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Escaping S-102: Waste, Illness, and the Politics of Not Knowing

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Abstract: This paper explores the lived experience of radioactive and chemical poisoning following the S-102 accident at the Hanford Nuclear Reservation. It seeks to understand how sickness is made intelligible (or not) in the context of nuclear toxicity, and how layers of certainty and uncertainty structure medical decisions, legal action, procedure, and daily life in the nuclear complex. Discussions about nuclear risk and illness often hinge on the issue of causality, on whether—and at what dosage—radioactivity causes harm. I argue, however, that centering these discussions on truth versus falsehood sidesteps critical examination of the politics that created the terms of the debate. Rather, improving nuclear safety and accountability means analyzing how the boundaries of valid (and by default, invalid) nuclear illnesses are identified and made legally actionable. It also means integrating qualitative measures of health and safety with the quantitative measures of risk currently informing management practice at Hanford.

Keywords: Nuclear Waste Management, Radioactivity, Illness, Hanford Nuclear Reservation, Uncertainty, Worker Health and Safety, Risk Assessment

The Accident

July 27, 2007. 2:10 am. Hanford Nuclear Reservation Tank Farms

THE DILUTION HOSE must have burst. Splash patterns indicate as much. Perhaps radioactive liquid sprayed outward in a graceful toxic arc, thrown aloft in a fantastic burst of energy. Maybe it hung there for a millisecond of triumphant escape before falling to earth with a soft patter. Or maybe the moment was uglier, more befitting the imagined temperament of waste—a belch of air and a poisonous squirt, followed by a slow, hollow, glugging.

Only the waste knows exactly what happened in that instant, for no humans were there to bear witness. Radioactive liquid escaped holding tank S-102 under the cloak of darkness, it melted into the night. Though unseen, its exit did not go unnoticed. Hints of nuclear breakout hung in the air as pungent vapor, entering the lungs of several tank farm workers nearby. Noticing a strange smell in the night around them, an odor that signaled danger to the experienced nose, the workers radioed their office with concern. Perhaps their message of alarm, as it moved on rolling radio waves, encountered the waste's more frenetic gamma rays in the air. Maybe the two sets of waves, each communicating their own story of hazard, passed each other as they moved through the darkness.

It wasn't until morning that the full-extent of the spill became apparent. A wide expanse of wet, oily-looking ground near tank S-102 confirmed the previous night's fears. An investigation was duly performed, and educated conjectures made about what caused the spill. In the months that followed, the requisite "lessons learned" and procedural re-examinations took their place on Department of Energy PowerPoint slides. The public and the press were informed of the incident. They saw pictures of the spill area, peppered with indicator arrows. They learned the here and there of waste splatter—where contamination touched hoses, chairs, wires, pipes, ladders, equipment, ground. They shook their heads as they read newspaper headlines on the matter.

In the end though, life moved on. For most, anyway. Contamination, leaks, radioactivity, risk…these are simply part of living near a nuclear facility. Hazard becomes normalized after awhile. Spills happen, they cause a stir, but eventually newspaper headlines are spill-free once more. And life in the nuclear zone keeps going.

This essay is about the workers who cannot move on after a nuclear accident, whose symptoms do not go away when the headlines change. It explores the lived experience of nuclear poisoning and the strange incarnation of an illness born radioactive. It seeks to understand how sickness is made intelligible (or not) in the context of nuclear toxicity, and how layers of certainty and uncertainty structure medical decisions, legal action, procedure, and daily life in the nuclear complex.

Discussions about radioactive risk and illness often hinge on the issue of causality, on whether radioactivity does or does not create harm. These are, of course, necessary debates that spur activism and scientific investigation and keep environmental health and safety issues in the public eye. However, centering the discussion on truth versus falsehood and requiring certainty before action, sidesteps critical examination of the politics that created the terms of the debate. Rather, I argue that we need to consider the structures of governance that place the burden of proof on the sick worker. We need to analyze the processes through which knowledge about illness and nuclear hazard are constructed. We need to take seriously how that knowledge becomes a tool of enforcement within the legal system.

