

Front Page – Sunday, January 23, 2011

Big cleanup questions still loom at Hanford

At the Hanford nuclear reservation, the Department of Energy is building a plant to clean up 53 million gallons of radioactive waste. But after a quarter-century of preparation — and cost estimates that have nearly tripled to \$12.2 billion — builders still haven't resolved this project's most vexing technical and safety issues.



STEVE RINGMAN / THE SEATTLE TIMES

The Department of Energy's Erik Olds walks inside a mockup of one of the Hanford nuclear reservation's 177 underground tanks. The tanks hold 53 million gallons of radioactive waste from 40 years of plutonium production. A million gallons have leaked into the ground.

RICHLAND —

Rising from the desert sand outside the Tri-Cities is a construction project unlike any in history. The buildings going up in this gated-off stretch of tumbleweed are reinforced with as much steel as three Eiffel Towers. The concrete structures are being threaded with enough pipe to funnel water 200 miles to Seattle. Workers are installing giant melting machines, which will burn so hot they could turn gold to soup.

This is supposed to be the most sophisticated garbage disposal on Earth, the centerpiece of the Western world's costliest environmental cleanup. It's supposed to rid the Hanford nuclear reservation of its deadliest poisons: 53 million gallons of radioactive waste, now buried in aging, leaky tanks.

But after nearly a quarter-century of preparation — and cost estimates that have nearly tripled to \$12.2 billion — builders still haven't resolved this project's most vexing technical and safety issues.

That leaves some worried the federal Department of Energy (DOE) and its contractors may build themselves into a corner and produce a plant that's dangerous or doesn't treat as much waste as expected. They fear construction will drag on and increase environmental risk, or cost billions more to get right.



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One of Hanford's "tank farms," where some of the site's 53 million gallons of nuclear waste is stored below ground in giant, aging steel-and-concrete tanks.

This one-of-a-kind plant is supposed to turn the nuclear slop from Hanford's 177 underground waste tanks into glass. Today, the plant is more than half-constructed. The DOE and its contractors are making the case to Congress that design and planning are all but finished.

But parts of the plant still face risks of bursting into flames, exploding or triggering uncontrolled nuclear-chain reactions, according to project documents, interviews and formal critiques by scientists at other federal agencies.

The government's own tests show that equipment may fail or pipes may clog in areas of the plant so hot with nuclear waste that no human or machine could ever get in and make repairs.



STEVE RINGMAN / THE SEATTLE TIMES
Construction of Hanford's \$12.2 billion plant to turn nuclear waste into glass takes shape in the desert outside the Tri-Cities.

In addition, each of Hanford's underground waste tanks holds a unique mix of hundreds of toxic compounds and radioactive isotopes. But crucial elements of the plant's testing and design were based on samples that don't reflect this unusual cocktail.

"We figured out how to put a man on the moon in 10 years using slide rules," said Walt Tamosaitis, a high-level Hanford engineer who said he was removed from the project last year after raising safety concerns. "We still can't seem to get this right."

A "wicked problem"

To be sure, cleaning up Hanford's atomic mess after 40 years of bomb-making is devilishly tricky. The

DOE and lead private contractor Bechtel National insist they know how to make the plant work. They say they have a strategy for solving remaining problems and point to an outside review by scientists appointed by DOE that suggests they are on track. They say if future tests show an approach is risky, they'll alter it.

The plant is scheduled to begin operating in 2019.

"From the management perspective, we believe we have a handle on the larger technical issues," said Delmar Noyes, the treatment project's deputy director for DOE.

But the project presents what some call a "wicked problem."

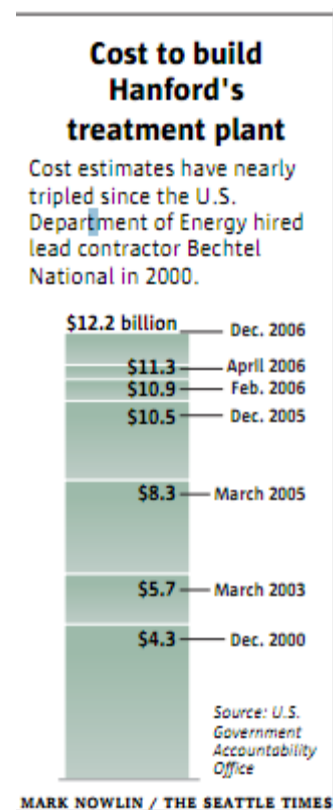
Slight design changes in one area can trigger a cascade of unforeseen issues elsewhere. And the plant is being built before contractors have figured out details of the final design.

