Episode Book

EPISODE #5798

Project Sundial: Teller's 10-Gigaton Doomsday Proposal

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SYNOPSIS

In July 1954, Edward Teller walked into a meeting of the Atomic Energy Commission's General Advisory Committee and proposed the largest weapon ever conceived: Sundial, a 10,000-megaton bomb fused by a 1,000-megaton primary called Gnomon. Isidor Rabi called it an advertising stunt. Livermore kept working on it anyway, planning a prototype test during Operation Redwing in 1956 that never happened. This episode digs into what Sundial actually was, why the staged Teller-Ulam design put no theoretical ceiling on yield, and why blast physics — which scales with the cube root of yield — made every step up the ladder a worse deal than the last. Featuring Fermi's verdict on Teller, a Los Alamos blackboard that listed "Backyard" as a delivery method, and the Mark 41, the largest weapon the US ever actually fielded.

TRANSCRIPT



Corn

Ten gigatons. One weapon. Two hundred times the Tsar Bomba, six hundred and sixty-six thousand times Hiroshima. It never existed, it was never built, and it was proposed by Edward Teller at a secret meeting in July of nineteen fifty-four.



Herman

And Daniel's back.



Corn

Daniel's back. He wants part two of the nuclear story. The Soviet bomb was the spectacle, this is the American one. He's asking what Project Sundial actually was, whether it was a real engineering proposal or a thought experiment, what detonating ten gigatons would actually do, and why nobody ever built it.



Herman

He also wants the anecdotes. He said so.



Corn

He wants the anecdotes. The personalities, the proposals seriously entertained, the reactions from the people in the room. That's the part he's actually after, underneath the three questions.



Herman

Three big ones.



Corn

So here's the thing that pulled me in first. The man who called it an advertising stunt was Rabi, and Rabi is not a crank. And yet Livermore kept working on it for years afterward. So let's start with the most basic question, which is what this actually was, and who was doing



Corn (continued)

the proposing.



Herman

Edward Teller proposed it at the July nineteen fifty-four meeting of the General Advisory Committee of the Atomic Energy Commission. That's the setting. And what he proposed wasn't one bomb. It was two linked designs.



Corn

Two.



Herman

Gnomon at one thousand megatons, and Sundial at ten thousand. Gnomon was the primary. Gnomon was going to set off Sundial.



Corn

The fuse has a name.



Herman

The fuse is a thousand megatons. That's the part people skate past. A thousand megatons is twenty times Tsar Bomba, and in Teller's framing that was the detonator. His line to the committee was about the possibility of much bigger bangs. He described Castle Bravo at fifteen megatons as child's play.



Corn

Fifteen megatons. Child's play. You can hear the room.



Herman

You can hear the room, and we actually have the room. The minutes record Whitman saying he had been shocked by the thought of a ten thousand megaton weapon, and that it would contaminate the earth. Rabi called it an advertising stunt, not to be taken too seriously.



Corn

And Teller's timing here matters, doesn't it. This isn't a man at the height of his institutional standing.



Herman

No. Wellerstein's reading is that Teller was feeling somewhat wounded at that point. Livermore's one hydrogen bomb design at Castle had been a dud, and the Commission had cancelled another of his designs. So he came into the meeting and raised the ante. Tried to be the bold idea man again.



Corn

Which is a real diagnosis of a real person, and it's also the least flattering possible reason to propose a ten gigaton weapon. You've just lost two bets, so you double them.



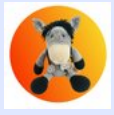
Herman

I don't think it's quite that cynical. But it's close enough that you have to say it out loud.



Corn

Fermi said it better than either of us could. In my acquaintance, you are the only monomaniac with several manias.



Herman

That's a generous insult. It's affectionate and it's a diagnosis at the same time.



Corn

But here's where it gets interesting. Rabi dismissed it as a stunt, and Livermore kept working on Gnomon for several years. They planned a prototype test during Operation Redwing in nineteen fifty-six. It never happened. So was this a serious proposal or not?