In the following pages, I engage with the politics of ambiguity, safety, and illness within the nuclear industrial complex through the lens of the S-102 accident at Hanford. Observations and analyses in this paper are informed by fieldwork completed during the summers of 2005, 2006, 2009 and 2010 as well as more than five years of research into nuclear remediation at Hanford. This research relies primarily on ethnographic methodology—most importantly, in-depth interviews with Hanford employees, area residents, and anti-nuclear and health activist communities. Though this paper cites specific interviews with but a handful of Hanford workers, broader structural analyses are informed by numerous discussions I have had with Hanford community members over the past five years. Telephone interviews cited in this paper represent subsequent conversations with individuals that I met and interviewed while working in the field. Workers' names and some personal details have been changed to ensure anonymity.

Structuring Sickness

> "When I woke up it hurt to breathe. It hurt every breath in and every breath out. I'd never had that happen before. So I start to worry."[1]

The doctor did the customary tests included in any physical examination—he took blood, sampled urine, listened to her heartbeat and breathing, checked for high cholesterol. Then

[1] Telephone Interview, December 1, 2009.

he told her to return to work, told her she looked fine, told her to go to the Emergency Room if it got worse. It was the equivalent of "take two Aspirin and call me in the morning"—strange, considering she had been exposed to poisonous vapors for several hours the night before. The doctor did not test for the possible deleterious effects of chemicals she could have inhaled, or radioactive exposure she could have received. The S-102 spill was so recent that they didn't have much data. "He didn't know what chemicals to test for," Karen told me.

Back at work, she found her orders were to return to Tank Farms. To return to the spill perimeter where she had spent much of the previous night, inadvertently inhaling chemical vapors that would permanently alter her body. Incredulous, she refused. Amazing, she thought, disquieted, "the blood tests are not back yet, but they're sending you into the hot zone!"

Later, Karen's test results came back normal, but her symptoms persisted. She developed extreme sensitivities to certain smells—a lit cigarette or a neighbor's perfume could initiate respiratory failure, sending her to the Emergency Room. Things got so bad she had to stop working. Every day tasks like grocery shopping became a challenge, an exercise in envisioning the invisible, as she tried to anticipate the geography of potential hazard in each building she entered.

She was not alone. Other tank farm workers present on the night of the spill developed similarly ambiguous symptoms—frustrating sets of amorphous illnesses that, though they evaded definition, were real enough to make normal life unmanageable. In each worker's case, Hanford denied a causal relationship between their symptoms and their exposure to S-102 waste. These workers are still fighting for medical compensation and unemployment benefits. It has been a tiring uphill battle.

Why, we must ask ourselves, has Hanford denied the validity of these illnesses? The workers were most certainly exposed to toxic vapors—that much is well documented. They were present at the site of a nuclear spill involving 85 gallons of high-level radioactive and chemical waste, and exposed to toxic materials for many hours before the Take Cover alarm was initiated. And yet, they can't prove causality, they can't prove harm. How do we explain this apparent break in logic? How is it possible that illness can *not* be taken seriously after a nuclear accident? Furthermore, why is it the onus of the worker to prove harm?

That workers must evince their illnesses to the entities responsible for their contamination reflects a deeply unequal power structure at Hanford. Risk and nuclear safety are managed in such a way on site that the burden of responsibility for accidents often falls on workers' shoulders, rather than on the officials who approved the procedure. It also reflects a governmental fiction that risk-free nuclear management is possible. These structural inequalities and fictive expectations impede workers' struggles for compensation.

Hanford's denial of harm also reflects a bias in the medical community about what kinds of illnesses are valid. Karen's sickness exists outside the bounds of biomedical logic—her symptoms simply do not conform to scientific conceptions about normal physical function. When her body reacts violently to one brand of perfume, but not another, it does so in a "domain of supposed impossibility…in a condition outside of 'disease'—that is, as an invalid bodily state" (Murphy 2006, 152). In effect, the inability to taxonomize her bodily functions has removed her symptoms "from the realm of legitimate corporeal illnesses" (152), a delegitimization that has made her ineligible for worker's compensation and health coverage. It has also made legal action more difficult—for how does one hold a company or corporation (or the Department of Energy) legally responsible for a medical condition that, officially, doesn't exist?

