

EYEWALL

Rick Shelley

Although it's true that everyone talks about the weather, some people do try to do something about it, as the tense and exciting story that follows demonstrates. . . . The question is, at what cost?

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The five week journey out from Earth taught me only one thing. Twenty-five years had taken the excitement out of space travel for me. When I was a graduate student going off-planet to research my dissertation, space travel was an adventure. Now it was just wasted time between here and there. I spent most of my time in my cabin, going back over every line of our operating program for the Trident experiments. My two research assistants quickly gave up trying to include me in anything. We met at meals and only rarely at other times, despite the restricted passenger accommodations. It wasn't until I got a call from Captain Linearson that I came out of the doldrums.

"Doctor Jepp, we're about to enter orbit around Trident. If you want a preview of the weather, you're welcome to come up to the flight deck."

"On my way." After all, the weather was the reason for this trip.

Trident has been notorious since its discovery a little more than twenty years ago. In many ways it's the most ideal of the several dozen Earth-like planets we've found. It has thousands of miles of prime tropical and sub-tropical coastline, lush lowland forests, scenic mountains, abundant wildlife, and all the rest. But the colonizers haven't struck yet. They're still waiting for the end of Trident's hurricane season . . . and it may snow in hell before that happens.

Beautiful hurricanes.

My trek up to the flight deck was slow and awkward. Now that we were back in normal space, we were back to zero gravity conditions, and I was having difficulty moving about. When I got to the flight deck and looked out, down was up, I had a moment of disorientation.

"Think it'll rain?" Captain Linearson asked with a laugh. After twenty-five years with the International Weather Service, I'm almost hardened to weather jokes. Almost.

"If it doesn't, I've come a long way for nothing." I looked out at Trident. The IWS had maintained a research team on Trident for the last eight years. We would have set up shop sooner but it took a decade to get general assembly funding and approval for the project.

"Well, there's your Angry Sea." The captain pointed out and "up."

Trident was hanging overhead—as far as I was concerned. The Angry Sea (that *is* the official name) was on the daylight side and dominated the visible portion of Trident. In media shorthand, Trident is called "the water world" as often as not. It's a misnomer. We've never come across a true water world, that is, one covered entirely by ocean. Percentage-wise, Trident has only 3 percent more of its surface covered by water than Earth does. But it is more concentrated. Earth has gone through similar periods in its tectonic history. Take Earth back to when the continents were just separating. Make the Atlantic Ocean 200 miles wide, allow for a few large bays and gulfs, call the rest of the water the Pacific Ocean and you have a decent idea of the makeup of Trident. The Angry Sea covers a huge chunk of the

surface.

And it's always hurricane season. Trident's axial tilt is less than a third of Earth's, keeping the tropic and subtropic portions of the ocean warm enough for hurricanes year-round. I could see four of them at the moment.

"Am I going to be in your way here, Captain?"

"Not at all, Doc. Look as long as you want. We'll make one orbit before we deploy your satellites. On the second pass, we'll get you and your team into the shuttle and separate for landing. If the weather holds." She laughed but didn't look at me, so I was spared the necessity of any response to the joke. "Tim will take you down." Tim Andrews was at the other command console. He was a quiet man still in his twenties.

"Set you down without any trouble," he promised. "Even if it's raining." Another comedian.

"Captain, have you contacted the IWS station yet?" I asked.

"Just to tell them we're here. Anything special?"

"Flash them that canned message from IWS if you would," I said. Captain Linearson hit several keys on her console.

"Going down now."

"Fine, thanks. I'll make sure my people are ready to move out." The sooner I got away from looking "up" at the ground, the better my stomach would feel.

I never expected to be welcomed with open arms. Donna Elkins wasn't merely the director of the Trident Hurricane Study Center, she was its creator and driving force. Trident had become her career almost from the day we received the first reports on the planet from the survey team. The proposal for the HSC had been hers and she fought for ten years to get it approved and funded. She had been on Trident since the start of construction and, as far as anyone in IWS could tell, she intended to stay there until somebody wrapped her in chains and carried her off. There was little chance that she would be overjoyed to see me with my temporary writ superseding her authority.

But she was there to meet the shuttle when we landed. "Doctor Jepp. It's been a long time."

"Doctor Elkins." I nodded and we shook hands. "It has been a long time." I had never really known her personally, but we had met at conferences now and then before she left Earth, and her single-minded drive to establish the research center on Trident had made her something of a "personality" in the agency. *Everybody* knew about her. She was forty-five years old now, according to her personnel file, and even though there was only a little gray showing in her hair, she looked much older—the sort of look that people get when they push themselves to the limit all the time. I knew her record. I made a point of studying it when I got approval for my finger-in-the-eye experiments.

"These are my research assistants, Jenny Evert and Ike Pappas." They nodded and there was more handshaking.

"We weren't expecting a ship for another seven months," Doctor Elkins said as we walked toward the electric van she had brought out for us.

"That ship should still be on schedule," I said. "We did bring some of the items you had on order though, what we could fit in. And we brought enough supplies to make up for the extra drain we represent."

I had trouble concentrating for a moment when I spotted an animal standing on top of the van. It stood three feet tall and might almost have passed for a monkey. This animal's fur looked like military camouflage, patches of olive green, dark brown, and tan. It had a broad face with large, slightly protruding eyes, a vertical ridge between them that was apparently not a nose, and a tiny mouth that didn't make sense until it unreeled a 15-inch-long tongue. An insectivore.

"Part of the staff?" I asked, glad to have something light to ease the moment.

Doctor Elkins gave the creature an annoyed glance. "That's Mona. We call them chimps, or T-chimps, though Dov Marchiese gave them a full Latin classification. There's a whole troop of those things that hang around the center."

Mona stiffened and saluted. Behind me, Jenny and Ike laughed. I avoided sound effects, but I gave Mona a smile and returned her salute. "Seems fairly intelligent," I said.

"Too smart to scare off, too stupid to know enough to stay away," Elkins said.

That was the extent of conversation until we reached the station's permanent buildings. *Permanent*: seventy-five miles inland, the weather could get much too fierce for anything less than nanofabricated modules of grown diamond, silicrete, and steel-graphite composites. Under test conditions on Earth, the design had survived four-hundred-mile-per-hour winds, the equivalent of eight inches of rain per hour for twelve hours, and impacts from weights of up to nine tons dropped from thirty feet.

Perhaps half of the station's people gathered to meet us when we reached the main facility. Doctor Elkins did the introductions, then assigned rooms for me, my assistants, and the shuttle pilot. There was a little chat. The resident staff had questions about home and any mail and so forth that we might have brought. The news that we had a bag of mail chips was welcome. Finally, the director steered me off to her office.

She slammed the door behind us.

"Now just what the hell is this all about?" she asked. Her voice was low, but there was no missing the intensity of it.

"I'm here to see if it's possible to kill a category five hurricane, Doctor Elkins." I said, just as softly, but without the tension behind my words.

"Forget that 'Doctor' crap, Roy. It's all first names here." That definitely was *not* a friendly invitation to a closer relationship. "What do you mean, 'kill a category five hurricane'?"

"Just that. After Hurricane Lisa hit the Florida coast two years ago, IWS has to produce more than long-term research reports from Trident. We have a new mandate to produce action rather than observation, technology rather than basic science."

"Political pressure." She said those words as expletives.

"Twenty-seven thousand people died in that storm, Donna. IWS lost nearly a hundred. More than two million people lost their homes. They still haven't totaled the bills. There are *still* a half-million people living in so-called 'temporary' refugee camps from Florida all the way up to South Carolina. What do you expect?"

"I expect nothing," she snapped. She turned away. "But I think I *deserve* a little support from the agency. I can't run this project here and defend it day by day back on Earth."

"I agree," I said. I did, in principle. But bending with the wind is more than another tired weather cliché. It's political survival. "This is something beyond interdepartmental squabbling though. The general assembly has been making noises about the expenses here from the beginning, and since they're still looking for money to complete the recovery from Hurricane Lisa, they're looking hard at anything they can do to cut expenses else-where. 'Why spend all this money if we're not going to get anything practical out of it?' You know what it's like." I waited until she nodded before I continued.

"The Trident program would never have been approved without a lot of promises that it would finally make it possible to do something about tropical cyclones. Promises *you* made." I waited for another nod.

"Hurricane Lisa merely brought it to a head." I shut up until she turned to face me again.

"It's put up or shut up time, Donna," I said, as sympathetically as I could manage. "To be a little more precise, it's put up or shut down. And I want to keep Trident HSC going as much as you do."

For an instant, a haunted look got past the anger on her face. Then the anger returned, stronger than ever. "You can't do basic science on a timetable."

"They don't want basic science. They want usable technology."

"Basic research was the whole purpose for this station. Given time, we can learn more about cyclonic weather than anyone ever imagined. We *need* the basic research before we start thinking about technology to control hurricanes. We're not set up for that sort of task."

"That's why I'm here. We brought along everything we'll need for our experiments."

"And if they don't work?"

I took a deep breath before I answered. "In that case, when the regular supply ship comes in seven months, it will be to close down the project and take you all home. But if they do work, we'll be long gone by then and your project will continue." Our ship would wait in orbit to take us back to Earth when we finished.

"I won't leave."

"You won't have any choice. You're not self-sufficient here and you can't make yourself self-sufficient in seven months."