Herman

Both, and the answer to which one depends on whose seriousness you're measuring. Teller's seriousness, or the laboratory's.



Corn

Start with Teller's.



Herman

Wellerstein asked a scientist who knew Teller well whether he was actually serious about the ten thousand megaton bomb. The answer was, I don't doubt that Teller was serious about it. Until the next enthusiasm took over. That's the whole man in one sentence. He was serious while he was serious, and then the next idea arrived.



Corn

You've been sitting on that line since the research.



Herman

I have. I think it's the most Teller sentence anyone ever produced. But I want to be fair to him, because there's a reading where he's just flighty, and I don't think that's right either. He was serious about it in the way he was serious about everything, which is completely, until he wasn't.



Corn

Fine. But seriousness of intent is one question, and the laboratory continuing to work on it is a different and harder one. A man can be enthusiastic in a meeting. A laboratory doesn't keep a program alive for years because one guy had a good afternoon.



Herman

No. And that's where the technical case actually holds up. The Teller-Ulam staged design lets you link bombs to bombs to bombs. That's the actual principle. Wheeler called the configuration the sausage model. Ted Taylor said it was clear you could have an infinite number of sub-bombs.



Corn

Infinite.



Herman

Infinite in principle. The standard reference work is explicit that there is no theoretical limit to the number of stages and no theoretical limit to the size and yield of a thermonuclear weapon. The limit is practical. It's weight, it's size, it's whether you can deliver the thing.



Corn

So the physics doesn't stop you.



Herman

The physics doesn't stop you. That's the crucial point. Sundial was not blocked by any law of nature. It was blocked by everything downstream of the physics.



Corn

Which means the interesting question isn't whether it was possible. It's why anyone thought it was worth doing.



Herman

And on that, most of the documentation is still classified. Teller's actual testimony from that meeting, the design details, that's largely not available. So the multi-stage structure people describe is inference. Kurzgesagt's researchers worked it out with Wellerstein reviewing, and they concluded it would have been a five-stage device. Three stages for a



Herman (continued)

hundred megatons, a fourth for Gnomon at a thousand, a fifth for Sundial at ten thousand.



Corn

Inference.



Herman

Inference. Nobody has found a standalone declassified Sundial design document. I want to be careful about that, because it's easy to talk about this thing as if somebody has the blueprints in a drawer.



Corn

Nobody has the blueprints in a drawer. Okay. So Gnomon is the piece that got closest to existing. Where did it end?



Herman

It was planned as a prototype test in Redwing, nineteen fifty-six, and it never took place. That's as far as it got. But Gnomon wasn't the only American superweapon concept floating around. There's a third one, TAV, in the Los Alamos discussions in fifty-four. Carson Mark, who ran the theoretical division there, said he saw no reason why the two-stage approach couldn't be extrapolated to yields in the gigaton range, and described the result as being the size of a submarine.



Corn

The size of a submarine. That's the moment where the engineering stops being engineering and starts being set dressing.



Herman

It's the size of a submarine, and you have to deliver it to a target.



Corn

To another country.



Herman

And that problem, as we'll get into, is where the whole thing collapses. But before that, the Americans did build toward the big end. There was a sixty megaton bomb pushed by Strategic Air Command in the late fifties. General Thomas Power made it SAC's top priority in fifty-seven.



Corn

Sixty megatons. That's not Sundial, but it's more than Tsar Bomba.



Herman

It's more than Tsar Bomba as designed. Livermore offered SAC two options, a twenty-five thousand pound sixty megaton bomb and a twenty-two thousand pound forty-five megaton bomb, and they offered them without testing them. And then the test got cancelled, and we'll come to why.



Corn

So what did they actually field.



Herman

The Mark 41. That was the largest weapon the United States ever fielded. About twenty-five megatons, depending on which document you read. It's the only three-stage weapon the US ever put into service, and it was never tested at full strength.