That worries the Defense Nuclear Facilities Safety Board, a federal panel of nuclear scientists appointed by the White House to oversee Energy Department projects. The board makes recommendations and updates Congress about safety issues.

"I think it's fair to say the board is concerned about many aspects of this project," Chairman Peter Winokur said in an interview.

Certainly Hanford cleanup demands haste. The 586-square-mile Manhattan Project site began producing plutonium for atomic weapons in the 1940s. Production continued until Hanford's last reactor was shut down in 1987.

The rush to arms produced billions of gallons of waste. Some of the hottest was funneled into concrete and carbon-steel tanks that today are decades past their projected life span. Some have spontaneously heated up or burped explosive gases. Sixty-seven are suspected to

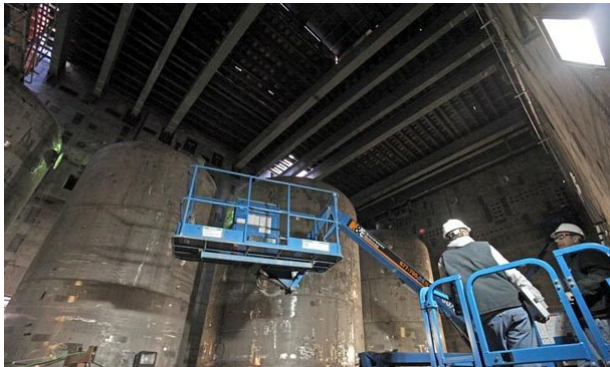


have leaked. At least a million gallons of radioactive goo has spilled into the ground and is working its way to the Columbia River.

But year after year, cost overruns and delays dogged cleanup.

The government spent \$197 million building processing plants and vaults to dispose of waste by mixing it with cement only to drop the idea. It bagged plans to melt and seal nuclear material in insulated boxes — after spending \$418 million. Contractors got bonuses for doing work after scheduled start dates, and for completing projects not needed for years.

As recently as 2009, auditors learned a Hanford contractor had spent \$103,000 in taxpayer money buying frozen dinners for employees working overtime. An inspector figured out the practice was probably illegal but had been written into Hanford labor agreements since 1955.



STEVE RINGMAN / THE SEATTLE TIMES
Workers prepare to test welds on some pipes inside Hanford's waste-treatment plant. This section of the plant is a "black cell," which means it will be closed to people and equipment once the plant starts treating waste.

But there has been progress, too. Gone are hundreds of millions of pounds of contaminated dirt and concrete, along with nearly one-third of Hanford's buildings. Gone, too, are basins that housed leaky pools filled with tens of thousands of deteriorating nuclear-fuel rods. The spent rods are now packed in steel and buried in concrete vaults.

Still, after more than 20 years of full-time cleanup, the site's most urgent problem remains: the tanks.

A volatile stew

Hanford's tanks range in size from 55,000 gallons to 1 million gallons, and they were built between the 1940s and the 1980s. The oldest 149 have only a single shell, and much of the liquid from them has

been pumped into newer double-shelled tanks. Remaining waste is a mix of sludge, cakey salts, gas and liquid. In all, the 177 tanks hold two-thirds of the country's high-level bomb-making wastes.

Over the years, each has become a distinct and changing caustic brew. As tanks filled during the Cold War, workers piped contents from one to another. Some spilled during transfer. Some was dumped intentionally into the ground to make room for more. Chemicals and heavy metals were added to neutralize waste, or to separate reusable nuclear materials. Tank managers poured in sodium so acids wouldn't dissolve tank walls. Water was added and boiled off.

Record-keeping was poor or inaccurate. No one knows precisely what's in them.

"The waste was changing and chemically reacting all the time," said Dirk Dunning, with Oregon's Department of Energy.

Visions of a plant that could melt this garbage into glass to be safely stored forever gained traction during the late 1980s. The process is used in Europe and South Carolina, but for substantially smaller quantities of waste. It's never been tried with such a toxic mix.

