Why Mistakes Happen Even When the Stakes Are High: The Many Dimensions of Human Fallibility

Lloyd J. Dumas, PhD

Serious reliability problems in systems subject to sudden criticality can be caused by boredom, drinking or drug taking, habit and routine, isolation, and sustained high levels of stress. Nuclear military forces require that groups of people act together, but transferring capability and responsibility from individuals to groups does not by itself protect against the limits of safety imposed by human error, illness, or malevolence. While practical steps can minimize the risks of human fallibility, there is no way to completely eliminate the potential for catastrophe in nuclear military systems except by completely eliminating nuclear weapons. [M&GS 2001;7:12-19]

There is no reason to believe that people are any less fallible today than when the first true humans walked the earth. But through spectacular scientific and technological advances, we are much more capable of affecting the physical world around us today than we have ever been. The collision between our unchanging fallibility and the awesome power of the most dangerous technologies that we have created threatens our common future—perhaps our very

LJD is Professor of Political Economy, University of Texas at Dallas, and the author of Lethal Arrogance: Human Fallibility and Dangerous Technologies. Address correspondence to: Lloyd J. Dumas, 3204 Sugarbush Drive, Carrollton, Texas 75007 USA. E-mail: ljdumas@utdallas.edu

survival. Nowhere is this more clear than in the case of nuclear weapons.

According to a 1998 study by the US General Accounting Office, human error was a contributing factor in 73% of the most serious US military aircraft accidents in 1994 and 1995.[1] A 1998 study by the Union of Concerned Scientists of ten nuclear power plants (representing a cross section of the American civilian nuclear industry) concluded that nearly 80% of reported problems resulted from worker mistakes or the use of poorly designed procedures.[2] At the end of November 1999, the Institute of Medicine of the US National Academy of Sciences issued a report finding that medical errors cause more deaths each year in the US than breast cancer or AIDS.[3]

There is a strong possibility that human error also played an important role in the crash of the Air France Concorde on July 25, 2000 and in the sinking of the Russian submarine Kursk a few weeks later, on 12 August. Each incident cost more than 100 lives.

Failures do not have to be continuous in order to be dangerous, in systems subject to

sudden criticality. The pilot of a transatlantic airliner could be virtually asleep for much of the flight without causing any real trouble. But if that pilot is not fully alert and reliable when a problem suddenly develops, hundreds of lives could be lost. Similarly, if a nuclear weapons guard is drug or alcohol impaired, it is not a problem most of the time, because most of the time nothing happens. But if that guard is not alert and ready to act the moment terrorist commandos try to break into the storage area, it could be a major disaster. The problem, of course, is that there is no way to know when those critical moments will occur, so any failure of reliability—even one that is very temporary—must be taken seriously.

The surrounding situation often determines the difference between a trivial error and a catastrophic error. For example, a telephone call begins when a sequence of numbers is fed into a system of computers that switch the call to the party whose number was entered. If we make a mistake in entering the number, we get the wrong person, apologize, disconnect, and try again. The error is trivial. But on a clear night in December 1995, the pilots of American Airlines Flight 965 made essentially the same mistake as they were flying toward Cali, Colombia. They entered the wrong sequence of numbers into the plane's navigational computer. The plane steered into the side of a mountain, and 160 people died.

In the analysis that follows, the term "unreliability" refers to the tendency to either fail to carry out proper actions or to make mistakes. The examples are intended to illustrate what can go wrong and how it can happen, not to blame, ridicule, or embarrass anyone.

Aspects of Fallibility
Boredom

For all of the danger and technological sophistication involved, much of the day-to-day work for many of those who serve in the nuclear military is really quite boring. Guarding nuclear weapons, sitting in missile silos, watching radar screens, and sailing in nuclear submarines are not inherently stimulating activities. Boring work directly impairs performance because it dulls the mind, leading to a lack of vigilance. Attention drifts; concentrating is difficult. Mild forms of dissociation—the splitting off of one group of mental processes from the rest of the mind's functions—become more common. In such a state of mind, reliability is at least temporarily compromised. In extreme situations of boredom, serious threats to reliability can occur. Laboratory studies show that people exposed to unremittingly monotonous living and working environments for weeks sometimes experience serious emotional oscillations,

diminished judgement, and even visual and aural hallucinations.[4]

