THE LIMITS OF SAFETY

ORGANIZATIONS, ACCIDENTS, AND NUCLEAR WEAPONS

Scott D. Sagan

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For My Parents

JOHN SAGAN AND MARGARET PICKETT SAGAN

Although observers of warfare have often noted the confusions of battle, the ideology of military decision-making emphasizes the imposition of order through organization and command and the importance of clarity, coherence and comprehensiveness. As a result, examining ambiguity in military decision-making is a little like examining the sexual habits of Victorian England. It requires a willingness to accept the possibility that things may not be exactly what they appear to be, or are supposed to be.

(James G. March and Roger Weissinger-Baylon
Ambiguity and Command, 1986)

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Finally, I want to thank my wife, Bao Lamsam, and our son, Benjamin, for their love and support. It is good to know that some things in life are beyond the reach of accident.

Acronyms

ADC	Air Defense Command
ADIZ	Air Defense Identification Zone
AFHRC	Air Force Historical Research Center
AFSC	Air Force Systems Command
ANMCC	Alternative National Military Command Center
BMEWS	Ballistic Missile Early Warning System
CC&DF	Command Control and Display Facility
CIA	Central Intelligence Agency
CINCEUR	Commander in Chief, Europe
CINCLANT	Commander in Chief, Atlantic Command
CINCPAC	Commander in Chief, Pacific Command
CINCSAC	Commander in Chief, Strategic Air Command
CINCUSAFE	Commander in Chief, United States Air Forces, Europe
CMEWS	Cuban Missile Early Warning System
DEFCON	Defense Condition
DEW LINE	Distant Early Warning Line
EAM	Emergency Action Message
ECC	Emergency Combat Capability
EMP	Electromagnetic Pulse
ESD	Environmental Sensing Device
EUCOM	European Command
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FOIA	Freedom of Information Act
GAO	General Accounting Office
GRU	Chief Intelligence Directorate for the Soviet General Staff
HASP	High Altitude Sampling Program
HF	High Frequency
ICBM	Intercontinental Ballistic Missile
IRBM	Intermediate Range Ballistic Missile
JCS	Joint Chiefs of Staff
KGB	Soviet Committee for State Security
LCC	Launch Control Center
NA	National Archives
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NEACP	National Emergency Airborne Command Post

NMCC	National Military Command Center
NORAD	North American Air (or Aerospace) Defense Command
NSA-CMCC	National Security Archives–Cuban Missile Crisis Collection
NSAM	National Security Action Memorandum
PAL	Permissive Action Link
PARCS	Perimeter Acquisition Radar Attack Characterization System
PAVE PAWS	Precision Acquisition of Vehicle Entry New Phased-Array Radars
PCL	Positive Control Launch
PCTAP	Positive Control Turn-Around Point
PG&E	Pacific Gas and Electric
QRA	Quick Reaction Alert
RCA	Radio Corporation of America
ROE	Rules of Engagement
SAC	Strategic Air Command
SACEUR	Supreme Allied Commander, Europe
SAGE	Semi-Automatic Ground Environment
SEAGA	Selective Employment of Air and Ground Alert
SIOP	Single Integrated Operational Plan
SIS	Secret Intelligence Service (United Kingdom)
SLBM	Submarine Launched Ballistic Missile
SRF	Strategic Rocket Forces (USSR)
SWESS	Special Weapons Emergency Separation System
USAF	United States Air Force

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INTRODUCTION

Expecting the Unexpected

ON THE NIGHT of October 25, 1962, an air force sentry was patrolling the perimeter of a military base near Duluth, Minnesota. It was the height of the Cuban missile crisis, and nuclear-armed bombers and interceptor aircraft, parked on air base runways and at commercial airports throughout the United States, were alert and ready for war. The sentry spotted someone climbing the base fence, shot at the figure, and sounded the sabotage alarm. At airfields throughout the region, alarms went off, and armed guards rushed into the cold night to prevent Soviet agents from sabotaging U.S. nuclear forces.

At Volk Field in Wisconsin, however, the wrong alarm bell rang: the Klaxon signalling that nuclear war had begun went off. Pilots ran to their nuclear-armed interceptors and started the engines. These men had been told that there would be no practice alert drills during the tense crisis, and they fully believed that a nuclear war was starting as they headed down the runway. Fortunately, the base commander contacted Duluth before the planes took off and discovered what had happened. An officer in the command post immediately drove his car onto the runway, flashing his lights and signaling the interceptors. The pilots saw him and stopped their aircraft. The suspected Soviet saboteur that caused the whole incident was, ironically, a bear.