Round one. "That went better than I expected," I mumbled when I got to my room. Of course, I hadn't said anything about the actual nature of the experiments I had come to conduct. I knew damn well that the real argument wouldn't start until Donna Elkins found out what I was planning to do on Trident.

There was little noteworthy about the arrangement of the buildings that housed Trident HSC. The long, low, narrow modules were linked together like so many dominoes, meandering about a clearing that was a kilometer across. The trees that had been felled around the center had been pruned and used as extra bulwarks around the perimeter. At the edge of the clearing a series of large bunkers had been excavated from the side of a hill to store supplies and equipment, and to serve as hangers for the center's aircraft and the odd orbiter that might be on the ground for a day or two while a ship was in orbit.

Everything about the center was utilitarian, Spartan. My room was a cubicle ten feet square and eight feet high. There were no windows. The bed was a simple, uncomfortable cot. There were two tables and

two chairs. One table held a computer terminal. The other table was empty.

I sat on the bunk and leaned back against the wall. I was more tired than I had any right to be. The return of gravity after a few days without any wasn't excuse enough. I reveled in having weight and a proper orientation to "up" and "down" again. I suppose I was wasting energy dreading the arguments yet to come. Confrontation has never been my style. I just sat there and fretted until Jenny and Ike came to report.

"Everything is in the bunker," Ike said. "It hasn't been opened." The "everything" in question was the shuttle cargo module with our experimental gear. Our module had made the trip out from Earth in the hold of the ship's main shuttle. The unit had been designed to use every cubic centimeter available in a lander bay. It would take two more shuttle trips to bring down the food supplies and other things we had brought for the center.

"Dinner will be in just a few minutes," Jenny said. From the way she looked at me, I could tell that she was worrying about my health and well-being again. Jenny had clucked over me like a mother hen since she joined the project twenty-one months before—despite the ribbing she took about being so old-fashioned. Sometimes I think Jenny figures that I'm as old as Methuselah and incapable of taking care of myself. Well, since we had started preparing for this trip, I had occasionally felt that old, so maybe she had just cause.

"I think I can hobble as far as the dining room," I said, getting up while Jenny had the grace to blush. "Remember, it's going to be a long haul here." I looked from Jenny to Ike. I had lucked out in my choice of assistants. They were both conscientious and highly qualified. The data we collected on Trident would provide the final elements for both of their dissertations.

"Just how do you plan to kill a hurricane?" Doctor Elkins asked when I went to her office the next morning. The obvious anger was gone—suppressed at least—but I could still see the tension in her face.

I leaned back in the chair across from her. None of the furniture at the center seemed to be designed with any thought for human comfort.

"I'm not going to jump right in with anything," I said, postponing the moment. "I want to take a few days to familiarize myself with both current and historical storm tracks, take a couple of survey flights over the Angry Sea, run some additional measurements."

"No runarounds, please? You have your killer experiments ready. You know what you're going to do."

I nodded. "There aren't that many possibilities. We're going to try atmospheric compression—finger-in-the-eye stuff. We're here to run a series of experiments to see if it can be done and what the minimal force levels might be."

"Atmospheric compression?" The disbelief was clear in her voice and on her face. I might as well have told her that we were counting on Santa Claus to do the job.

"Disrupt the tight pressure gradients around the eye," I explained. "We've worked up computer simulations that show that it may be possible to destroy the hurricane by disrupting the eyewall. Compression and rebound."

"You can't be serious. You know as well as I do how much energy a major hurricane carries. There's

no possible way to counteract that."

"We don't have to equal the total energy of the storm," I said. "That *would* be impossible. Our approach is a little different. Our simulations show that it might be possible to cause sufficient disruption by the precise application of considerably less than one percent of the energy carried by the storm. In fact, the stronger the storm is, and the more strongly defined the eye is, the easier it should be to tip it into chaos, causing the storm to self-destruct. The idea is to use the storm's own strengths against it, make it work against itself." I shrugged. "There's always some uncertainty about deterministic chaos," I conceded. "If we were absolutely certain that it would work, we wouldn't have come all the way to do the field tests."

She didn't respond to that immediately. Concentration pushed aside the anger on her face as she tried to imagine what I might have in mind. The basic idea wasn't new. It had come and gone as a topic of discussion for ages. Until Hurricane Lisa wrecked the Atlantic coast of Florida from Biscayne Bay to Fort Pierce, then regrouped to come back ashore in North Carolina, the idea had never gone beyond idle chatter and the roughest of preliminary work-ups.

Finally, she put the look of concentration aside.

"I hope you're not going to disrupt our routines too much as well," she said. "Particularly if we may be running out of time. We *do* have our own ongoing projects, research that may do more long-term good than this politi-cal knee-jerk show you've got."

"At least until we run our active experiments, any disruption should be minimal," I assured her. And, no, I wasn't offended by her characterization of our experiments. They *were* a "political knee-jerk show." But I did think we had a real chance of success. "We'll be spending a lot of time at computer terminals, of course, and I'll need some air time in one of your aircraft. And we'll need a survey plane for the actual experiments, when the time comes. Oh, in case you haven't noticed yet, we've strung a few extra satellites to increase the coverage of the ocean. That data will all be available to your people as well. Jenny has all the access codes and orbital data. And after we finish, the satellites will still be there to increase the amount of data your people have to work with."

"I want plenty of notice before you go messing with any storms," Elkins said. "At least forty-eight hours. I want to make sure that my people are well out of the way."

"We'll work something out," I said. "But if you insist on forty-eight hours, you might have to pull people on a few scrubs. We have tight test conditions to meet, and a storm might stray beyond our limits in forty-eight hours."

She started to say something to that, but stopped by biting at her lip.

"We'll work something out," I repeated.

In the eight years of the Trident HSC, there had never been a single minute without at least one hurricane on the Angry Sea—and the times when there were only one were rare enough to count on the fingers of one hand. The average number of hurricanes and tropical storms on any given day was slightly over three. Five at a time wasn't rare, and the record was eight. I had studied all but the last seventeen months' activity before we left Earth—all that had been received up to that time. When I got back to my room after that session with the director, I sat at the computer terminal and called up the storm track program.

The holotank built its model layer by layer, up from the sea floor, through the surface, to the lower levels of the stratosphere. I could watch a horizontal view or toggle over to the overhead view, cut a cross-section to throw on one of the flat data screens that flanked the tank, get any data I needed on the other screens. The scales were adjustable as well—physical dimensions and time. The first time through, I ran the seventeen months in seventeen minutes, sitting on the overhead view, watching the hurricanes form and plow their courses across the Angry Sea. Most ran into the bulge of the coast. Some turned north, missing land, finally dying out in the empty northern reaches of the Angry Sea.

Generally speaking, the tropical cyclones rose in one of two large, regularly defined areas, one south-southeast of the IWS station, the other east-south-east, and 3,000 miles away. The largest and more durable storms generally came from the eastern crêche.

Trident offered what seemed to be an infinite variety of patterns with its hurricanes. The fact that there were almost always several tropical cyclones moving across the Angry Sea provided opportunities that meteorologists could scarcely dream of on Earth. Occasionally, a series of hurricanes would follow each other west and north in a conga line, spaced between eighteen and thirty-six hours apart. At other times, two storms would merge. I found those episodes the most heartening. Eighty percent of the time, merger spelled the end of both hurricanes. They disrupted each other chaotically and spiraled back down through tropical storm and tropical depression within a matter of hours. Of course, the remaining one time in five, the storms *did* merge into a storm more powerful than either of the antecedents.

I ticked off bookmarks for each of the merger events in the past seventeen months and keyed them to the attention of Jenny and Ike. They would make the precise measurements we were interested in. Jenny came to my room just as I was loading up the storm track sequence for a second play. I was going for a scale of ten seconds per day this time.

"How soon do we get to look at some of these super hurricanes?" Jenny asked.

"Any in particular you'd like to look at?"

"There's a category seven about nine hundred miles out that looks interest-interesting." *Category seven*. On Earth, the Saffir/Simpson Damage-Potential Scale only goes as far as category five—winds over 156 miles per hour, storm surge over 18 feet—but that catch-all top end was ridiculously insufficient for Trident. The Elkins team had added three extra categories at the top.

"We're not here as tourists, Jenny."

"Come on, Roy." I had insisted on the first-name basis almost from the start. I hated being called "Doctor Jepp" or "Professor" all the time. "You want to see the big ones as badly as Ike and I do."

I grinned. "I confess. But does this category seven give us a chance to look at a four or five en route?"

She grinned back at me. "There's a category five about to hit the coast 250 miles northeast of here tomorrow afternoon."

"OK, I'll try to book us a flight."

Back home, I teach a graduate seminar at American Regional University in Washington and I give eighty or ninety talks and lectures to various outside groups each year. Public relations is a large part of any researcher's job, particularly in a government-sponsored agency. People always want to know why weather forecasts aren't more precise than they are and why—with all the time, money and effort that

have gone into studying weather and climate-mate—the forecasts are sometimes dramatically wrong, even for the next twenty-four hours. And people have a fascination with the most dramatic expressions of weather, the killer storms, tornadoes and tropical cyclones—hurricanes and typhoons.