Serious reliability problems can also be caused by the things people sometimes feel driven to do to cope with grinding boredom. They may try to distract themselves by consciously focusing their attention on more interesting or amusing thoughts, which means that they are not paying close attention to the task at hand. They may play games. For example, in the late 1970s, an investigative reporter did a series of articles about security at Tooele Army Depot in the US, which at the time contained enough GB and VX nerve gas to kill the population of the earth 100 times over.[5] According to the reports, the guards sometimes distracted themselves from the boring routine by racing their vehicles. One source claimed there were an average of three drag races a night. They also played "marathon card and cribbage games." Arsonists burned down an old railroad station inside the Army Depot while guards on the night shift played poker.[5]

Sometimes people doing extremely boring work may play games of another sort, intentionally doing something different, even something wrong, just to break the routine. More commonly, they may try to make the boredom more palatable by drinking or taking drugs. In interviews of American Vietnam veterans conducted by the psychiatry department at Walter Reed Army Institute, soldiers often cited boredom as the main reason they used drugs.[6] An American sailor who served as helmsman on the nuclear aircraft carrier Independence during the late 1970s and early 1980s claimed that he used LSD almost every day on duty. He said it was the only way to get through eight hours of extremely boring work.

Military personnel with day-to-day responsibility for the safety and maintenance of nuclear weapons, such as these 1-megaton B83 gravity bombs, must cope with boredom, routine, and other forms of stress that can affect judgment and reliability. Photo © Paul Shambroom.

Seeing What One Expects to See: The 1988 Airbus Tragedy

On July 3 1988, the American Navy cruiser Vincennes found itself engaged in a firefight with Iranian gunboats in the Persian Gulf. The crew had been warned that Iran might try a major attack on US forces around the American Fourth of July holiday. They were also well aware of the deadly attack by an Iraqi Air Force jet on the US Navy frigate Stark that had taken place under similar circumstances in the Persian Gulf only about 14 months earlier. Suddenly, the crew detected an aircraft rising over Iran and head-ed for the Vincennes. With only 7-8 minutes to react, and predis-posed to believe this

Habit and Routine

Habit and routine can help protect against some of the mistakes that result from boredom. Even though one may not really be thinking about what he or she is doing, that individual continues to do the right thing because of deeply ingrained habit and rou-tine. Many people have had the experience of driving a car on a very familiar and frequent-ly travelled route, and then realizing halfway though the trip that they actually had little or no recollection of the part of the trip they had just travelled. They were not asleep, not drug or alcohol impaired; they were doing all the right things to guide the car safely over a complex route, yet somehow their mind was somewhere else.

Habit and routine, however, can create serious problems when the situation some-how deviates from the familiar, but the imbed-ded routine continues to be followed for a time. The person simply does not recognize quickly enough that something important is different and the habitual behavior must be abandoned. In the words of psychologist James Reason of Manchester University, a stu-dent of absent-minded errors:

> The erroneous actions...would have been perfectly appropriate in another context. In each case, the inappropriate activity, more familiar to the subject than the appropriate one, had been carried out recently and frequently, and almost invariably, its locations, movement and objects were similar to those of the appropriate action.[7]

During special NATO training exercises over western Germany in the 1980s, a British Phantom jet pilot followed the same routine he had followed in the more common train-ing missions he had been flying for eight years. Completely forgetting that this time he was carrying live Sidewinder missiles, he fired one and destroyed a multi-million dol-lar Royal Air Force Jaguar aircraft.[8] In 1977, the experienced Dutch pilot of a Boeing 747 jumbo jet departing from Tenerife in the Canary Islands, failed to wait for takeoff clearance and slammed into another jumbo jet still on the same runway.[8] How could an experienced pilot—in fact the head of KLM's fight training department—make such an ele-mentary error? For the past six years, as a flight instructor, he had been spending near-ly all his time in flight simulators where, to save money, pilots were never required to hold position waiting for takeoff clearance. His temporary, unthinking reversion to the familiar routine in what appeared to be familiar surroundings cost 577 lives.

The "Mindset" Problem

Related to the problem of habit and rou-tine is the problem of "mindset"—when what one expects to happen colors what one thinks is happening, which in turn affects how one interprets the available data. This distorted view of reality can lead to actions that turn ordinary problems into disasters. In order to make sense of the barrage of information that our senses detect every day, we need some sort of interpretive framework that tells us what to pay attention to, what to ignore, and how things are connected to each other. We are thus able to interpret the sounds we hear as intelligible speech, and we know what the symbolic shapes on a printed page mean. The "mindset" problem is what happens when the interpretive framework we are using is inappropriate to the situation at hand. There are many examples.