Corn

The high water mark is twenty-five megatons. Everything above that stayed a proposal.



Herman

Everything above that stayed on paper or on a blackboard.



Corn

Tell them about the blackboard.



Herman

Robert Serber recalled a blackboard at Los Alamos that listed hypothetical weapons, with yields and delivery methods. The largest one on the list had its delivery method written down as Backyard.



Corn

Backyard.



Herman

Because that particular design would probably kill everyone on Earth, so there was no use carting it anywhere. You might as well set it off in the yard.



Corn

That's the funniest thing anyone has ever written about a doomsday weapon, and it was written on a wall.



Herman

It was written on a wall, and it's the period in one line. These were people who understood exactly what they were pricing out and made jokes about it anyway, because the alternative was to sit with it.



Corn

I want to circle back to something you said, because I don't think we've actually answered Daniel's question yet. He asked whether Sundial was a credible engineering proposal, an exercise in theoretical physics, or a thought experiment. You've given me the chemistry for two of those, and you haven't picked one.



Herman

I don't think you can. The line between them in that period was blurrier than the vocabulary suggests. Livermore would work out a design far enough to know whether it was possible, without any intention of building it, because knowing whether something is possible was the point of the lab. So you get a document that looks like a proposal and functions like a feasibility study.



Corn

But the Redwing test isn't a feasibility study. You don't schedule a detonation to find out whether something is possible if you don't actually intend to detonate it.



Herman

No, you don't. That's the part that tilts it. Scheduling a test means somebody was treating it as a real object with a real date attached.



Corn

Then it was serious.



Herman

It was serious for a while, and for some people, and not for the people with the authority to fund it. That's the honest answer. Rabi could dismiss it because Rabi was never going to have to build it.



Corn

Which raises a question I don't think gets asked enough. The committee is shocked, and one of them calls it an advertising stunt. And the proposal dies, eventually. But who actually killed it. Was it a decision, or was it just weather.



Herman

It was weather, mostly. And this is the part I find interesting, because it's not a story about a wise committee stopping a madman. It's a story about the technical case being weak and the political case collapsing underneath it at the same time.



Corn

Take them in order.



Herman

Take the technical one first, because it's counterintuitive and it's the actual answer to Daniel's third question. Blast effects don't scale with yield. They scale with the cube root of yield.



Corn

Say that again, because it does something strange to the intuition.



Herman

A ten megaton bomb does medium damage out to about nine miles. A hundred megaton bomb does medium damage out to about twenty miles. Ten times the yield, a little more than twice the radius.



Corn

That's an appalling exchange rate.



Herman

It's an appalling exchange rate. And weight scales roughly linearly with yield. So a bomb ten times as powerful weighs about ten times as much, and destroys a little more than twice as much area.



Corn

So every step up the ladder is a worse deal than the one before it.



Herman

Every step up the ladder is a worse deal. Which means the rational move is never one big weapon. It's ten smaller ones, delivered separately, on ten targets you actually care about. Ten gigatons in one package is the least efficient way to deliver ten gigatons of destruction that anyone has ever devised.



Corn

And yet they proposed it.



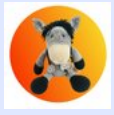
Herman

And yet they proposed it, which tells you the proposal wasn't really about destruction. It was about magnitude. It was about being able to say the number out loud.



Corn

That's a hell of a thing to say, that the biggest weapon ever seriously proposed was proposed for rhetorical reasons.



Herman

I'm not sure that's quite it, but I think it's closer than anything about military utility.



Corn

So take the effects seriously for a moment, because Daniel asked. What does ten gigatons actually do.



Herman

Wellerstein says it's hard to convey the damage of a gigaton bomb because at those yields traditional scaling laws stop working. The bomb essentially blows a hole in the atmosphere.



Corn

A hole in the atmosphere.