When considering illnesses that exist outside the boundaries of accepted medical territory, the following questions inevitably arise: How do we determine what "normal" or "legitimate" bodily function actually is? Under what rubric does nuclear illness fall into the category of "impossible"? What are the politics that created such hierarchical categorizations of health and the body? It was not long ago that American doctors eschewed the typologies that standardize medical treatment today, instead adhering to a "principle of specificity" in which each patient's individual age, gender, temperament, socioeconomic status, etc., were taken into account when assessing their illness and determining their treatment. Symptomatic diversity was an accepted part of medicine—of treating the patient, not the disease. However, towards the end of the nineteenth century, "U.S. physicians gradually abandoned the notion that treatments should be tailored to the idiosyncratic constitutions of patients in favor of the idea that each specific kind of illness required a distinctive treatment that might be applied universally to sufferers" (Epstein 2009, 40). Why this change of heart (mind)?

In large part, this transition is located within twentieth century developments in the scientific experimental community, "pharmaceutical drug testing and regulation, epidemiological studies based on notions of statistical risk, the codification of international classification systems for morbidity and mortality, the rise of evidence-based medicine as a movement within biomedicine, and the growth of managed care as a system of rationing and surveillance" (40). Such changes also reflect an increasing reliance on the logics of global capitalism—on market-based forms of social interactions that rely on commodification, standardization, and regulation. Within this structure, consumption exists in abstraction from the conditions of production. Consumers do not have to understand the labor, natural resources, or political conditions that brought them their breakfasts, lampshades, or pillowcases. So too, the market mediates social interactions—individuals do not have to know the communities who grew their food, or the people who built their children's schools. Societal interaction based on this system of abstraction supports a biomedical infrastructure that sees patients as medical objects, rather than living, breathing beings. And objects are much easier to taxonomize, to categorize, to assess, to control.

One-size-fits-all medical practice that locates truth in statistics, in large *n* samples rather than individuals, in coefficients and correlations rather than personal testimony, relies on the logic of the standardized patient—an "average man" who represents the "golden mean" of society—both physically and emotionally. Though scientists have been critiquing the validity of assigning "average" the role of normal for centuries, the "golden mean" continues to pervade medical trials, drug development, and patient care.

So who, then, becomes the average? Against what body do we measure appropriate pathogenic or radioactive resistance? In the nuclear industry, federal standards for radiation protection are based on the physical resiliency of theoretical "Reference Man"—a 20-30 year old white male living in a comfortable temperate climate (50-70 degrees F on average). Reference Man is five foot seven, weighs 154 pounds, and adheres to Western European or Northern American habits and customs (IRCP 1975). His bodily responses to radioactivity inform criteria for nuclear safety—his reactions to radioactive particles in the air, water, and soil create the yardstick with which nuclear hazards for the rest of the population are measured.

It will come as no surprise that Reference Man is a poor barometer for radioactive health and safety. Studies show, for example, that women and children are more vulnerable to nuclear risks than adult men (Makhijani 2008). The US Environmental Protection Agency acknowledges the logical flaws punctuating Reference Man's use, and is currently at work determining what other possible median could more accurately represent vulnerable populations. Though injured nuclear workers will no doubt be happy to see Reference Man go, his replacement with another average (another ideal type) actually fails to address the central problem of standardizing humanity in the first place. It lacks critical examination of the logic that supports singling out "a particular sociodemographic group as the ideal specimen of humanity—the ones most worthy of study—and then treat[ing] knowledge derived from the study of this group as universal truth" (Epstein 2009, 38). Pinning the badge of "normal" on an approximation of the average denies the validity of individual experience; it denies the importance of diversity. It denies outliers. As such, medical practice informed by statistical averages and correlations acts as an exclusionary force for people with uncommon or ambiguous illness.

The Cultural Politics of Not Knowing

In addition to the unusual symptoms that nuclear exposure imposes, the seemingly random pattern of affliction among workers complicates causal explanation. Not everyone exposed to nuclear materials during the S-102 spill became ill. One person stood close enough to touch the waste, and yet he didn't develop symptoms. Another worker, who was a mile away that night, did. Karen likened working in a radioactive risk zone to eating an enormous chocolate chip cookie with only a few chocolate chips in it. You can take many bites before you hit a chocolate chip, or you can encounter one in the first bite. Radioactivity is a strange beast, impossible to truly anticipate. You never know when you will get a bite of it, she told me, and how it will affect you if you do.