• When US forces were on high alert during the Cuban missile crisis, a guard at an airbase saw someone climbing a fence, fired at the intruder he believed to be a saboteur, and set off an alarm linked to other airbases near-by. Due to a flaw in the system, the alarm sent to one base was not the sab-otage signal, but the signal for the beginning of nuclear war. At the last minute, the base commander managed to stop the nuclear-armed fighter planes rolling down the runway from taking off. What the guard had seen as a saboteur turned out to have been a stray wild bear.[8]

• In 1983, the Soviet Air Force made a tragic mistake, destroying a Korean Airlines Boeing 747 with 269 people aboard. Under circumstances that strongly predisposed them to believe it was an American military aircraft on a spy flight over a top secret Soviet mili-tary complex, they misidentified the plane despite having followed it for more than two hours.[9]

Familiarity

Greater experience with a device, a sys-tem, or a job has many obvious advantages that tend to increase reliability. But when an object, a system, or a job becomes very famil-iar, awareness can be dulled. If things go well and all is calm for an extended time, familiar-ity tends to breed sloppiness, no matter how much danger there is.

The tendency to relax once we become familiar with a task is not only a common human trait, it is useful in most situations. Unfortunately, the tendency does not disap-pear when the task is dangerous. Many acci-

dents on construction sites and many industrial accidents are caused every year by this kind of sloppiness. For example, in September 1999, workers at a nuclear fuel fabrication plant near Tokyo were routinely mixing uranium with nitric acid in a tank. They were transferring the uranium in buckets in a sloppy, error-prone procedure they should never have been using. The workers dumped almost seven times the proper amount of uranium into the tank. Suddenly, there was a blue flash of light and radiation spewed into the air, driving levels of radioactivity to 10,000 times normal. Thirty-five workers were exposed and 300,000 people in the vicinity of the plant were ordered to stay indoors. It was the worst nuclear accident in Japan's history.[10,11]

Isolation

Any working environment that isolates those at work from friends and family is predictably difficult and stressful. Unfortunately, isolation is an important dimension of the environment in which the nuclear forces work. The work is enveloped in secrecy, which socially, experientially, and emotionally isolates those who perform it from their families and from those friends who are not also in the nuclear forces. For many, the work is physically isolating as well, because it involves long periods away from friends and loved ones.

Ordinarily, physical isolation in the nuclear military does not so much require individuals to be by themselves, as it requires them to be part of a group that is isolated from everyone outside the group. The crew of a nuclear submarine, for example, sails for weeks or months in close quarters with each other, isolated from contact with anyone else.

Laboratory studies of "group social isolation" done by social psychologist Irwin Altman beginning in the mid-1960s, show that simply being part of a socially isolated group is stress-inducing. In Altman's studies, men in socially isolated groups showed more territoriality and increased social withdrawal —not particularly healthy behaviors. After only about three weeks, even with access to separate compartments for privacy, this environment tended to be highly stressful.[12-15]

Stress

While a little stress can actually increase reliability and alertness, sustained high levels of stress can lead to serious physical and emotional problems that cause reliability to deteriorate. Physically, stress can cause blood pressure to rise. A team of cardiologists showed in a 1991 study that stress can cause abnormal constriction of blood vessels in patients whose coronary arteries are already clogged with atherosclerotic plaque, further restricting blood flow and raising the chances of heart attack.[16] High levels of stress tend to compromise the immune system, making it more difficult for the body to fight off infection by organisms ranging from ordinary cold viruses to virulent, debilitating, even life-threatening pathogens.[17]

Sustained high levels of stress can bring on emotional disturbances as well as physical illness. For example, stress can play a significant role in triggering episodes of severe depression. US National Institute of Mental Health psychiatrist Philip Gold has suggested that extended periods of high stress can overwhelm the mechanisms that normally regulate the natural human response to stress, creating a free-running state of constant stress that leads to maladaptive reactions like severe melancholic depression (characterized by hopelessness and intense anxiety about the future).[18]

The effects of chronic stress may be temporary, subsiding when the sources of stress are removed, or they may have a very long reach. Acute stress, from emotional trauma such as divorce or the death of a close friend or family member, can have long term impacts in addition to its powerful short term effects. The most extreme, longest-term reactions to stress seem to occur when the stress is both high and prolonged. Post-traumatic stress disorder (PTSD) is characterized by difficulty concentrating, extreme suspicion of others, and emotional detachment from loved ones. Recurrent nightmares—even full-fledged flashbacks of traumatic events—may be triggered by a sight, sound, smell, or situation that is somehow connected to the original trauma.