Unlikely Events

When I began working on this book, I believed that the probability of a serious nuclear weapons accident in the United States was extremely low. I also believed that escalation from a single accident to an accidental nuclear war was even more unlikely. I still hold those beliefs. But new knowledge about bizarre and dangerous incidents within the U.S. nuclear weapons arsenal—like how a bear climbing a fence almost caused nuclear-armed aircraft to be launched—has led to a new appreciation of how often unlikely events occur. In the large and very complex organizations that control hazardous technologies in our society, one should expect that the unexpected will occur, that unimaginable interactions will develop, that accidents will happen.

The historical research presented in this book has discovered a large number of previously unknown "close calls" with U.S. nuclear weapons: serious incidents within the U.S. nuclear arsenal that could have produced an accidental or unauthorized detonation of a nuclear weapon, and potentially even an accidental war, had they occurred under different, though plausible, circumstances. The seriousness of some of these incidents was immediately recognized by the actors involved and the command system problems were properly reported and addressed at higher levels. My research has "discovered" these cases only in the most narrow sense of finding archival material or receiving declassified evidence through the Freedom of Information Act. Other cases, however, were not recognized as serious incidents or even as potential command system problems by the individuals or organizations involved. These incidents have been "discovered" in the more meaningful sense of identifying a real-world problem for the first time. Finally, a number of these events were recognized as being very dangerous by the individuals involved, but were not fully reported, either inadvertently or intentionally, to higher authorities. This research has "discovered" them in the sense that a detective can be said to have discovered hidden evidence about a criminal case, facts that were known to someone, but not to the judge.

Motives and Methods

Why and how was this book written? It began, as most books do, with a puzzle. We live in a world full of hazardous technologies and some risk of catastrophic accidents is therefore ever present. We try to keep these risks as low as possible, yet in recent years, the names of many social and environmental tragedies have been etched into our memory: Chernobyl, the *Exxon Valdez*, Love Canal, the space shuttle *Challenger*, Bhopal. The safety record seems quite extraordinary, however, with the most hazardous technology of all: nuclear weapons. There has never been an accidental or unauthorized detonation of a nuclear weapon, much less escalation to an accidental nuclear war.

Why? How have imperfect humans, working in imperfect organizations and operating imperfect machines, been so successful? Have the military organizations that maintain custody and control over U.S. nuclear weapons done something extremely intelligent to avoid accidents? Have they been designed in such a way to produce reliable safety? Or have they merely been extremely lucky?

The first step toward solving this puzzle was to arm myself with the major scholarly theories that exist about the causes of safety and accidents in complex organizations. Two competing schools of thought—what I call

normal accidents theory and high reliability theory—are analyzed in chapter 1. Such theories are always necessary to understand complex social phenomena; they are the conceptual tools we use to pull disparate events together and understand what caused them. The point is especially obvious for anyone who tries to do historical research with records kept in massive collections like the National Archives: theories are absolutely necessary to tell you where to look for evidence. (The final scene of the movie *Raiders of the Lost Ark*, in which the ark of the covenant is slowly wheeled into a mammoth government warehouse, conveys a sense how effectively historical objects are hidden in the recesses of the archives.) Using the theories discussed in chapter 1 as guides, I was able to explore the historical records of the U.S. military, searching for clues.

Let me give just one example of how the process worked. (See chapter 3 for the substantive details about this particular case study.) The literature on the Cuban missile crisis is immense, but no scholar has previously studied the emergency radar warning system, which the United States deployed on a crash basis in October 1962 after the Soviet missiles were discovered. A study of the activities at the three radars used in this Operation Falling Leaves appeared to me, however, to be a very useful way of comparing the strengths of the two theoretical perspectives outlined in chapter 1, since these theories provide contrasting expectations about this warning system's reliability. Normal accidents theory would predict that Falling Leaves would be a very accident-prone operation: the warning system displayed all the signs of high interactive complexity and tight coupling, the two structural factors that the theory suggests lead to dangerous accidents in other high technology systems. High reliability theory would predict that Falling Leaves would be a relatively safe operation, since the factors that the theory suggests produced safety in other hazardous systems also existed here: significant decentralized decision-making authority was given to operators in the field, redundant radars were used to provide more accurate warning information, and officers' caution was heightened by the crisis environment. I therefore visited the Air Force archives, found a number of relevant declassified documents, and then used the Freedom of Information Act to request that additional related documents be declassified and sent to me.

