Risk of Reduced Crew Health and Performance Due to Hypoxia (Hypoxia Risk) (Revision C)

Hypoxia Risk DAG Narrative

❖ Hostile Closed Environment is the primary spaceflight hazard requiring NASA to create an engineered atmosphere optimized for mission success.

❖ Altered Gravity leads towards negative physiologic changes in the body and so does hypoxia, therefore any nominal hypoxia must be driven by operational needs and minimized.

❖ There are two levels of Hypoxia stemming from different sources that are concern in spaceflight. The Hypoxia node represents more severe hypoxia that can occur as a result of a Suit Failure, Toxic Exposure, or Depressurization from Vehicle Failure. This severity of hypoxia can lead to Loss of Crew Life or can impact Individual Readiness and Crew Capability.

❖ Mild Hypoxia is a different concern that can lead to issues with Cognitive Function—which is affected by Individual Factors—Fatigue, Exercise Prescription, and Medical (Risk) conditions such as acute mountain sickness, and issues addressed by other Human System Risks including DCS (Risk), Immune (Risk), SANS (Risk), Sleep (Risk), and Muscle/Aerobic (Risk).

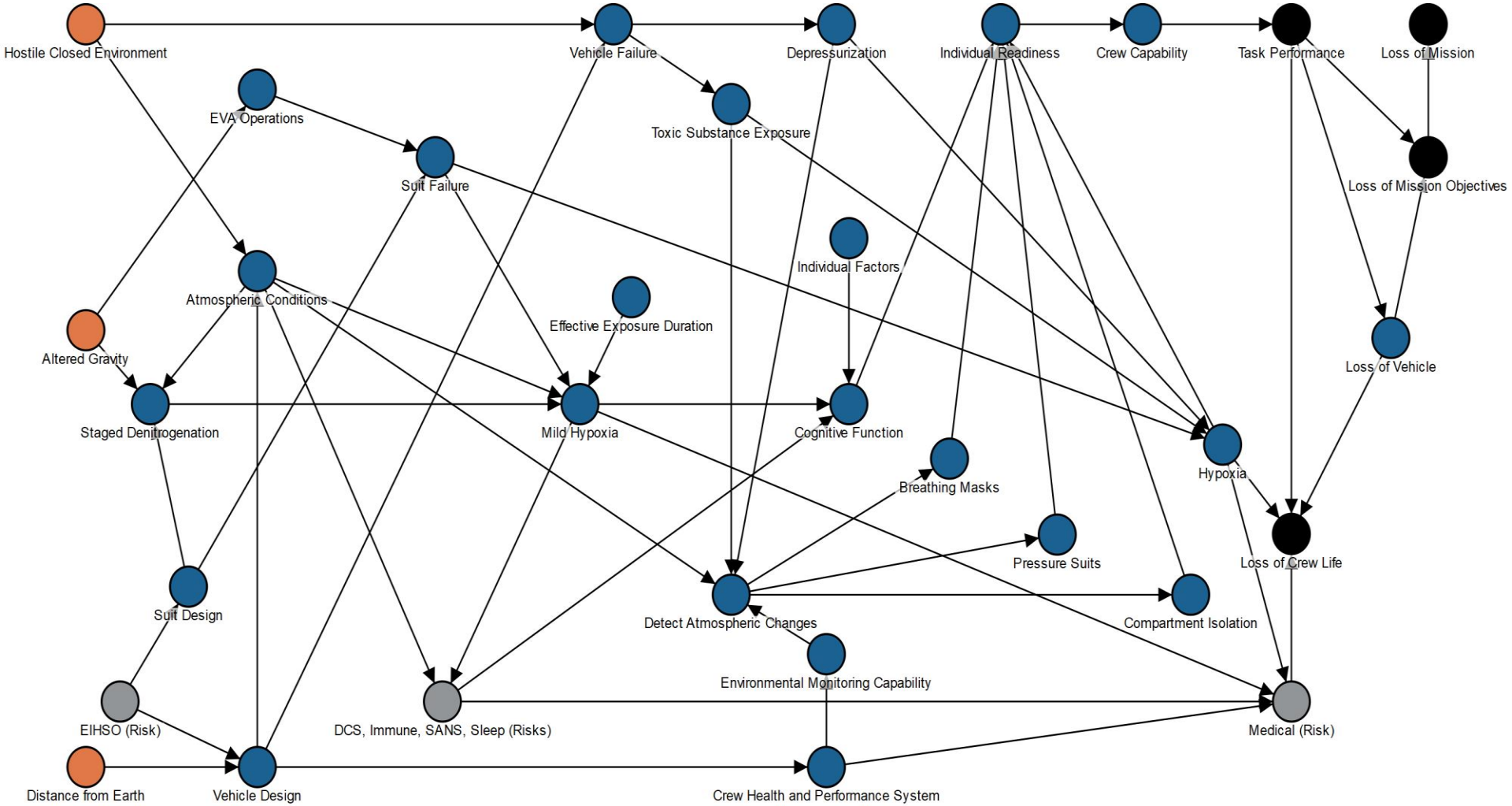
❖ Atmospheric conditions (specifically low pressure) can affect food processing (converting raw ingredients such as soybeans into tofu) or food preparation beyond simple heating and rehydration is conducted. This concern will be addressed by the Food and Nutrition Risk Team.

❖ Mild Hypoxia is of concern when considering Exploration Atmospheres for example, where changes to Atmospheric Conditions during Staged Denitrogenation can expose astronauts to physiologic hypoxia that is at a low level and chronic over time. Suit Failures that are not catastrophic can also induce Mild Hypoxia and these can be caused by either Suit Design issues or EVA Operations. The level of hypoxia experienced is also dependent on the Effective Exposure Duration.

❖ Distance from Earth affects the available mass, power, volume and bandwidth available to a Crew Health and Performance System. Issues addressed by the HSIA (Risk) contribute to Vehicle Design and capabilities of the Crew Health and Performance System, which enables Environmental Monitoring Capability that can Detect Atmospheric Changes. In cases where those changes warrant, countermeasures such as Breathing Masks, Pressure Suits, and Compartment Isolation can be implemented to protect Individual Readiness, Crew Capability, and health.

❖ Historically pilots and astronauts are exposed to hypoxic conditions prior to flight so that they can understand how their unique symptoms are expressed. This is because the insidious onset of hypoxia can affect Individual Readiness and Crew Capability severely enough that Task Performance for critical

tasks like piloting a vehicle may be affected and Loss of Vehicle, Loss of Mission Objectives, or Loss of Mission can occur.


Hostile Closed Environment
Vehicle Failure
Depressurization
Individual Readiness
Crew Capability
Task Performance
Loss of Mission
EVA Operations
Toxic Substance Exposure
Suit Failure
Loss of Mission Objectives
Individual Factors
Atmospheric Conditions
Effective Exposure Duration
Altered Gravity
Loss of Vehicle
Staged Denitrogenation
Mild Hypoxia
Cognitive Function
Hypoxia
Breathing Masks
Pressure Suits
Loss of Crew Life
Suit Design
Detect Atmospheric Changes
Compartment Isolation
Environmental Monitoring Capability
EIHSO (Risk)
DCS, Immune, SANS, Sleep (Risks)
Medical (Risk)
Distance from Earth
Vehicle Design
Crew Health and Performance System