At least 500,000 of the 3.5 million American soldiers who were sent to Vietnam have been diagnosed as suffering from PTSD;[19] some 30% of them may be so severely afflicted that they are unlikely to ever lead a normal life without medication and/or therapy.[20] The potentially long reach of this disorder is also clear from a 1991 psychological study of 22 American veterans taken prisoner during the Korean War. Nineteen of them were still suffering from PTSD and other serious mental problems more than 35 years after their release.[21]

The onset of the problems that result from trauma-induced disorders may be delayed days, months, or even years. Someone who appears to have completely recovered from the effects of severe trauma may still be subject to serious reliability problems that lie hidden beneath the surface. Even if someone who has been severely traumatized appears to be completely normal, his or her ability to cope with stresses wholly

was the attack they had expected, the crew identified the plane as an Iranian Air Force F-14 descending toward their ship at high speed, as if to attack. They fired two surface-to-air missiles, blowing the plane out of the sky. The craft was not an F-14; it was a civilian Airbus A-300 airliner with nearly 300 passengers and crew on board. Predisposed to see a hostile military aircraft, the Vincennes crew misinterpreted the electronic signal coming from the plane that identified it as a civilian airliner; they misread their own data that correctly showed the plane was rising, not descending to attack; and they failed to find the flight in the airline schedule they consulted, even though it was clearly listed there.[32]

unrelated to the original events may have been seriously compromised. Finally, because of the very nature of their career path, people in the military have often been exposed to more "PTSD stressors" than the public at large.[21] That is especially true of those who have served in combat or have been taken prisoner.

Drugs and Alcohol

The use of alcohol and nonmedical drugs affects mood, clarity of thought, judgement, and reaction time in ways that cause unreliable behavior. What is less well appreciated is that the side effects of ordinary medicines, sold with or without a doctor's prescription, can also seriously degrade reliability. For example, Dimetapp, a drug commonly prescribed for allergies can produce dizziness and visual disturbances. Inderal, prescribed for high blood pressure and migraine headaches, can reduce alertness, cause mental depression, precipitate hallucinations, and even lead to congestive heart failure. Sudafed, a sinus and nasal decongestant available without prescription, can produce agitation, insomnia, and, in rare cases, seizures. Advil, a readily available pain reliever, can cause dizziness, drowsiness, depression, and, on occasion, blurred vision, confusion, and even convulsions.[22,23]

Data from a 1995 survey on nonmedical drug use taken for the US military imply that more than 70,000 armed forces personnel had used illicit drugs at some time during the preceding year, and almost 33,000 had used them during the preceding month. Estimates based on those sample survey data indicate that almost 16,000 active duty military personnel had tripped on LSD or some other hallucinogen during the preceding year; more than 6,500 during the month preceding the survey.[24]

While an intensive anti-drug campaign seems to have reduced overall drug use among military personnel by as much as 38%,[24,25] hallucinogen use may have actually increased—perhaps as a direct result of the campaign. The use of marijuana, opiates, and amphetamines can be detected by simple, efficient, and inexpensive mass screening of urine. But because of its special characteristics, there is no cost-effective mass urine screening test for LSD. LSD is also easier to conceal than most other drugs, and thus could be more readily smuggled into a user's work station or living quarters. At the same time, LSD's mind-altering impacts are potentially much more disruptive of reliability than the continuing use of marijuana or heroin. The fact that it subjects the user to the possibility of flashbacks days, weeks, or even months after its last use, also means that the

drug does not have to be taken while on duty, or even anywhere near the time of active duty, for it to pose a serious reliability risk.

Drug and alcohol abuse is a problem not just in the military at large, but in the nuclear military specifically. Data released by the US military for the years 1975-1990 show that almost 20,000 American military personnel were permanently removed from nuclear duty over that period as a result of drug abuse, an average of more than 1,200 per year.[26,27] Alcohol abuse added almost another 7,000 to the total (an average of more than 430 per year).

Circadian Rhythms

People who work on night shifts or on shifts that periodically rotate around the clock are regularly exposed to the equivalent of jet-lag. This kind of work pattern is unavoidable in the nuclear military, where duty stations must be staffed 24 hours a day. Circadian disturbances are also associated with certain forms of mental illness, such as depression and bipolar disorder.