Among the confounding elements of nuclear exposure, is that its effects are inconsistent. Some days, Karen is more sensitive to chemicals than others. The capriciousness of her symptoms weakens her fight for legitimacy and compensation. In effect, when she feels better, she undermines her own cause. "It makes you look like a liar," she told me. Hanford has been known to have sick workers followed by private investigators—documenting their activities throughout the day and highlighting instances when they imagine the worker *should* have a symptomatic reaction under the conditions of their "supposed" illness. Thus, every day activities like pumping gas, or getting a pedicure (both odorific exercises) become evidential moments, the simple act of living becomes an exercise in credibility.

Not only is erratic bodily reaction, then, a legal liability, it also becomes a source of guilt and self-doubt. It creates a paradoxical relationship with one's own body where legal and even personal legitimization depends on a set of inconstant (yet, very real) symptoms. A confusing emotional connection between illness and wellness is the inevitable result. Recovery becomes a contradictory act.

Uncertainty as to the "true" effects of nuclear poisoning on workers and the environment is an everyday reality of nuclear remediation efforts. Hanford workers and residents of the surrounding community understand and process their proximity to hazardous waste in different, and often contradictory ways. A large percentage of the local populace denies the risks associated with nuclear production, rolling their eyes at environmentalist rhetoric, some even sporting T-shirts that boast, "A little dose doesn't scare me."

Daily life in the Hanford region normalizes risk in routine ways—the area's drinking water comes from the Columbia River *after* it has passed through the nuclear reservation, the atomic symbol adorns park benches and beer mugs, the football players have mushroom clouds on their helmets and letterman jackets. Each piece of nuclear culture reflects a shared history of weapons production, and the collective feelings of pride and honor integral to that effort. The Hanford community spent more than forty years containing the Soviet menace by producing Plutonium. In the collective regional imagination, nuclear production kept the nation safe. The conceptual disconnect that such efforts to protect America could have simultaneously injured its citizens with radioactive poisons, is evident in the community. This historical production of nuclear risk as pertaining to communism rather than contamination plays a central role in delegitimizing radioactive injury.

Negotiating the difficult cognitive terrain of daily interaction with a deadly substance also influences how Hanford workers interpret their injured colleagues. In Karen's words, "workers tell themselves, 'if I really believe that it's hazardous enough for her to get sick, I should quit immediately. But I can't afford to so…". Of course, many people at Hanford understand that their jobs involve risk, but they have faith in safety procedures and managerial judgment. Psychologically, it is easier to doubt the validity of the illnesses that occur after exposure events like S-102 than to acknowledge the possibility of danger. "Because," as Karen told me, "to keep working out there that's what you have to tell yourself." You have to believe that it's safe.

Assuring worker health and safety at Hanford means managing uncertainty as much as managing the radioactive materials themselves. The level of contamination on site is unbelievable. Four hundred and fifty billion gallons of radioactive liquids have made their way into the soil and water table. Poisonous groundwater plumes transport contamination to the Columbia River, where it travels to the Pacific Ocean. Cleanup is expensive and inefficient—only about 2% of the radioactivity at Hanford has been contained (Hanford Challenge 2009). Much of the site's high-level waste is stored in leaky underground tanks, and, short of pumping the materials above ground, it is difficult to ascertain what types of chemicals and radionuclides those tanks contain. The scope of the problem at Hanford is so great, and managing its materials so complicated, the potential for nuclear accidents, mistakes, and mismanagement is very high. How then, can Hanford truly ensure worker protection? How can remediation efforts operate under such high levels of uncertainty? What are the consequences of action in this state of not-knowing?