Even after nearly a quarter century with the International Weather Service, I still find myself constantly amazed that most people, even highly educated people, think of a hurricane as nothing more than a big rain storm. Five or six years ago, I gave a talk in Indianapolis. During the question and answer session afterward, one chemistry graduate student tried to get at the nature of hurricanes with a sports analogy. "I mean," he started, "so an afternoon thunderstorm is sort of like Saturday club soccer, right? And a big hurricane is like the World Cup final?" I hid my instinctive grimace and tried another explanation of the driving mechanism of hurricanes. I had already gone through it once, but I drew my analogies down a notch and started over.

Basically, a hurricane is an immense furnace, a heat-driven engine. It requires hot, moist air, low barometric pressure and rotational momentum. Winds spiral inward—from high pressure to low pressure—pulling moisture and warmth from the ocean's surface. These are concentrated in the eye, with the energy being pulled up along the eyewall in a chimney effect and redistributed at the top. Rob a hurricane of its heat or its influx of moisture, and it dies. Tropical cyclones weaken and die when they hit cold water or move over land. The longer they stay over warm tropical water, the longer they last, and the stronger they can get. And Trident had more room for them to grow than Earth.

Donna Elkins didn't make even a ritual protest at my request for a plane for the next morning, but she did insist that one of her people go along to check me out on the craft. That was fine with me. I've never been a full-time pilot, and obviously I had never flown around a category seven hurricane.

The pilot's name was Kasigi Jo, but he insisted on being called Casey. He sat at the right-hand controls of the six-seat Imre survey plane and watched me and the instruments.

"This flight's yours unless you screw up or ask me to take over," he said before we took off. "Your log shows you have more than 2,000 hours of instrument time. That's more than I had when I came here." Casey took his job seriously. He had examined my log chip before we went out to the plane.

"Maybe, but it appears that your reflexes have about ten years on me. And you've had flight time here. Don't be bashful about suggestions."

"I won't. My favorite neck is aboard this plane."

The ink had still been wet on Casey's Ph. D. when he left Earth for Trident eight years back. And unlike Elkins and a few of the others, he didn't plan to make Trident his entire career. He was already scheduled to return to Earth on the next regular ship. "I promised them eight years when I signed on," he said while we flew toward the coast. "They're getting a few extra months as it is."

"You staying with IWS?" I asked as we leveled off at 35,000 feet. We were crossing the coast, south and a little east of the center, banking through a gentle turn to eventually bring us up on the category seven from behind.

"Nah. I'm going into broadcasting. I've already got three offers, two in Tokyo and one in Jacksonville. They came in with the mail you guys brought. First nibbles."

I made a slight change to our flight plan. There was a new storm just starting to develop a distinctive eye in the western crêche. The side trip would only add twenty minutes to the flight, so I took it. And even though I hadn't done any flying in a year, the feel came back quickly. The Imre 370 virtually flies itself.

"Not bad," Ike said as we crossed the boundary of the eye of the new storm. "It tripped across the scale from tropical storm to hurricane just as we entered."

"I didn't do it," I said with a soft laugh.

As we left the new hurricane behind, I took the plane up to 45,000 feet, mostly to pick up a little speed, partly to get a broader look at the ocean. We had a little over an hour and a half of flying left to reach the eye of the category seven.

"So tell me, Casey," I said as I let the autopilot take over, "what's Trident like?"

"Where do you live?" he asked. The return question surprised me.

"Southeast Georgia. Halfway between Savannah and Jacksonville, and about twenty-five miles inland."

"Oh. You ever live in one of the megalopolises?"

"I spend a lot of time in Washington," I said. "At least one day a week, one semester a year. I commute to the old capital to conduct my seminar."

Casey shook his head. "That's just at the edge."

"I get to most of them, now and again," I said. "What are you getting at?"

"I grew up in Tokyo. Choose any ten-meter square in the entire city and it has more people than the entire planet of Trident. This is heaven."

"But you're thinking of going back there?" Jenny asked.

Casey shrugged, then laughed. "They don't have much use for typhoon experts in the Gobi." He had a point. Tropical cyclones are only a problem for specific areas of Earth—the east coast of North America, the Caribbean, the western Pacific, and the Indian Ocean.

"You'll have a hard time finding low population densities anywhere they need your expertise," I said.

"Ain't it the truth."

Even with an airspeed of 570 miles per hour, it took us more than 30 minutes to cross the trailing radius of the category seven hurricane and reach the eye. At 45,000 feet, we were skimming the cloud cap and fighting the outward spiral of air from the top of the chimney. Conversation dampened down to the essentials. Casey paid closer attention to the flight instruments and read off anything he thought I needed to know. I focused on the basics of keeping the wings level and our altitude steady. There was enough turbulence to ensure concentration. Jenny and Ike were busy studying the storm. The survey planes were equipped with storm-monitoring equipment, and they were trying to keep tabs on everything at once.

"Hey, kids, forget the instruments for a while," I said as we neared the eye. "You can stare at those later. Look at the real thing while you can." Neither of them had ever flown in or over a hurricane before—or been in one on the ground for that matter.

Far from looking sinister and threatening, the cloud cap was a thing of awesome beauty from above. As close as we were, the stratification wasn't quite as noticeable. Except for the extent of the clouds below us, we might almost be skipping across the top of fair weather cumulus. The plane's windows had polarized enough to offset the glare of the sun off the top of the cloud deck, but not enough to mar the

scene.

"You'll have a strong updraft when we cross the eyewall," Casey reminded me. "I mean *strong*."

I nodded. "We'll go through that and circle down inside." Once we got past the strong updraft right along the eyewall we would find gender down-drafts through most of the clear space at the center of the storm. "Any thoughts on a safe minimum altitude inside?"

"Depends how good your nerves are." Casey met my gaze when I turned to him. "Generally speaking, an eye this well-formed will be fairly calm, but there's always a chance for serious shear."

"How about you? How low would *you* feel safe?"

"Since I want to go home, I probably wouldn't go below five thousand."

I nodded slowly. "Five thou it is."

If you could harness all of the energy wrapped up in one storm that size and put it into a spaceship, you'd have the most powerful rocket ever. This storm had *sustained* winds of 219 miles per hour. If it hit land without weakening, the storm surge would top 30 feet.

It was magnificent.

The updraft at the eyewall carried us up a thousand feet like an express elevator before I compensated. Then I kicked the plane into a slow clockwise spiral down into the eye—clockwise, against the rotation of the storm. The eye was thirty miles in diameter, not quite a perfect circle. The sun brightened a considerable portion of the ocean surface below. The eyewall was regular and well established, tiers of clouds extending all of the way down to the sea, the slight hourglass curve hardly noticeable.

We had scarcely started our descent when I heard a soft, "Oh, my God," from Jenny. I glanced back just long enough to see that she had her face plastered against the window to her side. Ike was staring out past her, just as intently.

"A little different than seeing it on a screen or in a tank, isn't it?" I asked. If I hadn't been so intent on the plane, I would have stared that way myself.

"It's so ... so *immense*," Ike managed after a moment.

I chuckled. Ike and Jenny were both graduate students in meteorology, specializing in tropical cyclones, and they could still get that excited. So can I. It helps to get that involved in your work. It keeps it from being nothing more than a job.

We spent nearly ten minutes at our slow descent, circling around the clear eye, staring out at the almost eerily regular tiers of clouds that marked the eyewall. It wasn't *just* wasteful sightseeing. The survey plane carried a lot of weather instrumentation, and it was all running. Trident had too many hurricanes and too few researchers to get thorough data on every tropical cyclone that made its way across the Angry Sea.

"Getting close to five thousand," Casey informed me casually—with five hundred feet to spare.

"OK. Going up." I banked us around into the updraft closer to the eyewall and we took a real elevator ride to the top. Five thousand feet above the cloud cap, I asked Casey for a course to the category five and locked onto it. Then, as soon as we were away from the eye, there was time to relax a little and get

back to normal breathing.

"Wow!" Jenny said—some ten minutes later. It was her first word since early into our descent.

The category five storm wasn't quite as broad as the category seven. The eye was also narrower, though just as sharply defined. I didn't bother to take us nearly as deep into that one. We went down to 20,000 feet and took a couple of laps while the instruments recorded what they could. Then we climbed out and headed back for the center.

"It's pretty close to the stats on Hurricane Lisa," Ike said as we crossed the cloud cap of the category five. "Size, sustained winds, pressure gradients— all within a couple of percentage points."

"They come in six packs here," Casey said. "At the moment, it's only the third largest active hurricane we're tracking."

"And Lisa was the most powerful ever recorded in the Atlantic," Jenny said.

"We've gone to the top of category eight on the modified Saffir/Simpson and we think that category nines must occur occasionally," Casey said.

I wrote that first full day on Trident off as acclimatization and told Jenny and Ike to take the rest of the afternoon to themselves after we landed. The weather had taken a turn for the worse at the center. A line of squalls was moving in. It had already started sprinkling and heavy rain was only minutes away.

Ike and Jenny went on toward the living quarters as soon as we landed. I stayed out with Casey to go through the post-flight checklist on the plane. As we finally started for cover ourselves, I spotted several of the local chimps capering about—running along the roofs of the center's buildings, jumping to the ground, then scampering back up.

"They always carry on like that?" I asked.

Casey laughed. "They get a little crazy when the barometer dips. The lower it goes, the wilder the chimps are. They're sensitive to weather. A lot of the wildlife is, even this far from the coast."

"Makes sense," I said. "As extreme as the weather gets, knowing when heavy rain and storm winds are coming would be a definite survival advantage."