The Fallibility of Groups

Nuclear military forces try to assure that an unreliable individual cannot cause a disaster by requiring that a group of people act together to, say, permit removal of a nuclear weapon from a storage area or to launch a nuclear missile attack. But there are conditions under which groups may also behave unreliably—sometimes even less reliably than individuals.

Both the upward flow of information and the downward flow of directives tend to be distorted in all hierarchical bureaucratic organizations, including the military. One classic manifestation of this problem is the "good news" syndrome, in which subordinates edit problems out of the information they send up to managers in order to pass along a more pleasant picture. The result of all this good news is that top level decision makers come to have a very distorted view of what is really going on. It is very difficult to make good decisions when one does not have good information. Unfortunately, this problem tends to get worse, not better, when there is more at stake.

In a dissenting safety report, largely focused on the Pantex nuclear weapons plant (the final assembly/disassembly point for all US nuclear weapons), senior Department of Energy (DOE) safety expert Frank Rowsome characterized two of the six leaders of major DOE safety review teams under whom he had worked in the preceding four years as follows:

...their faith in safety was such that it was quite difficult for them to enter-

tain the idea that there might be real safety problems or that we should look for them. They wanted to please their management with good news. Both took steps to curtail our review....[28]

Rowsome argues that such behavior is reinforced by the DOE bureaucracy:

...those of us who help to cover up deficiencies are rewarded, and those who bring them to the fore...are at best ignored, resented, or dismissed as troublemakers....

When subordinates in bureaucratic organizations receive directives from their superiors that are in conflict with familiar and convenient ways of doing things, there is a disturbing tendency for those directives to be diverted, distorted, or ignored. Probably the most spectacular example related to the nuclear military occurred during the Cuban Missile Crisis. More than a week into this dangerous nuclear confrontation, President Kennedy received a letter from Premier Khruschev proposing that the Soviet Union remove its nuclear missiles from Cuba in exchange for US withdrawal of its nuclear missiles from Turkey. President Kennedy could hardly believe what he was reading. Three times in the preceding 18 months, Kennedy had ordered those missiles withdrawn from Turkey, thinking them both obsolete and provocative. He now learned from Khrushchev that his persistent directive, issued as President and Commander-In-Chief of the American military, had been essentially ignored.[29]

Groupthink

Yet another serious problem of group reliability is "groupthink"—psychologist Irving Janis's term for a process in which the quality of decisions made by an "in group" deteriorates as a result of the pressure to maintain consensus and good feeling among its members.[30] Increasingly isolating themselves from external points of view, the members of the group become convinced of the correctness and inherent morality of their views. They develop a shared illusion of invulnerability and adopt stereotypical views of opponents as too evil to negotiate with seriously, and too weak or stupid to successfully interfere with the group's objectives. All of this sets the stage for very risky decision making.

The most dramatic group-reliability problem is group psychosis, a situation in which a crazy but charismatic leader is able to draw the otherwise sane members of a group into his or her own delusional world view. The greater the degree of control the leader has over the conditions in which the members of the group live, and the more he or she can isolate them from outside contact (especially with friends and family), the more likely group psychosis will develop. Twentieth century examples of group psychosis include the Reverend Jim Jones and his followers at Jonestown, Guyana in the 1970s; David Koresh and the Branch Davidian at Waco, Texas in the early 1990s; and Shoko Asahara and the Aum Shinrikyo in Japan in the mid 1990s.

If a delusional commander with control over many aspects of his or her troop's lives were able to isolate them from the outside world, it would be relatively easy to disorient them and draw them into the delusional worldview by disrupting their sleep, controlling their eating, keeping them on continual high alert, and haranguing them with repeated lectures. They are already primed for obedience by their training and by the very nature of military life. But how and where could they be isolated so completely for long enough for this to happen?

The crew of a nuclear missile submarine is completely cut off from outside contact for months at a time, and lives in a totally artificial environment from which there is no relief. The captain and ranking officers aboard have nearly complete control of the conditions in which the crew lives and works. And every nuclear missile submarine carries enough firepower on board to do devastating harm to any nation on Earth.

Transferring capability and responsibility from individuals to groups does not by itself protect the nuclear military absolutely against the limits of safety imposed by human error, illness, or malevolence. From the banalities of bureaucracy to the arrogance of groupthink to the nightmare of group psychosis, groups not only fail to solve the problems of human fallibility, they add their own special dimensions to it.