The Department of Energy will not approve a project at Hanford unless the risk of hazard to workers and the surrounding community is 10^{-6} (one million to one). This is an unthinkably high expectation, especially for a nuclear facility like Hanford—it is simply not possible to function at Hanford without incurring some level of risk. The Department of Energy's strategy for dealing with this logical inconsistency lies in a near religious reverence for the regulatory power of procedure. In order to maintain the fiction of control, every step of every remediation project is carefully constructed, detailing what order to flip switches, open valves, close doors, etc. As one tank farm worker told me,

> [Hanford engineers] write procedures—step by step—that say what you will be doing exactly that will not let you get outside of these bounds [of safety]. There are safety

> based rules and regulations and you make sure you don't ever get out from underneath of them.[2]

Enforcing strict compliance with procedural controls, while meant to ensure safety, risks "transforming people, who initially, were supposed to be competent and intelligent, into 'programmed machines' (Colas 1995, 213), and denies the value of real-time commonsense decision making when "unplanned situations" arise (Perin 2006, 218).

Creating procedure also involves some level of decision making about what risks are necessary to manage. This places nuclear engineers and DOE managers in the position of determining what is possible—allowing managers almost divine predictive capacity. Personal and institutional biases about the deleterious effects of radioactivity or chemical vapors on worker health is thus integrated into remediation procedure. Because a causal connection between chemical inhalation and illness has not been validated by the appropriate scientific experiments and nuclear experts (and has therefore been deemed "incredible"), guarding against chemical vapors may not be included as part of the procedure. Workers may or may not be required to use artificial air when working in potentially vaporous places, for example.

The nuclear accident at S-102 represented a moment when radioactive waste acted in a way that procedure-creators didn't anticipate—the waste's actions exceeded the possible. The material in tank S-102 actually escaped through a dilution hose, which had been adding water to the toxic sludge in the tank, easing the waste pumping process. However, in this instance, the waste changed physical form—it created a cement-like substance around the bottom of the pump, clogging it, and forcing waste up the dilution hose—a piece of equipment never meant to hold high-level nuclear materials. "In 30 years of experience at Hanford, I had never seen anything like that before,"[3] one worker told me. "The waste formed its own containment, its own vessel, the hose gave out before it did." Another worker told me, "The reason they had a problem was they decided it [waste going up the dilution hose] was incredible. And you don't put in extra safety features when you think it's incredible."[4]

Assuming the stance that risk-free nuclear remediation is possible places the burden of responsibility for mistakes (and for their own illnesses) on workers rather than on the Department of Energy. As Karen told me,

> If they [DOE] say do it safe, what they mean is do it safe and do it as fast as you can. As long as that can be done and get something accomplished. But don't be safe at a standstill. But that contradicts itself. Hanford has this zero accident mentality—they say zero accidents, they say that's what the goal is. Well, that's an unachievable goal. But people [at DOE], have said, no, we really mean that. Well, sorry you can't get anything accomplished then. So does that mean, just don't tell us? Just tell us it's safe?

Thus, workers have to negotiate the conflicting messages they receive from upper-level management—and when accidents happen, the workers inevitably take the blame. One woman described a post-accident conversation like this,

> Worker: "But I thought you knew it was happening."

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[2] Telephone Interview, December 1, 2009.
[3] Telephone Inteview, December 1, 2009.
[4] Telephone Interview, December 16, 2009.

DOE Manager: "Oh no, I would never approve that."

"Well," she told me, "they [DOE] oked it by not asking."[5]

Blaming accidents and mistakes on worker error—on improper adherence to procedure or poor safety culture—rather than on structural deficiencies means that Hanford's institutional framework evades scrutiny. Thus, systemic changes are politically unnecessary and bad cleanup policy persists.

Calculating risk is inevitably complicated by personal bias, economic incentives and constraints, and political pressure. However, even if it *were* possible to conduct risk assessment from a neutral position, inadequate data makes creating safety protocol virtually impossible. The S-102 tank, for example, was part of a tank "stabilization" project that transfers high-level nuclear waste from leaky, single-shell tanks to newer, double-shell tanks where it can await treatment and disposal. Retrieving nuclear waste from underground tanks at Hanford is no easy task. One Department of Ecology official likened it to "trying to suck up an Olympic-sized swimming pool full of peanut butter with a coffee-stirrer straw."[6]

Even when methods are devised for successfully retrieving waste from holding tanks, its chemical composition remains ambiguous—no one knows for certain what nuclear materials the storage containers hold. As one S-102 worker said, "If anyone ever tells you they know what's going on, they're either ignorant or a liar. Because no one really knows. You can't see in there. You're doing it blind. It's like sticking a straw in a Styrofoam Big Gulp container"[7]—you can't look before you sip. Tank waste stabilization is further complicated by the fact that chemical properties change when various materials interact over time. Thus, waste records from decades past may hold little information about the substances currently stored on site.