In the late 1990s, the DOE hired a British company to design and build the plant. The government sacked the contractor in 2000 after cost estimates rose to \$15.2 billion. Energy officials then hired Bechtel, for \$4.3 billion.

As designed, Hanford's plant is supposed to pump waste from the tanks into a series of holding vessels. From there, the radioactive elements will be separated and turned into two kinds of glass.

But Bechtel, too, soon faced criticism. It installed an important holding vessel only to discover later — and by accident — that the welds were faulty. It was forced to return flawed steel beams.

Project behind schedule

Congressional investigators with the Government Accountability Office complained repeatedly, as early as 2003, that the plant moved to construction before proving parts of the design would work. Costs shot back up to \$12.2 billion. The project fell a decade behind schedule.

An Army Corps of Engineers report found little evidence Bechtel controlled costs. It reported Bechtel and DOE were overly optimistic about how fast and well they could finish their work. It revealed engineers were struggling to figure out technical problems — how to protect against fires, keep explosive gases from building, or keep waste mixed up safely. The report was written in May 2005.

Five years later — halfway through construction — plant builders still wrestle with the same issues.

In the fall, a panel of scientists appointed by the DOE said contractors had finally found a reasonable "path forward" with remaining technical problems. Bechtel's "professionalism and effectiveness," the panel determined, would keep the project on track.

But even those scientists made clear that didn't mean the problems were actually solved. And Bechtel's approach still makes other scientists uneasy.

For example, one of the most confounding and dangerous issues is how to keep nuclear waste stirred. A consortium of university researchers and DOE's own Pacific Northwest National Laboratory said Bechtel's approach is based on overly simple tests that are too small to reflect real-world operations.

There are other concerns, too. Fast tracking this project has led to so many late design changes that DOE officials recently claimed the plant was too complex. So they began simplifying the design by scaling back safety measures.

For instance, because waste can generate dangerous gases, builders first tried designing and aligning piping systems in ways that prevented fires and mini-explosions. But now, pipes are being designed so that explosions are expected and allowed; plant operators will just have to keep them manageable.

An independent review team raised concerns about this approach. Other government scientists said Bechtel's confidence again seemed based on simplistic tests.

Allowing explosions also means radiation leaks are more likely. Contractors said that would be OK because leaks would quickly be discovered and cleaned up. But an increased possibility of leaks makes it that much more important to understand and limit exposure risks to workers and the public.

In the fall, scientists pointed out that the Energy Department had underpredicted by a factor of four just how far radiation could spread in an accident. The DOE conceded its numbers were wrong but insisted other calculations guaranteed the public's safety.

Race against time

One of those sounding alarms is Walt Tamosaitis, an engineer who helped identify many of the problems.

"I maintain that debating how many hydrogen explosions pipes can withstand is the wrong thing to be discussing," Tamosaitis said. "When you start adding up the marginal factors ... you're setting the stage for a major problem. You begin to see how



STEVE RINGMAN / THE SEATTLE TIMES

Long, thin canisters (above) will be used to permanently store Hanford's hottest, high-level nuclear waste after the treatment plant has turned the waste into glass logs. Low-activity waste will be poured into shorter, stockier canisters (left).

an accident like BP's in the Gulf could happen."

Tamosaitis raised these issues with his bosses last summer but said he was immediately removed from work on the project. He since has filed whistle-blower claims against the contractors and DOE. None will comment on his case. A Labor Department investigation is under way.

The Defense Nuclear Facilities Safety Board also has questions about whether the plant will work fast enough. As is, the plant isn't expected to process all the waste until 2047, and operational costs could hit \$100 billion. By then some of Hanford's underground tanks will be a century old.



STEVE RINGMAN / THE SEATTLE TIMES

Walt Tamosaitis worked as an engineer at the treatment plant until last summer, when he says he was removed from the project after raising safety issues.

And that schedule is doable only if everything works as planned. Things at Hanford often don't work as planned.

Some worry processing the waste may take longer, and the plant is being designed to work for only 40 years.

Recently, the Energy Department reignited a push for new technologies, and is working with a company to investigate alternative waste-treatment ideas. Officials have said the hope is to reduce the timetable for Hanford cleanup.

But critics like Tom Carpenter, with the activist group Hanford Challenge, see that as a tacit admission the waste-to-glass plant won't do as much as once

intended.