Similarly, it is impossible to eliminate human error by relying on computers. Computers are extremely fast, but in many ways they are quite stupid. They have no "common sense" and no "moral sense." Built and programmed by fallible human beings, they respond only to what they have been asked, and do only what they have been told to do. And, of course, fallible human beings ask the questions and give the commands.

"Those of us who help to cover up deficiencies are rewarded, and those who bring them to the fore...are at best ignored, resented, or dismissed as troublemakers."
— DOE safety expert

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What Can and Should Be Done

The many dimensions of human fallibility inevitably lead to mistakes, even when the stakes are very high. What then can be done to reduce the likelihood of catastrophic error in nuclear military systems? The list of strategies briefly discussed here is intended to be illustrative, not comprehensive.

To begin with, an effort should be made to reduce the boredom that is associated with so many nuclear duties. Rather than making the work as simple as possible to avoid error and/or to simplify control, managers should make the work as varied and interesting as is consistent with the nature of the job and the personnel who perform it. Those who do particularly mind-numbing work—for example, those who work with radar screens or sonar equipment, and those who guard nuclear weapons—might be assigned shorter times on-duty before breaks, along with access to more stimulating things to do during break time. They should be encouraged to undertake whatever mix of physical activities (such as exercising or playing sports) and mental activities (such as reading or studying to learn new skills) is most appropriate. Their schedules should also be arranged to assure that they can get adequate sleep between on-duty periods. None of this, however, should be done by rotating personnel frequently between night and day shifts, since the loss of reliability due to increased circadian disruption could more than cancel out the gains from reduced boredom and less grueling schedules.

To help break the hold of the "mindset problem," training exercises should periodically include situations in which making the right decisions and taking the right actions require shedding a pre-existing picture of what is happening, keeping a broader perspective, and reinterpreting information.

Although it is necessary to call "surprise" alerts and to set up response tests at random intervals, it is important that these not be done so often that they substantially increase the level and duration of stress. Access to formal or informal short term voluntary counseling for those temporarily undergoing high-stress life events is also a good idea, providing the stigma associated with seeking such help can be overcome and meaningful assurance can be given that the mere act of seeking temporary counseling will not sabotage an individual's military career. Amnesty drug and alcohol treatment programs should be placed alongside programs to discourage and detect substance abuse. Combining an increased likelihood of being caught and punished with the possibility of avoiding punishment and formal stigmatization if treatment is sought voluntarily should help encourage those who are abusing drugs or alcohol to get effective help sooner rather than later.

There are ways to minimize the distortion of information flows that is natural to hierarchical bureaucracies, but it is difficult to see how they can be effectively applied in the nuclear military. Two general approaches have been discussed in the organizational management literature: flattening the organizational structure and management by "wandering around."[31] Because hierarchy, rank, and the chain-of-command are so embedded in the structure and function of military systems, flattening the hierarchy does not seem a usable option for regular military forces. Management by "wandering around" requires regular and consistent informal contact of superiors with their subordinates, a practice widely discouraged by militaries for fear of undermining the authority of rank.

Groupthink can be minimized by deliberately encouraging criticism within the group, for example, by assigning one or more group members the explicit task of pointing out weaknesses in every position taken by any other group member. Others can be asked to play the role of the "enemy" and describe reactions to the group's proposed decisions that might frustrate the group's goals. Forums should also be provided for the opinions of knowledgeable individuals who are not part of the "in group" to be heard by group members, especially those individuals who have perspectives that strongly differ from that of the group.

The likelihood of a full-blown case of group psychosis developing is admittedly low, but the potential damage it can do is so great that we cannot safely ignore it. It can be made still less likely by rotation of crews and commanders. Military personnel could be explicitly trained to recognize the signs of inappropriate cult-like attempts at "brainwashing" by superior officers, to report such attempts to those higher in the chain-of-command, and to protect themselves from the effects. This is an exceedingly tricky business in military organizations, where mental conditioning, unit cohesion, and obedience to authority are so strongly ingrained and central to the mission of the organization.

There is no way to completely eliminate the potential for catastrophe in nuclear military systems except by completely eliminating nuclear weapons. This is not nearly as idealistic or impractical an idea as it might seem on the surface. In the past few years, a substantial number of high-ranking military officers and top-level civilian officials who have been intimately involved with the nuclear militaries of a variety of countries have publicly advocated the position that

nuclear weapons can and should be abolished. Until we succeed in finding a workable path to this ultimate solution, however, everything that can be done should be done to reduce the potential for human-induced disaster in the nuclear miltaries of the world to the lowest possible level.   ❧

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