This, again, highlights a central paradox of management at Hanford. Nuclear policy requires a level of certainty to assess risk and create procedure—however, it is managing fundamentally uncertain materials. The frustrating reality is that those in charge of managing nuclear waste do not acknowledge the basic irony of their task, but continue to operate as if radiation and risk are containable within the bounds of mathematical modeling and carefully planned procedural controls. Hanford workers and the surrounding environment bear the brunt of such willful ignorance.

Ambiguous Conclusions

In response to growing concern about chemical vapor inhalation from tank waste, an expert committee of non-Hanford affiliated academics and industry professionals convened to assess chemical hazard and risk assessment methodology at Hanford. Though the findings in this 50-page document are not surprising (i.e. current protective measures are insufficient to ensure worker safety) they are nonetheless powerful in their capacity to initiate change. As I have outlined, the first step in creating safety procedure with the potential to protect workers at Hanford, is proving that chemical vapor and radiation exposures are, in fact, hazardous to health. This onus of proof is an unfortunate part of the nuclear complex's structure of governance.

[5] Telephone Interview, December 1, 2009.
[6] Personal Interview, Richland, Washington, August 21, 2006.
[7] Telephone Interview, December 1, 2009.

Such means of resistance that exact change by using institutional frameworks and procedures simultaneously threaten and protect worker safety. For example, intra-structural resistance in this form uses Hanford-accepted metrics like Threshold Limit Values (or TLVs) created by the American Conference of Governmental Industrial Hygienists (ACGIH) to evaluate chemical vapor hazard. TLVs are the product of studies examining worker exposure in the real world—they represent the lowest level at which risk has been measured in association with certain chemicals. According to one risk expert I spoke with, TLVs don't necessarily prove that a chemical is safe; they simply note the absence of a study qualifying the chemical as harmful. Thus, the accepted metrics to evaluate hazard are ones whose representation of safety is fraught—and using those complicated metrics to analyze worker safety actually gives them legitimacy.

The expert committee concluded that the best way to protect Hanford workers is to reduce uncertainty within remediation procedure. This is an interesting conclusion to make in the context of Hanford's governing structure, which is actively engaged in reducing uncertainty on a daily basis—only their actions to reduce uncertainty, to control the impossible, to dictate the possible, produces a fictional reality in which workers must operate. Hanford's practice of reducing uncertainty actually creates the situation in which workers are to blame for nuclear accidents.

Thus, the relationship between certainty and uncertainty at Hanford can be both empowering and disempowering for workers there. Certainty that Karen's illness was caused by S-102 waste would change her life for the better. However, it was also certainty (which considered the S-102 spill to be impossible) that created the conditions for her exposure. It is within the categorial bounding of illness that Karen finds both her exclusion and the potential for her salvation. Perhaps it is in looking between those boundaries, and exploring the bounding lines themselves and re-evaluating them, that relief for injured workers like Karen truly lies. Nuclear waste at Hanford destabilizes the certainty-uncertainty binary upon which current remediation policy and safety procedure relies. Improving remediation practice may entail closer examination of such opacity.

The United States will be tasked with nuclear management for generations to come, and the longevity of radioactive materials complicates decisions about their disposal and stewardship. Recent financial boons to nuclear industry in the form of loan guarantees will likely increase American atomic production, making critical analyses of radioactive waste management ever more essential. Enhancing environmental health and safety within the nuclear industrial complex requires reevaluating the scientific and institutional hierarchies of nuclear expertise that govern procedure and management (Masco 2006; Gusterson 1998). It also means integrating qualitative measures of health and safety with the quantitative measures of risk currently informing management practice at Hanford.

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About the Author

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Shannon Cram is a Ph.D. student at the University of California, Berkeley in the Department of Geography. Her dissertation research (as well as her previous masters thesis research) examines nuclear waste management in the United States, with a specific focus on the Hanford Nuclear Reservation. She is particularly interested in the politics of long-term environmental stewardship, worker health and safety, indigenous rights, and risk assessment within the nuclear industrial complex.

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