used for thermal insulation and for equipment protection inside the cabin. A high density teflon foam is available now. A low density foam is preferred and is being developed. We are also investigating the availability and applicability of silicone foams. Our investigations in this area are promising, but some development work is undoubtedly required.

In summary, we do expect to be able to replace or protect all the very flammable materials in the spacecraft.

Spacecraft atmosphere

We are continuing tradeoff studies on spacecraft atmosphere for each operational phase of the Apollo program. These studies include one versus two gas tradeoffs, evaluation of the prelaunch atmosphere and a fire resistant oxygen system.

Pad operations

With regard to the spacecraft atmosphere during pad checkout and launch operations, our tradeoff studies, which are still in process, are indicating that serious consideration should be given to the use of air in the cabin, with the crew on pure oxygen in the spacesuit loop, to improve safety.

Air, which contains 79 percent nitrogen, is attractive for the cabin atmosphere, because it greatly decreases the fire hazard while providing the capability to support life if there is a failure in the oxygen supply to the suit loop. This decrease in fire hazard, in conjunction with a reduction of cabin combustibles, improved egress capability and the normal provisions for pad rescue and fire fighting instituted during hazardous operations, will greatly reduce the crew risk during pad operations. A cabin atmosphere of pure nitrogen would further reduce the fire hazard but is not favored because it will not support life in case of a suit disconnect or other suit leak. During the prelaunch period, as a precaution against dysbarism (bends) after ascent, the suit loop would be held at slightly higher pressure than the cabin, and continuously monitored by gas sensors to assure complete denitrogenation of the crew at launch.

Launch phase

During the launch ascent phase, the cabin and suit loop would bleed down to space flight pressure. With the crew remaining on the suit loop, oxygen would then be supplied to the cabin to enrich its atmosphere. We are studying several alternative procedures for this enrichment. These include (1) cabin decompression, followed by repressurization; (2) partial decompression followed by oxygen replenishment; and (3) gradual enrichment by replenishment of normal cabin leakage with oxygen. These procedures offer tradeoffs, which are now being considered, between the system weight, and the time which is required to achieve the desired atmosphere.