"No scoffing at all?" Casey asked. He looked as if he were genuinely surprised.

"None at all. Just don't tell me that your corns hurt when a big blow's coming." We both laughed. Casey didn't seem the least bit put out by the arrival of "big guns" from Earth.

Unfortunately, he was in a minority in that regard. Most of the members of the permanent staff seemed to share Donna Elkins's resentment of me, my assistants, and our overriding authority from IWS headquarters. Our reception was generally very cool. I didn't expect it to get any more cordial once the exact nature of the work we were on Trident to do became known.

Halfway through my second morning on Trident, Doctor Elkins knocked on my door and came into the room after barely waiting for any reply.

"I've been running some simulations," she said without any preliminaries. I nodded. I had assumed that she would. "What kind of explosives are you planning to use?"

"Tri-thermolite-four initially," I said. I turned my chair away from the computer terminal and leaned back. TT4 is the hottest, most powerful chemical explosive known, and we had forty tons of it.

"Initially. And when that doesn't work?" She didn't say "if," but "when."

"If that doesn't work, we'll go to hydrogen fusion devices," I said, still calmly.

There was no sudden, emotional outburst from the director. She had run her simulations. The answer was too obvious for there to be any surprise. She stared at me for a moment, then took a deep breath.

"I thought that must be the answer," she said. The tension was back in her voice, more obvious than before. "It had to be, even if it still doesn't make sense." She shook her head. "My first thought was that you can't be serious ... but you wouldn't have come out here if you weren't."

"That's right," I agreed when she paused.

"But still, I can hardly believe it. No one has exploded a nuclear weapon in more than a century. It was against the law the last I remember. And what I really can't—don't—believe is that anyone would permit it back on Earth, even in the unlikely event that it would kill a hurricane."

"A few years ago, you would have been right," I told her. "But you've been out of touch. After Hurricane Lisa, people would accept anything that could prevent a repeat."

"And you're going to contaminate an untouched world just to try out this crazy theory of yours." Statement, not question.

"It's not crazy," I said. "And contamination will be minimal. The devices we have are nanofactured, as clean as possible. There will be some immediate radiation, of course, but little long-term contamination."

"Not to mention killing a lot of aquatic life," Elkins said, as if she hadn't even heard what I said.

"It's not as if Trident had any sentient life forms." Yes, I *know* how callous and cavalier that sounds. But there are always trade-offs. And most humans still rank their welfare above that of inedible wildlife on a distant planet that is too wild for colonization to be an immediate prospect.

"We haven't been here long enough to rule out the presence of native sentients. Eight years! And that hasn't been our primary purpose even. At that, those chimps might come close to some definitions of sentience."

"I know all the arguments," I said. "All the 'ifs, ands, and buts,' and it still doesn't alter a damn thing. Stacked up against the deaths, injuries, and property damage of Hurricane Lisa, it doesn't mean a damn thing. As soon as we're ready, we start the TT4 experiments. And if those don't work, we go on to the fusion devices."

Doctor Elkins bit her lip so hard that I saw blood, but she didn't say anything else. After a moment, she turned and left. I punched up the intercom channel on my terminal and called Jenny.

"I want you and Ike in here, right now," I said. It was time to talk about security measures.

Even though you can't control experimental conditions as completely in the field as you can in a

laboratory, you have to set tight standards. *This is acceptable. That isn't.* The narrower your parameters, the more reliable your test data will be. And even then nature can come up with a surprise that might destroy the validity of your experiment.

We needed data that would be applicable to conditions on Earth. We needed storms that were category five and threatened land, but right off the bat I ruled out using any tropical cyclone that reached category six or higher at any point in its career. I also ruled out daisy-chained storms—and *that* cut seriously into the available test population. There was a chain of three hurricanes dancing across the Angry Sea when we arrived on Trident. Our experiments also demanded storms that had strong and clearly defined eyes. And, to protect the integrity of our test data, we ruled out any storm that showed any sort of maverick activity, any anomalies that weren't routinely observed in hurricanes and typhoons on Earth. Other than that, any storms would do.

Ike and Jenny did the first tag on storms, tracing them back to their formation and logging all the available data—data that became better for storms that brewed after our new satellites were operating. I reviewed the storms that my assistants logged, ruled out about half right away, and followed the rest.

We had been on Trident eleven days before I finally picked a storm for our first test.

"Isolate the trace and double up the satellite coverage," I told Jenny. From that moment on, Trident tropical cyclone SSE-14-42 would be under the microscope. Until the storm died, whether as a result of our interference or on its own, we would draw every possible bit of data from it. I had already called Donna Elkins to tell her that we had our first candidate.

"If it stays good, we'll take off at dawn, day after tomorrow, deploy and push the button as soon as we can." That was what I had told Elkins, and that was what I told my assistants. "Ike, let's take a look at our birds."

We walked. That was as close as we could come to being sure that we wouldn't be overheard. The center didn't have a lot of equipment for eavesdropping, but wherever you have radios and computers, you have the potential.

"Have you picked up even the slightest hint that anyone might try to stop our experiments?" I asked softly, once we were well away from the main complex of interconnected buildings.

"Nothing," Ike said. "I guess everyone knows what we're here for by now. It's no secret. I hear a little now and then. Mostly nobody thinks that our experiments can possibly work. Some resent us. More, they resent the threat that our failure means that the center will be closed down. They don't like what we're going to do, but they like what will happen if we fail even less." After a long pause, he added, "Casey stopped talking to us when he found out about the fusion devices. He won't even answer if Jenny or I say something."

The sky over the center was brilliantly clear. The temperature was 85 but there was a delightful breeze from the northeast. Despite the frequency of tropical storms, Trident isn't *always* a wet and gloomy place, not even the stretch of it that sits in the path of most of the hurricanes.

"I almost wish there had been some way to hide the fact that we're going to use fusion devices, if need be, until the last minute," I said. Casey had walked out of a room just because I entered—a couple of times. I felt bad about that. I had liked Casey when we met. "But anyone who spent a few minutes running the calculations could guess it." Anyone likely to be working at the Trident Hurricane Study Center, at least.

There was one other possibility, but it was even more exotic—and there-fore less likely. One of the

proposals we had investigated had called for deploying a series of large mirrors in orbit to concentrate sunlight on the center of a hurricane. In theory, it would be possible to concentrate more energy that way, but the process would be slower than explosive compression (if *that* worked), and it would be much more expensive and complicated. And, in the case of Earth, it probably wasn't feasible. There's simply too much garbage orbiting Earth after two centuries of space exploration and travel—all the way out to geo-stationary. Mirrors large enough to do the job would be ripped apart by the flotsam and jetsam long before they could manage the task.

"Well, they can't get into the module," Ike said. "And I can't see them doing anything melodramatic like sabotaging a plane to keep us from finishing."

"It's possible that they would simply cut off our access to the planes and computers," I said. "Maybe even confine us to our rooms."

"They couldn't get away with that!" Ike protested.

"No, but they could stop our experiments. Elkins and enough of the others might be willing to take that chance."

"I don't get it."

"History," I said.

For the moment, that was where the discussion ended. A troop of the local chimps spotted us and came charging across the clearing. With them chattering and bouncing around, there wasn't much chance for Ike and me to continue our talk. But they were a welcome distraction. I couldn't distinguish among the T-chimps, so I didn't know if Mona was with this group. I *could* see differences in the color patterns between different chimps, but I didn't know them well enough to identify individuals the way Elkins and most of the permanent staff could.

When Ike and I reached the supply bunker that held the shuttle payload module with our equipment, the chimps broke off their play and ran back toward the center. Evidently, they knew they weren't permitted in the bun-bunkers.

I keyed in my password to the main door. Then Ike keyed in his. I had used my authority to commandeer an entire bunker. The door needed any two of three passwords. Jenny had the third. The module we had brought along was protected by a similar two-of-the-three password arrangement, but in that case, one of the two had to be mine. Security.

Once we got the bunker open, I dug out the electronic log I had put into the lock mechanism to make sure that there had been no attempts to enter. The log was clean. I reset and replaced it.

"We might as well haul out the first set of sleds," I told Ike while we were unlocking the payload module. It had been taken out of the shuttle and stored the afternoon before. Ike nodded as he finished keying in his password.

"I'll get on the manipulator," he said.

Our Manta air sleds had been considerably modified for our experiments. To give them enough payload capacity for our largest explosive loads, we had to strip off a lot of their standard maneuvering and navigating equipment. They were set to maneuver expressly within hurricane eyes, looping clockwise along the eyewall. We could adjust the diameter of the loops within limits, but that constant right bank and sufficient leeway in climbing and descending were the only maneuvers those sleds were capable of.

They had to be dropped into the eye from directly overhead. There was no chance of sending them off to find their places from a distance. They no longer carried enough fuel for that, even if we hadn't limited their maneuverability.

Ike got the top of the module opened with the bunker's manipulator— something more than a simple crane, much more flexible—and lifted the first four air sleds out one at a time. Very carefully. Each of these sleds held a ton of TT4. The next four held two tons, the next group three, and then four tons. If four sleds, each carrying four tons of TT4, didn't provide enough force to disrupt a category five hurricane, we would go to the last set of sleds. Each of those carried a seventeen megaton fusion device—the largest we could squeeze into an air sled. While it might have been more logical to cut down on the number of TT4 trials and include a second set of fusion devices in the moderate kiloton range, logic isn't always the dominant force when science and politics meet.