One of the technologies being considered is steam reforming — turning waste to gas using steam and converting it to crystals — a process once rejected as inappropriate for Hanford.

"I think it shows how desperate they are," Carpenter said. "I think it makes clear they're worried it isn't going to work."

Delmar Noyes, with DOE, disputes that characterization. Others aren't sure what to think.

Ken Niles, who is head of Oregon's nuclear-cleanup program, said he fears some of the current issues are "significant."

But he doesn't see any option but pushing forward with the plant.

He acknowledges his position requires a leap of faith.

"I still believe the plant is going to work," Niles said. "But I believe that, in part, because it has to. It's got to work."

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Key players at Hanford

The Department of Energy (DOE): Responsible for the cleanup of nuclear-weapons sites around the country, including Hanford.

Bechtel National: Contractor hired in 2000 to design and build the waste-treatment plant.

URS: Subcontractor working on the waste treatment project. Walt Tamosaitis' employer.

Defense Nuclear Facilities Safety Board: Federal agency led by nuclear scientists that oversees safety issues at large DOE projects. It raised many concerns in recent months about Hanford's plant.

Pacific Northwest National Laboratory: DOE science and research lab that often reviews or tests science behind technologies used at Hanford. Raised several concerns about "pulse-jet mixing." [See responses to Question 18, page 167 \(PDF\)](#)

Environmental Management Advisory Board Tank Waste Subcommittee: Team of scientists, appointed by DOE, that determined Bechtel was on track to resolving major technical issues. The subcommittee said the conclusion did not mean Bechtel had solved the problems. [Full report \(PDF\)](#)

Consortium for Risk Evaluation with Stakeholder Participation (CRESP): University scientists from around the country who raised questions about Bechtel's pulse-jet mixers. [Report \(PDF\)](#)

No proof Hanford mixers will work

It sounds like a sci-fi thriller: Dangerous gases build up in a giant drum of nuclear waste. It explodes and spews contamination, threatening workers or the public. Or it cripples a facility that cost taxpayers \$12.2 billion.

By [CRAIG WELCH](#)
The Seattle Times
RICHLAND, Wash. —

It sounds like a sci-fi thriller: Dangerous gases build up in a giant drum of nuclear waste. It explodes and spews contamination, threatening workers or the public. Or it cripples a facility that cost taxpayers \$12.2 billion.

Pulse-jet mixers

Nuclear material inside Hanford's waste-treatment plant needs to be kept stirred so plutonium, uranium or other heavy metals don't settle to the bottom, where they could trap dangerous gases and cause explosions or trigger uncontrolled nuclear chain reactions. Air-driven pumps, called pulse-jet mixers, will operate like turkey basters, alternately sucking up and pushing out the waste to keep it mixed. Here's how:

Why pulse-jet mixers

Pulse-jet mixers were selected because they have no moving parts and can be used in areas of the plant called "black cells." These are sealed rooms expected to be so hot with radioactivity that no people or equipment can enter once the plant is operational. Monitoring will be done by instruments and cameras.

Potential problems:

- Contractor Bechtel National doesn't think all the waste has to be lifted entirely off the bottom of a vessel to keep heavy elements like plutonium from settling. Other government scientists disagree.
- The process of sucking up and spitting out waste could take far longer than expected, leading to expensive delays in treatment, or forcing changes elsewhere in the process.
- The force of waste being ejected from pulse-jet mixers could damage the mixer or the tank in an area of the plant that could never be repaired.

Sources: U.S. Department of Energy; Pacific Northwest National Laboratory; Defense Nuclear Facilities Safety Board; "Investigation Of Erosion From High-level Waste Slurries At The Hanford Waste Treatment And Immobilization Plant" by Ivan G. Papp and Garth M. Duncan

Reporting by [CRAIG WELCH](#) Graphic by [MARK NOWLIN](#) / THE SEATTLE TIMES

It could happen at Hanford's nuclear-waste-disposal plant if radioactive material isn't kept stirred.

So engineers years ago proposed a solution. Inside the plant's giant drums they would put pumps that work like giant turkey basters. Using air and suction, they would slurp up and spit out radioactive sludge to keep it constantly churned.