These historical records confirmed the more optimistic view of the high reliability theorists. They reported on no serious false warning incidents occurring during the crisis. Indeed, the Falling Leaves after-action reports recommended that the emergency radar system be set up again if there was ever another superpower crisis.

This success story was puzzling from a normal accidents perspective. That theory, however, also reminds us to be skeptical of documents that are written by organizational actors who are interested in promoting their

cause. Operators do not want to get blamed for making serious errors and leaders of military organizations want to promote the reputation of their command. I therefore sent the documents to a large number of the retired Air Force officers and civilian contractors who had participated in the Falling Leaves operation, and asked that they comment on them. A number of these men recalled that there had been one or more serious false warning incidents during the crisis and expressed puzzlement as to why such events were not in the unit histories. I did not know whether to trust the documents (which could be faulty) or the memories (which obviously could be faulty too).

Fortunately, one retired officer said that he was sure that he had written something about a false warning incident in the command post log back at Air Defense Command Headquarters in 1962. I had not known that such records existed, but I immediately requested that the Air Force Space Command declassify these command post logs for the dates of October 26–29, 1962. These handwritten notes were like a smoking gun.

They revealed that a serious false warning incident occurred on October 27, 1962, at the height of the Cuban crisis. The radar operators at one site in Moorestown, New Jersey, informed the national command post that a missile had just been launched from Cuba and was about to detonate near Tampa, Florida. The command post officers immediately informed other U.S. military commands that a nuclear attack appeared to be under way. After the event, operators discovered that a software test tape, simulating a missile launch from Cuba, had been inserted into the radar operators' screen and that, simultaneously, a satellite came over the horizon. The operators "became confused," according to the command post log, and therefore reported "the test target as real." Who would have anticipated that a satellite would appear on the radar screen at the exact moment when a test tape was running and at the exact location where a missile launched from Cuba would have appeared? To make matters worse, the Falling Leaves system had been carefully designed to include overlapping redundant radars to provide more reliability, but the other radars were not turned on when the incident occurred. In addition, although the radars were supposed to get advance information on satellites passing overhead, the key facility involved had been taken off that mission, ironically, to help provide warning in the Falling Leaves operation. None of this was reported in the classified after-action reports on the operation.

The research strategy proved laborious, but it also proved necessary. This book thus attempts to show one way in which social science theories can illuminate, indeed even identify, important events in history. It also attempts to show how such historical case studies can be used to evaluate our theories, and thereby improve our broader understanding of how complex organizations manage and mismanage hazardous technologies.

A Note on Sources

Nuclear weapons and military operations are obviously very sensitive subjects within the government. Getting information on nuclear weapons accidents and safety problems has therefore been an extremely difficult task. Four kinds of sources provide the primary evidence used in this book.

First, I made extensive use of the declassified government documents available to researchers at the National Archives, the presidential library system, and the operational archives of the U.S. Air Force and U.S. Navy. I had to visit a number of these archives many times, as new material became available or subsequent ideas suggested new areas of inquiry. Many important pieces of the puzzle were found, however, once I figured out where they might be hidden.

Second, I requested and received literally hundreds of formerly classified documents (some in their entirety and some in sanitized form) through the Freedom of Information Act and the Mandatory Declassification Review process. Responses were forthcoming in anywhere from three weeks to three years. Sometimes my requests were lost; sometimes the wrong documents were declassified. I appealed most decisions to withhold documents in their entirety and occasionally the agency involved released more information. Copies of these documents have been placed in the National Security Archives in Washington, D.C., so that other researchers can use them.

Third, I conducted dozens of interviews with individuals who were involved in these dangerous incidents. These interviews spanned the hierarchy from former senior civilian officials at the Pentagon and the White House, down to individual interceptor pilots and crewmen inside a Minuteman ICBM launch control center. Often I would send the available declassified documents to these individuals to get their views on the accuracy of the records. Evidence from such interviews obviously has to be treated with caution, given the inevitable vagaries of memory and the potential biases of the individuals involved.

Fourth, a great deal of useful information on the subject of nuclear weapons safety can be found in congressional hearings. One must also use the material from such hearings cautiously, however, since testimony given in such hearings may or may not be absolutely accurate. Moreover, critical material is often deleted from the transcript, to protect classified information necessary for national security, and what remains can therefore be misleading.[1]

[1] Difficult detective work is not always necessary to fill in the blanks. For example, I already knew that 30 percent of the U.S. bomber force was kept on day-to-day alert from the following sanitized testimony: "With regard to the bomber force, we keep approximately (*deleted*) *percent* of the bombers and supporting tankers—roughly (deleted) aircraft—on