Ike set the first four sleds in a row down the center of the bunker. Then he came back from the manipulator and we locked the wings down on each of the Mantas, and ran the full list of pre-flight checks on each of them. Next Ike ran a hands-and-eyes check on each sled to make sure that there was nothing wrong that wouldn't show up electronically.

"Ready to go," he said when he finished with the last one.

I nodded. "Let's put new seals on them and then run the electronic tests on the rest of the sleds while we're here." That took us another ninety minutes. We didn't find anything out of order. I hadn't expected to. No one else had had access to the sleds since they were packed on Earth, and I had run a check on them before locking the module.

"We'll put the first four aboard the plane tomorrow afternoon. I'll tell Doctor Elkins that we have to have it then."

* * *

I had managed a couple of short flights in Imres during the days of waiting for a suitable storm to appear, so I wasn't nervous about handling a survey plane. At the altitudes we would be at, there was really little to worry about, even flying into the center of a category five hurricane. We wouldn't go down into the eye this time. Ike and I would drop the air sleds from above, guide them into position, and head back toward the research center. Jenny would monitor the results from there.

After we loaded the sleds in the drop hold, Ike spent the night in the plane—his idea, not mine. At that, he may have spent a better night than I did. I didn't sleep well at all. I shared many of Doctor Elkins's reservations about the possible success of our experiments, at least the TT4 runs. If we killed a hurricane with chemical explosives, it would be a fluke. But we had to start with those tests.

It was raining over the center when I got up in the morning and drove over to the landing strip. A category three had come ashore to the south during the night and it was quickly losing strength, fizzling away in scattered showers. Ike was already up and running another equipment check on the sleds when I climbed into the plane.

"I wondered when you were going to get here," Ike said, grinning. I just shook my head. The computer terminals showed the portions of the Angry Sea we had to worry about. "Our" hurricane was marked in contrasting colors to make it easier to watch. A quick glance at the data screen showed me that it hadn't changed character in the twenty minutes since I had left the terminal in my room.

"We're set to go," Ike said, brushing his hands off on his coveralls. I nodded and moved up to the pilot's seat.

We worked our way down the preflight checklist. I was very careful about that, going down the list item by item. That was one thing about a long lay-off from flying. It made me more cautious than I might have been if I flew regularly. But the list of manual steps was fairly short, mostly a series of checks of the plane's electronics and mechanical connections. The Imre's own diagnostic programs handled most of the work.

The two jets fired up quickly and checked out perfectly. We had a full load of fuel. Hydraulics were in top condition. So was everything else. There wasn't anything even close to yellow on the readiness scale.

"Let's go," I said when we finished the list. I taxied the Imre away from the bunkers and turned into the wind before I cranked the jets around for a 45-degree take-off. There was no real need for the STOL start. I'm just more comfortable with that on grass.

The flight was uneventful. That's how I like all of my flights. Jenny was on the radio with us almost continuously. Twice, Donna Elkins broke in to ask nonessential questions—mostly to let us know that she was keeping tabs on the operation. I didn't ask, but I figured that there was a good chance that most of the permanent staff were where they could keep track of what we were doing. It didn't matter how they felt about our experiments. They knew that their future on Trident rode with them.

I let Ike spell me at the controls for part of the flight. He had his pilot's license, but not a lot of hours. Giving him a shot at the controls let me stretch my legs a little . . . and run a last check on the air sleds before we deployed them. That was just nervousness. We had no margin for botched runs.

"Ten minutes," Ike reported as I strapped myself back in the pilot's seat.

"We're ready." I looked to make sure that Ike was strapped in. While the hold doors were open, we would be slightly more vulnerable than at other times. "Oxygen masks," I said. The cockpit was pressurized separately from the hold, and I had sealed the hatch between them when I came back, but it was a matter of not taking any unnecessary chances.

We dropped to 40,000 feet, just above the top of the cloud cap, to release the air sleds. The center's Imres were all equipped to launch the Mantas—the basic design was used as a standard weather service probe. The sleds slid out smoothly, one at a time. Each sled's jet fired up when Ike hit the hot buttons. While I closed the hold door and turned us to our return course, Ike was busy juggling the four sleds, guiding them into position. We wanted the sleds spaced at 90-degree intervals, just over the slight inner bulge of the eyewall. For this storm, that meant at 18,000 feet. It took fifteen minutes to get all four sleds positioned properly with their jets keeping them on station.

"Jenny, give us five minutes from now, then fire them," I said as soon as Ike confirmed that everything was set.

"Counting down," Jenny replied. A repeater on the data screens in the cockpit flipped over to show the time remaining.

I cut the microphone before I told Ike, "We'll need more time than that before we do the fusion run." I didn't want all of the eavesdroppers to hear that. If Elkins and the rest knew that I was so certain of going on to the fusion devices, it might add to the hassles.

We were 160 miles in front of the eye and 5 miles above the sleds when Jenny touched off the TT4. We lost telemetry from the sleds at once but picked up the reports from the lowest of the tracking satellites. All four packages exploded precisely on schedule. The satellite picked up the flashes, and the pressure wave around the disintegrating Mantas.

And that was all. Any effect on the hurricane was minimal and transitory. Within seconds, there was no trace of any change.

"Well, we didn't expect anything from the first run," Ike said softly, his hand over his microphone, but I could hear disappointment in his voice.

"Not even a *hint* of any effect, not the slightest encouragement of eventual success," Donna Elkins said. At least she hadn't been waiting for us at the landing strip. It wasn't until after supper that evening that she asked me to step into her office.

"It's too soon to say that," I replied, probably just because I was feeling too stubborn to concede anything to her yet. Supper in the communal dining hall had been trying. The staff still did its best to ignore us, but they didn't try to hide their various reactions to the day's run. A few showed what may have been genuine regret, but I saw too many gloating smirks to feel very agreeable.

"We're still examining the transients we got immediately after detonation," I continued. "In any case, today's run was just the first—minimal load, minimal expectations. We couldn't afford to do a dry run without explosives. And today's results, minimal though they were, will give us a starting point when we start calibrating results for the series."

"You intend to continue?" Donna asked. There was no surprise in her voice. She just wanted confirmation.

"Of course. As a matter of fact, we've already isolated a likely candidate for our next run. Unless it turns out to be unsuitable, we'll hit it about noon, local time, three days from now. I'll key the data to you as soon as I get back to my room. More than forty-eight hour notice."

"In case you're interested, nobody on staff thinks you have much chance of succeeding. Only two of our younger people are willing to concede that you have any chance at all."

"Some people are born optimists," I said. I immediately regretted the flippancy. There was no point in aggravating the situation. A little more softly, I added, "I would be a lot happier myself if we had the means to make the test series a lot more comprehensive."

"Normally, I would agree with a statement like that," Donna said. "But I think that you're building on a fallacious theory to start with. I only wish that the fate of the center wasn't tied to your work. It's bad for morale."

A continuing lack of success was bad for my morale. It didn't do Ike and Jenny much good either, even though we had only minimal expectations for the chemical explosives. Our second run was with two tons of Tri-thermolite-four in each of four sleds. That went off on schedule and produced little more in the way of measurable data than the first test. The third was scheduled to use three tons of TT4 per sled. But before we got a chance to run that set, we ran into a period where none of the hurricanes were suitable. They were either too intense or they were daisy-chained. We spent our time going back over the scant

data that our first two runs had given us. But no matter how often we sifted through the data, there wasn't enough information to give us any clues about refining our procedure, or even to suggest whether or not there was any hope of eventual success.

"Is there any way we could use all of our remaining TT4 on one test?" Jenny asked, about ten days into our "dry spell." "Maybe that would give us enough of a bang."

"We're pushing the limits squeezing four tons into a sled for the last TT4 trial," Ike told her—as if she didn't know that already.

"And it might corrupt our data if we tried to juggle eight sleds around an eyewall at one time," I added. "If we could even manage it."

Ike's eyes narrowed, then he shook his head. "We don't have enough control circuits. And I'm not sure I could handle eight sleds at once if we did. Not with the kind of precision we need."

"In any case, it would take two planes to deploy eight sleds, which would mean using center personnel. I'm not sure that would be wise," I said, damping the idea a little further.

"It was an idea," Jenny said with a sigh. "Anything to speed things up."

"I know," I told her. "Look, kids, we both know where the holes are in our experiments. No matter what happens, our work is going to be flawed. If we fail, we might not be able to tell if it's just a matter of insufficient explosive power, or if better positioning of the charges would help. Even if the final run works, our work will still be incomplete. The big questions will be, 'How much overkill is there?' and 'How much less force would have worked?'"

"That's the same question, just worded differently," Ike said. "I know. That's the point."

By the time we had a suitable target for our third run, we had been on Trident six weeks. The storm was a minimal category five—barely within our test parameters. But the storm showed no sign of weakening. Jenny made this flight with me, leaving Ike on the controls back at the center. Deployment went without a hitch. I started us back toward the center while Jenny maneuvered the Mantas into position along the eyewall.

I held my breath from the time I gave the signal for detonation until my monitor confirmed that all four sleds had exploded. A minute later, Ike was on the radio.

"At least I could tell something happened," he reported. Jenny and I exchanged glances that acknowledged another failure before Ike continued. "We're still not showing anything significant though, and the effects are already damped out by the system."