But despite hundreds of millions of tax dollars and nearly a decade of effort, builders haven't proved these "pulse-jet mixers" will work and work safely, according to interviews, audits, internal and external project documents and e-mails.

The effort to perfect this mixing system is a case study of Hanford's

engineering challenges and helps explain why the site's waste-to-glass project often seems to be in crisis. Tracing this one technical problem reveals how cutting-edge technology and management missteps have led to setbacks, delays, cost-overruns, investigations and accusations of malfeasance.

Walt Tamosaitis, an engineer and high-level manager with one of Hanford's contractors, charges that speaking out about it cost him his career. He since has filed a whistle-blower complaint. An investigation is under way.

Neither the federal Department of Energy (DOE) nor its contractors will comment on his accusation. They maintain they've solved this mixing problem.

But university scientists and experts with several federal offices aren't convinced.

Hanford's treatment plant is supposed to run waste from leaky underground tanks into large drums in a shopping-mall-sized building. There, radioactive elements will be separated and turned into glass.

Along the way, when waste sits in the plant's dozens of holding vessels, pulse-jet mixers will stir them.

Here's why: Hanford's waste holds up to 1,700 pounds of plutonium-239, scattered among 53 million gallons of other poisons. It is a heavy element and will want to settle at the bottom of these drums. Over time, too many particles could gather and trigger a chain reaction.

It happened in Japan in 1999: Reprocessing-plant workers combined too much uranium. Suddenly, there was a flash of blue light and an intense surge of radiation. Two workers were vomiting within the hour. One died in 12 weeks, another in seven months.

That's just one possibility. Particles of plutonium or, for that matter, any other heavy element also could build up and trap and release hydrogen that could then explode.

Stirring ensures none of these particles accumulate.

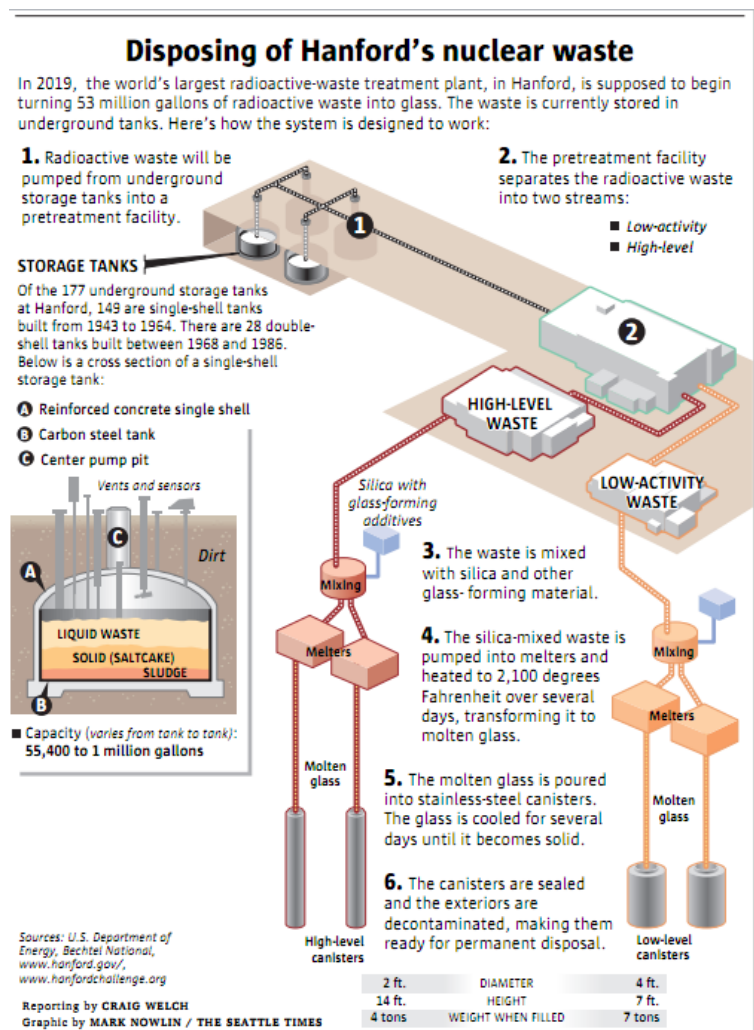
But jet mixers have never been used on this scale or with such a mix of chemicals and radioactive isotopes.