The fourth run, eight days later, didn't produce much in the way of positive results either. Four tons of TT4 in each of the sleds set off minimal ripples, and they lasted for less than a minute before they were lost in the general energy dynamo around the eye of the hurricane.

Doctor Elkins gave me a full day before she asked me to her office for another "conference."

"You're not getting anywhere," she said as soon as I sat down across the desk from her.

"We have one test left to run," I reminded her.

"Give it up, Roy," she said softly. "You're not showing any encouraging results at all. Since it appears that the center here is doomed to close its doors anyway, let's at least not contaminate Trident with nuclear explosions."

"I thought that you were so dedicated to this place that you would do anything to keep it open," I said.

"This place is my life," Donna said. She spoke softly, sorrow more than anger in her voice. "And I *would* do anything to keep it open—anything that offered any hope of success. And your experiments don't."

"I wouldn't be so quick to say that, Donna. It's true that none of our experiments so far have produced any lasting effect, but the last two have produced measurable results. The problem is that we have too few data points to make adequate extrapolations and the interactions are too complex to model with enough precision to make up for it." Even calm weather is difficult to model in detail, and we were dealing with hurricanes and large explosive countercharges.

Donna Elkins didn't show any reaction at all to what I said. She was looking at me, but I'm not even certain that she was actually seeing me.

"In a lot of ways, this project is a monumental cock-up," I conceded. "It was designed to meet political requirements more than scientific. It would help if we could do ten times as many experiments, keep working upward on the energy scale in logical steps. Ten times? Even a hundred times might not be too much. But there was only one ship available, and the General Assembly wouldn't have funded more in any case. My instructions are quite clear." And so *are yours*. I didn't have to voice that last part. Donna knew it as well as I did.

"Given enough force, concentrated at the right spots at the right time, we can disrupt a storm, even a category five hurricane," I said. One way or another, I qualified mentally. That wasn't a product of our early experiments, just a theoretical certainty that it could be done—although if it took too much energy, the cure might be worse than the disease. "The only real question is whether the necessary force remains at an acceptable level."

"It's been more than a century since a nuclear bomb was last exploded," Donna said. *Bomb*—I had deliberately avoided the word, and this was the first time she had used it in my presence.

"Bomb," I said. For a moment, I let the word hang between us. "In a way, it may be a good thing to use what once would have been a weapon of war as a tool to save lives."

"That's a terribly transparent attempt at rationalization."

"Maybe," I agreed. "But 27,000 people killed by one storm is a lot harder to accept. Hundreds of thousands of people still living in refugee camps is harder to accept."

"Nothing can bring the dead back. Nothing can erase the damage that Hurricane Lisa did," Donna said. "For more than 200 years we've warned people not to build close to the ocean in hurricane zones. It hasn't done a bit of good."

"And it won't do any good in the *next* 200 years," I added. "Earth can't afford to waste that much land. That's why we have to find another way."

"Even if your fusion bomb does kill a category five here, will they ever let you use it on Earth?"

"After Hurricane Lisa, yes," I said, with more confidence than I really felt.

"So you cure the disease. How many people will the cure kill? We don't have all the literature available here, but I seem to recall some death tolls much higher than 27,000 from nuclear weapons."

"From fission devices used in war, and from accidents in old fission power generating stations nearby," I said. "The only two instances of fusion weapons being used against people were terrorist acts, designed to kill."

"Designed to kill or not. Radioactive fallout keeps killing for decades."

"Not from our devices," I said. "They are as 'clean' as possible, to use the old term for it. They were manufactured to minimize radioactive fallout. There will be blast effects, high concentrations of neutrons, but very little lasting radiation. And the idea is to hit any storm as far from land as possible, so there should be little human exposure—here or on Earth."

She was silent for several minutes. I didn't get up or say anything. I hardly moved. I could see that Donna Elkins was still extremely unhappy with her situation. She had more to say—once she figured out what that might be.

"Have you picked out the storm yet?" she asked finally, lifting her head to look at me again.

"No. There's nothing suitable just now." I shrugged. "A couple of new tropical depressions forming in the eastern basin may turn out to fit our parameters. It's too soon to tell."

"Some of my people want me to force you to stop," she said after another long pause. "They think you are endangering the native animals. A few of my people think that the Trident chimps are nearly sentient. And I have one man who gets almost hysterical at the very thought of nuclear explosions."

"Kasigi?" It was an easy guess.

She nodded. "The Japanese remain extremely sensitive to the issue, even after two centuries. Casey tells me that he had relatives who lived in Nagasaki when it was bombed."

"Do you think he's likely to try anything . . . foolish?" I asked, hesitating before I added the last word. It sounded so banal.

"I don't know," Donna said, meeting my gaze directly. "I don't even know what he might think he could do if he *did* want to do something." A frown passed across her face. "I'm not used to thinking in those terms. Not here. Not with these people."

That's something else she'll blame me for, I thought. "I'll give you as much warning as possible before we use the fusion devices," I said. "But I would appreciate it if you would hold back on that knowledge as long as you can."

She shrugged. "It's difficult to keep secrets here. People will know the minute you start to load your *bombs* anyway. And you've made no secret of your criteria."

* * *

The next morning when I left my room to go to the dining hall for breakfast, I found a petition taped to my door. It was signed by every member of the permanent staff except the director. It was all very decorous—no threats, no polemic.

"We the undersigned members of the permanent staff of the Trident Hurricane-cane Study Center request that you terminate your experiments immediately."

Each signature was followed by the signer's degrees. Every one of them had earned at least one doctorate. They were all highly qualified, responsible professionals.

I found it almost impossible to eat that morning. No one stared. They were quite careful not to stare. And no one said anything about the petition or our experiments. But they didn't have to. The petition said enough.

I wanted a perfect specimen for our last trial.

I also wanted to get the fusion experiment run as soon as possible so that the three of us could gather the last of our data and get back up to the ship waiting to take us home to Earth.

The longer the wait, the greater the chance that Casey—or someone else—would try to stop our final run. That gave me a powerful temptation to grab the first hurricane that even approached our established parameters. I started looking very closely at the separation between storms, and at hurricanes-canes that were *almost* category fives, either a little too weak or a little too strong. Jenny and Ike shared my anxiety. Every day all three of us spent too many hours staring at the storm tracking data, as if we hoped to impose a suitable hurricane by force of will.

And we all got a little paranoid after the petition. We started looking over our shoulders whenever we were out among members of the permanent staff. We took our meals together, usually in my room. We checked the seals on the supply bunker and on our payload module a couple of times a day, tested the electronics on our last four Manta air sleds and their cargoes. Long days. Long nights. And the way we acted made the permanent staff more suspicious of us. They had been growing more distant almost from the beginning. Now, the separation became virtually complete. Except when it was absolutely necessary, we didn't associate with them and they didn't associate with us. Any communications went through Donna Elkins.

The first two prospective storms were wrong. Either might have been suitable, but they moved across the Angry Sea too close together for our purposes. Then the nearer crêche spit out three minor hurricanes—two that never got above category two and one that just barely reached hurricane force.

"I just wish we could get this over with," Ike said, eight days after my last long talk with Doctor Elkins. "I'm ready to climb the walls." The three of us were walking back to the center from the bunker, about an hour before sunset. The sun was out—one more reminder that we hadn't found a suitable storm yet. We had taken to spending as much of each day as possible out in the supply bunker. That kept us away from the staring eyes. It gave us some privacy, some sense of security.

"I can't even sleep any more," Jenny complained. "I keep hearing noises and imagining—well, just about anything."

I knew what she was talking about. Twice I had experienced the same nightmare. In the dream, I woke to find that the local staff had bricked up the doors to our rooms in the night, that we were prisoners doomed to die of suffocation—real "Cask of Amontillado" stuff. I kept that dream to myself.

"Soon," I said—wishful thinking. From my last look at the computer data, it would be at least another three days—and even that would take a few breaks.

Sometimes you get the breaks.

As soon as I was certain that we had the hurricane we needed, I went across the center to Donna Elkins's office. She knew what I had to say as soon as I entered. She had the same view in her holotank that I had in mine.

"This one, right?" she asked, pointing at the storm I had chosen.

"That one," I agreed. I took a deep breath. "Forty-eight hours from right now—if you still insist on that long a delay. We *could* take it on tomorrow though, if you have no one out where there might be a problem. The sooner we get this over with, the better everyone here is going to feel."

She looked at the tank again, then looked down at her desk for a moment before she met my gaze.

"Unfortunately, I agree with you. No one is out at our sub-station." There was a small facility on the coast. "People have been reluctant to wander too far the last several days." There was an accusation behind that, but it was too late to matter.

"Do it tomorrow." She turned away from me. I started to leave, but she said, "Wait."

I waited. After a moment, she got up from her chair and came around the desk.

"You'll be leaving as soon as you gather your data on this?"

"As soon as possible," I said. "We can finish our evaluation process and write our reports on the trip home. I can't see anyone here shedding any tears over our early departure."

"No." She went back to her chair and sat down. "It's better that you leave quickly. Best that you had never come. Give us what time we have left to close out our work before they drag us back to Earth."

"Don't give up yet," I told her—actually feeling a little sympathy for her. "We just might succeed."

She turned away again and I left. I didn't exactly run back toward our quarters, but I wasn't taking a casual stroll either. I was about halfway there when Casey stepped out into the corridor in front of me.

"You found your storm, yes?" he asked—his voice very tight, very tense. Everyone at the center had access to the storm tracking data, and the expertise to interpret it.

"Yes, we found it," I said. "I just left Doctor Elkins's office." "So you set your bombs off in two days." He didn't make it a question, and I didn't think that it was the time to correct his estimate. "We're going to run our final experiment," I told him. "You cannot. You *must* not!"

"We have to, Casey. You know that." I didn't see any hint of a weapon, but I could hardly have been more nervous if he had a gun pointed at my head. The tension that had been building at the center had pushed enough wild fears through my head. Casey was younger than me, probably stronger. I had no idea if he was a student of any of the "martial arts." That had nothing to do with his ancestry. I think half the people on Earth study them for at least a while during their lives. Back in my undergraduate days, I spent some time at it myself. But I hadn't kept up. You don't win bureaucratic fights with judo or karate.

"It is an abomination. You cannot let this horror be reborn." His voice was so tight that it sounded ready to snap. I started looking for a chance to get away from him.

"This time, maybe we can save lives with nuclear power, Casey," I said. "That's what we're trying to

do."

He drew himself up ramrod straight, took a deep breath, and held it for a moment.

"You will not cancel your plans?"

"I can't." I tried to balance my weight a little better, but I was carrying more poundage than I had when I frequented the *dojo*. But Kasigi just gave me a formal Japanese bow and walked off.

It wasn't until he turned a corner that I realized how badly he had fright-frightened me. I gave him a few more seconds and then I *did* run the rest of the way back to my room. I only stayed there a couple of minutes though before I went next door to the room Ike and Jenny were sharing.

"Time to load up," I said very softly. "Take anything you can't do without for the next twenty-four hours."

Neither of them asked questions. They were starting to look a little like zombies from lack of sleep—puffy eyes with dark circles, worry lines across their foreheads, clenched teeth. Maybe it was a good thing I couldn't see my own face. It probably looked just as frightful. Or worse. I hadn't told Ike and Jenny about Casey yet. In any case, they didn't need long to get ready—much less than a minute. We headed for the nearest exit from the building complex even though that meant detouring around a good part of the center before we could aim directly for the supply bunker.

"What's up?" Ike asked once we had put fifty yards of open ground between us and the nearest building.

"We're going out for our last hurricane tomorrow," I said. I slowed down.

I had to if I was going to keep talking. The air only goes so far. Very briefly, I told them about my interview with Doctor Elkins. . . and about my strange confrontation with Kasigi Jo.

"You think he'll try to stop us?" Jenny asked.

"I don't know and I don't want to take chances," I told her. "We'll pull a plane into the bunker, load the sleds, and lock ourselves in until it's time to take off in the morning. Jenny, I want you to stay in the bunker while Ike and I are gone. Locked in. There's at least one computer terminal in there so you'll be able to do your work without any difficulty."

When we reached the bunker, we searched it thoroughly—even though the tracer in the door showed that no one had even attempted to gain entry since the last time Ike and I had opened the door. Ike took a tractor and dragged one of the center's Imre survey planes in for us. And then we locked ourselves in the bunker. As soon as the red light showed over the inside latch, I let out a long breath. We were as secure as we could get on Trident.

"OK, let's take a short break," I said. I plopped myself down on a packing crate and wiped the sweat from my forehead.

"You *are* worried," Jenny observed.

I didn't even try to deny it. "I want a complete check on the plane," I said. "Not just the usual checklist, everything you can think of. I don't think there will be any problems. Except for Doctor Elkins, everyone probably thinks we won't go out until the day after tomorrow. But I don't want to take chances." I was getting a little sick of that phrase. "We'll give the sleds the same kind of check." I waited until Ike and Jenny both nodded.

"Then, if there's anything left to the night, we can try to catch some sleep, but I want one of us awake, on guard, all the time. We'll roll out at first light, take off at sunrise. That should put us in position over the eye with a few minutes to spare before it's time to deploy the sleds." The storm we had pinpointed was more than 800 miles east of the center, a couple of time zones, and I wanted to run the detonation as close to noon—local time in the eye—as possible.

It was a long, miserable night even though no one disturbed us. We didn't even have any calls over the comlink. But that didn't keep us from being jumpy. It didn't keep us from starting at every real or imagined noise. We checked every circuit on the plane, then visually inspected every part of it we could get at, comparing what we saw with the plans that the computer carried. We ran through checks on the four remaining Manta air sleds and their cargoes. Finally, we loaded the sleds aboard the Imre and inspected them again.

"That's about all we can do until morning," I said when we were finished with the sleds. It was well past midnight. In a little more than five hours it would be time to taxi the plane out to the landing strip. "You kids find someplace to get comfortable for a while. I'll take the first watch." I wouldn't be able to sleep anyway. Even when I'm not nervous, sleep takes its own sweet time coming.

Even with the plane sitting in the middle, the bunker was roomy. There was plenty of space for me to pace without bumping into things all the time. We were almost certainly safe in the bunker. The lock would be hard to breach. At the very least, we would have warning. And, as far as I knew, the only explosives on Trident were in that bunker with us. I don't mean just the fusion devices. A few explosive charges were kept around for construction and for seismic probes. It would take a cutting torch and probably more than an hour to get through the door. If a few members of the staff tried to get in, I could call for help and there would be time for help to arrive. Doctor Elkins would have to respond. The ship waiting for us in orbit would monitor any open call I made.

A security camera covered the outside of the bunker door, so no one could hide out there and surprise us when we opened up to run the plane out to the landing strip in the morning.

But I stayed nervous. I could empathize with Casey, and with Donna Elkins and the others. Different cases. Most of the permanent staff of the Trident Hurricane Study Center had put their professional lives fully into the work on Trident. The center literally was Elkin's career, twenty years of dedication and work. And she saw it all going down the drain for reasons that had nothing to do with the quality or utility of her work, because of something she had no control over at all—and over an experiment that she saw as impossible.

Maybe it was impossible. I couldn't guarantee that it wasn't. There's still a lot we don't know about nonlinear dynamics, scientific chaos. That's the nature of the beast. We build up a stock of empirical observation, a complex structure of experimentation to go with theories and equations that often appear maddeningly simple before you put them through their iterations. Then, sometimes in very short order, your model can become too complex for even the largest computers to handle reliably in any reasonable amount of time. We can model the fractal programming that allows genes to hold the complex instructions that will result in a human—or an orchid. But we still can't adequately model the old meteorologists example of a butterfly in China causing a hurricane in the Atlantic. Tomorrow's weather forecast is still wrong occasionally. If our computers could process ten times as much information at ten times the speed our best can now, tomorrow's weather forecast would still be wrong once in a while.

I pulled open a crate of meal packets and fixed something to eat. I couldn't even say what it was now—just a meal, food, fuel. Something to do: it gave me ten minutes of sitting down, enough time to rest

my feet. But when I got back up and started pacing again, my feet hurt worse than before. I'm not used to that much walking.

It was after two o'clock when a series of massive yawns convinced me that it was time to try to get a little sleep. I called Ike, and as soon as he responded coherently, I grabbed a couple of blankets and made myself a bed on top of several packing crates. I used one blanket as a pillow and wrapped myself in the other. Apparently, I fell asleep almost at once.

"Roy." A hand touched my shoulder. "Doctor Jepp."

"I'm awake, Jenny," I said, surprised that I had even been asleep.

"About forty-five minutes to sunrise. We'll have a little light before long."

I sat up, stretched, and yawned. I was a long way from alert, but I was awake.

"Ike's fixing breakfast packs for us," Jenny said. That's one thing about holing up in the warehouse. You can count on food.

"Any sign of activity outside?" I asked, collecting my thoughts. I felt drugged, still stuporous from sleep.

"Not a hint," Jenny said. "It's been quiet all night."

All night? There hadn't been much of a night for us. I stood and did some more stretching. I'm not used to going from sleep to working-alertness right away. Back home, I would have a couple of hours to gear up for the office. The morning routine at home and the commute to the IWS office gave me plenty of time to make the transition.

"You checked on our storm lately?" I asked.

"I've been watching. Steady on all points."

"Just hope it stays that way for a few more hours. I'd hate to get out there and have to scrub the run. I don't want to go through more nights like this."

"The winds didn't even weaken during the night," Jenny said. "They may increase today."

I needed a couple of seconds to dredge the last numbers I had seen during the night from my memory. "It shouldn't strengthen enough to get it out of our range," I said.

"Not by noon anyway," Jenny said.

I started walking around, swinging my arms and stretching, trying to pump myself up for the day's work. My back ached. My feet didn't need long to join the party. *I'm really going to feel like hell by the time this is over*, I thought with something less than joyful anticipation. My lifestyle has always been rather sedentary. It was catching up with me in a hurry. *I should get more exercise*. I make that decision periodically. Unfortunately, that's as far as I usually get.

Hurrying through breakfast was the best way to make it palatable. Then it was time to get ready for the day's work.

"Jenny, as soon as we get the plane moved outside, seal the door again. Stay put until we get back, if

possible, until we set off the devices at least." She nodded. We were going to trigger them from the Imre this time, rather than from the center—another safety precaution. "You'll be able to monitor everything from here." I pointed at the computer terminal that showed the storm track holo. Jenny nodded again.

I got especially jumpy again when we opened the doors, but there was no one out there waiting for us. Ike ran the tractor to pull the plane outside, then uncoupled the tractor and moved it out of the way. Jenny already had the bunker doors shut.