And some of Hanford's holding vessels are installed in "black cells," areas already expected to be so hot with radioactivity that no human or equipment can get in to fix them. That means nothing must break down during decades of operation.

Plus, these mixers have competing jobs. They must be strong enough to keep waste from clumping and delicate enough to not spit out air or particles with too much force. That could ruin the pumps or damage the holding drums, potentially disabling the entire \$12.2 billion plant.

Jet mixers were tested back in 2000, but questions emerged. Plant design and construction continued while engineers tried to answer them.

In the mid-2000s, mixers still had problems. Bechtel National, the lead contractor, set about redesigning them.



But because construction had continued, the Government Accountability Office, the investigative arm of Congress, said the redesign and delay drove costs up by \$300 million.

Bechtel led parts of a tour of the treatment plant, but declined to answer follow-up questions for this story.

In 2005, the DOE assembled experts to identify major issues facing the plant. Engineer Walt Tamosaitis, who worked for a Bechtel subcontractor, led the group. It came up with 28, including the pulse-jet mixers. The DOE set a deadline to find solutions. It came and went. In 2009 DOE's research arm, the Pacific Northwest National Laboratory (PNNL), showed jet mixers still failed tests. That's when Tamosaitis, at the request of DOE, stepped back in. He would later accuse the DOE, Bechtel and subcontractor URS of harassing him for raising safety issues.

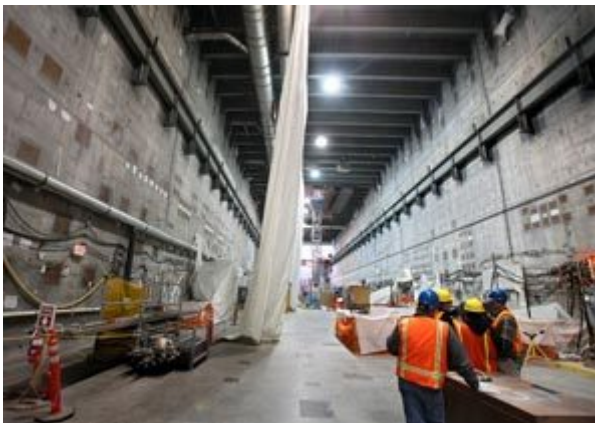
He recounts what happened like this: Bechtel managers wanted to perform tests based on computer models. Tamosaitis insisted on large-scale lab tests. The man overseeing the project for Bechtel said he'd use influence with a DOE official to make sure any fix the company proposed was approved. Otherwise, DOE might withhold some portion of a \$6.3 million payment. Another manager said resolving the mixing problem was so tied to compensation and career advancement that if the issue "doesn't close, I'll be selling Amway in Tijuana," according to Tamosaitis' complaint.

Last February, Tamosaitis complained proposed tests remained inadequate. In a June critique, a PNNL researcher said Bechtel took a "razor's edge" approach to safety and left not a whisker of room for error.

Still, on June 30, the new deadline, Bechtel offered its new plans. Bechtel hadn't solved every problem, but the company said it had a path forward, and that's all DOE required.

The next day, Tamosaitis pointed out important issues remained. One day later, Tamosaitis said, he was told to return his badge and phone and was escorted off site and told to report for work in the basement of another building. He said it is a "do-nothing" job.

Weeks later a review by university scientists said Bechtel's lack of massive full-scale tests was risky. The Defense Nuclear Facilities Safety Board, a federal panel appointed by the White House, agreed. In October, a scientist representing the board said Bechtel was "moving construction forward with significant technological risk and uncertainty."



STEVE RINGMAN / THE SEATTLE TIMES

A 406-foot-long canyonlike building at Hanford is under construction, to be filled with equipment to turn nuclear waste into glass.

Energy Department officials, another team of scientists and plant contractors disagreed. But "we recognize there is room for questions," said Delmar Noyes, DOE's deputy plant manager, in an interview. The DOE and Bechtel have agreed to conduct new tests.

Just before Christmas, the safety board outlined precisely how it hopes those tests will go because others "have been insufficient." The board reiterated its fear of explosions and chain reactions.

Those large-scale tests may take two years.

Meanwhile, plant construction will continue.

Information from: The Seattle Times,
<http://www.seattletimes.com>