"Let's move!" Ike shouted when he sealed the plane's passenger hatch behind him. I was already in the pilot's seat.

"Well, get up here and let's get through this checklist." I shouted back. I wasn't going to take any stupid chances just to make a fast "getaway," especially without trouble right there on top of us.

We had particularly rough air that morning ... or maybe it just seemed that way because my nerves were so jangled. As soon as we were airborne, I radioed Doctor Elkins—woke her up—to tell her that we were on our way and to make sure that everyone was inside when we set the devices off. The center was too far away from the eye of the hurricane for there to be any real danger, but the gesture had to be made. Then I radioed Captain Linearson to alert her to the timing of the explosions. Four 17-megaton fusion devices exploding fairly low in the atmosphere could hardly pose a radiation problem for the ship in orbit, but again, it was a gesture that had to be made. I also wanted to get all of the data the ship could collect on the explosions.

"I'm aiming directly for the eye," I told Ike when I finished with the "courtesy" calls. "We'll circle overhead if we have to. I want to make sure we're in place on time."

"I'll go back and run another check on the Mantas," he said. I nodded. Keeping busy was better than sitting idle.

Ike was still working in the cargo hold when Donna Elkins called. We were just under an hour into the flight.

"We've had trouble here," she said.

"What kind of trouble?" I asked, my stomach knotting up. I thought about Jenny back in that bunker and glanced over my shoulder at the hatch leading to the plane's cargo hold.

"Casey. He committed suicide during the night, apparently not long before dawn."

I closed my eyes for an instant and took a deep breath. Relief mixed with sorrow. To be honest, relief was the dominant emotion at the moment. Donna Elkins kept talking.

"He left two notes, one in English on the computer net, the other on paper, handwritten in kanji characters. I've seen Kasigi writing in Japanese. He's not—he wasn't—very speedy. This must have taken him hours to write."

"What did he say?" I asked.

"There's no one else here who reads Japanese, so I can't be sure that the two notes are the same. I'm pretty sure that they aren't. The Japanese note appears to be materially longer—maybe private messages to his family. The note in English says that he killed himself to protest against the use of any nuclear

devices for any reason. The note is quite passionate."

I hadn't even thought of the possibility of something like this. I had been so worried that Kasigi might try to physically stop us from carrying out our final experiment that I hadn't thought beyond that.

"I'm sorry, Donna," I said. "I had no idea that he might do something like this."

"Neither did I," she said—with more than a little bitterness. "And since I've known him for more than ten years, I should have."

"I'm sorry." I couldn't think of anything else to say. No, I didn't even think of calling off the mission. And even if I *had* thought of it, I wouldn't have.

The next seventy-five minutes were probably the longest of my life, as trite as that may sound. I told Ike what had happened when he came back from inspecting the sleds. Jenny came on the radio long enough to tell me that she had heard the other call and to say that she felt terrible about it. Well, so did I, but there was nothing any of us could do. Not after the fact.

"Jenny, once we get in position, we'll deploy the sleds as soon as possible. I'm not going to bother waiting for the clock." It was only a minor flaw in procedure. The noon blast time had been mostly for convenience. And we wouldn't be early by a lot anyway.

"Still no deviation in the storm data," Jenny said. I knew that. We had the same information on the cockpit terminal.

The squall lines ahead of the main storm were clearly visible from above, the converging arcs like the blades of a child's pinwheel. Up where Ike and I were, the sky was clear, the sun reflecting off the clouds in a dazzling display. For a change I felt no pleasure, no exaltation at the sight of the familiar beautiful patterns of weather systems in the atmosphere. The majestic brush strokes of nature seemed flat and lifeless, faded copies of copies.

Ike and I didn't talk much after I told him about Casey. The flight didn't require much. Nor did the deployment of the air sleds when we got in position. And we didn't feel at all up to idle chatter.

We came in on the eye of the hurricane at 50,000 feet and descended toward the top of the hourglass-shaped eye in a gentle banking turn that left us pointed back toward the center. After a final check of the storm's vital statistics, Ike launched the four air sleds and went to work guiding them into position while I maneuvered the plane up away from the eye and ran the throttles full open to put as much airspace as possible between the eye and us before we triggered the fusion devices.

I would have liked to put a couple of AUs between us. In a pinch, I would have settled for a hundred miles. I hoped to get at least twice that.

"Let me know if any of the sleds start to lose stability," I reminded Ike for about the tenth time in five minutes.

"We're holding good," Ike said, not taking his eyes off the display. "The sleds have enough fuel for another twenty-one minutes."

I nosed the plane forward a little to pick up a few extra miles of airspeed. "We don't want to cut it *too* close," I said.

"The fuel calibration tested perfectly," Ike reminded me.

"Still. Keep a close watch and let me know when the first sled shows five minutes' fuel left." I started doing rough calculations in my head. Our airspeed was just over 550 miles per hour. The storm was moving at 12 mph, but not directly in our direction. That meant that we were pulling away from the eye at a rate of about 9 miles a minute. If we could hang on until the first sled got down to 3 minutes' fuel, we would have our 200 mile margin— and just a little more.

I started running through the satellite weather data we had, looking for better winds. And then I smiled for the first time that morning. By dropping another 8,000 feet I could pick up an extra 10 knots of tail wind. I nosed the plane down a little more sharply. That helped too. I was ready to start thinking about *inches* of margin. I did have a rough idea how much power we were going to unleash, and I was thoroughly intimidated.

At least worrying about the sleds and their cargo kept me from dwelling on Kasigi's suicide.

We were 203 miles from the nearest edge of the storm's eye when Ike told me that we had reached five minutes worth of fuel in the first sled.

"Detonate now?" he asked.

I shook my head. "Are all four sleds still stable?"

"Perfectly," he assured me. "They're keeping station like they were tied together."

"We'll hold off as long as possible," I said. "Just keep a close watch on them. Jenny, you listening?"

"I'm listening," she said. "Crank up the filters on your windows."

"Right. Thanks for the reminder," I said. I hit the manual control and the sky darkened noticeably. We were far enough away that the fireball wouldn't even be visible—if the historical data was correct. We shouldn't be able to see anything of the explosion. But again, we were taking absolutely no chances. "All the way to the stops," I reported.

"Four minutes on fuel," Ike said softly.

I glanced at my navigation screen. We were 213 miles from the nearest *bomb*. Even the most bizarre set of circumstances we could imagine wouldn't produce anything that might remotely endanger the Imre at that distance— shock wave or radiation. That didn't stop my nerves from jumping. It *had* been a hundred years since a fusion device had been detonated.

"As long as everything holds stable, hit the button at two minutes." I said. "If anything even starts to look as if it might be ready to go wacky, warn me and hit the button at once."

Two minutes. I must have aged ten years in the last seconds of waiting.

Ike detonated the explosives. We saw nothing, felt nothing. Only the reports from the satellites told us that all four devices had exploded. We waited for a short eternity, staring at the constantly updated model of the storm in our holotank. Things happened.

The eyewall pulsed out and down. The water-laden clouds boiled away, vaporized. The force of the explosions kicked against the 170 mph winds around the eye of the hurricane, pushing some forward, throwing a wall in front of others, disrupting the patterns through the middle altitudes of the storm. The

heat and downward pressure of the explosion increased atmospheric pressure below.

Our computer model couldn't show everything that was happening, couldn't keep up with the pace. Conditions in and around the eye changed too quickly for the satellite monitors to keep pace.

The hurricane rebounded inward.

And the system ripped itself apart.

It didn't happen instantly. After all, the hurricane was more than 600 miles in diameter. But there was enough action along the eyewall in the first two minutes to tell us that we were doing something. We had tipped a strong, well-organized hurricane into chaotic instability. After five minutes, the disruption was still increasing. Ten minutes after detonation, there was no doubt in my mind. The hurricane wasn't dead, but it was dying.

"We did it! We did it!" Ike was shouting almost right into my ear. Jenny was yelling the same thing over the radio. Maybe I did a little shouting myself.

But the shouting didn't last long. Against the darkened glass of the wind-shield in front of me, I could almost see Kasigi's face, begging me not to do it. *"You cannot let this horror be reborn."*

And now it was a squalling infant.

We left two days later. There was no trace remaining of the storm we had killed. But the ghost of a man remained, a man who had died to protest what we had done. Kasigi Jo had already been buried, on Trident, at his own request. I was carrying his suicide notes, his *manifestoes*, back to Earth. I would make his notes public, regardless of the *fallout* there. I owed him that much. Others could decide whether or not we should use our new weapon against the ravages of nature. I had little doubt what the final decision would be.

"I assume that the work will continue," I told Donna Elkins at our last meeting. "We know that the theory is workable now. It needs to be refined. If nothing else, we need to find the minimum force needed."

"Does that mean you'll be coming back?"

I shook my head first, then shrugged. "I don't know. I think that the work has to continue, but I'm having trouble working up any enthusiasm for doing it myself."

"I know the feeling," she said. Then she sighed. "You're right, the work will go on. But I've lost my enthusiasm too. When the next load of bombs comes out, I go home. Quit. I don't want any part of it." She turned away from me. "I love this place and I'll miss it more than anything, but I can't fight for it here. I've got to go back to Earth to do that."

"Maybe I'll see you there," I said. And then I left. Quickly.