Herman

There's a nineteen sixty-three study that looked at a ten thousand megaton weapon detonated about twenty-eight miles up. That altitude matters, because a high airburst spreads the thermal pulse over a much wider area than a surface burst. The study concluded it could set fires across a circle roughly five hundred miles in diameter.



Corn

Which is about the size of France.



Herman

About the size of France. And Wellerstein's own version of it is that a ten thousand megaton weapon would be powerful enough to set all of New England on fire. Or most of California. Or all of the UK and Ireland. Or all of France, or all of Germany, or both Koreas.



Corn

He's giving you the menu because no single comparison does it.



Herman

No single comparison does it, so he keeps going until one of them lands.



Corn

Here's where I want to be careful, because Wikipedia has claims about Sundial that I don't think we can use. A fireball thirty miles across, everything within two hundred and fifty miles ignited instantly, a magnitude nine earthquake, apocalyptic nuclear winter.



Herman

That claim is flagged as needing a citation. It's not sourced to anything I can find.



Corn

So we say that. That's the one the internet repeats, and it's the one nobody can source.



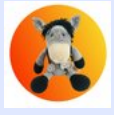
Herman

Right. And I'd rather be the show that says it's unsourced than the show that repeats it because it sounds good.



Corn

Fine. Then the fallout is the part that's actually documented.



Herman

Fallout is the part that's actually documented, and it's the part that killed the whole category. Sakharov calculated that even for clean nuclear weapons, you'd get about six thousand six hundred premature deaths per megaton, spread over eight thousand years, from carbon fourteen activation. A hundred megaton test works out to roughly six hundred and sixty thousand deaths.



Corn

Over eight thousand years.



Herman

They're not deaths you can point at. They're a number you carry.



Corn

And that's the clean version.



Herman

That's the clean version. The dirty version is enormously worse, and everyone in that room knew it.



Corn

Then there's the atmospheric side, the nuclear winter question.



Herman

Which is a different beast, and I want to separate it. Nuclear winter is about a full exchange, hundreds or thousands of detonations, soot lofted into the stratosphere blocking sunlight. The framework came out of Turco, Toon, Ackerman, Pollack and Sagan in Science in nineteen eighty-three. Robock and colleagues revisited it with modern models in two thousand seven, and Toon and colleagues again in twenty nineteen, where a US-Russia war could put on the order of a hundred and fifty teragrams of soot into the stratosphere.

Corn

A hundred and fifty teragrams.



Herman

That's the full exchange number. One weapon is not that. One weapon is not that.



Corn

So this is the piece of Daniel's question where the honest answer is that the number is doing the wrong work. One ten gigaton detonation would be catastrophic on a continental scale. It would not be a species-level event.



Herman

And I know you said the phrase, so I'll say it too. Threatening civilization is defensible as a description. Ending civilization is not.



Corn

Give me the distinction plainly, because I think it's the most useful thing we'll say all episode.



Herman

The immediate blast destroys a France-sized region. The thermal pulse starts fires across a continental area. The fallout contaminates global agriculture for years, and the carbon fourteen burden persists for millennia. What you've destroyed is a country and a century of its habitability. What you have not destroyed is the human species, and the people who wrote these proposals knew the difference.



Corn

They knew the difference between killing a country and killing the world.



Herman

They knew the difference. They just thought the first one was worth having.



Corn

Which brings us to why it never happened, and I want to start with the thing that actually changed the politics, because it wasn't the physics.



Herman

It wasn't the physics. It was Castle Bravo.



Corn

Walk them through it, because this is the piece I think is underrated.



Herman

Castle Bravo was March first, nineteen fifty-four, fifteen megatons. It was the largest American test ever, about a thousand times Hiroshima. And it was three times larger than the six megatons the people running it had predicted.



Corn

Three times.



Herman

And the fallout went places it was not supposed to go. A Japanese fishing vessel, the Lucky Dragon, was downwind of it, and the crew was sickened, and one of them died.



Corn

That's the moment.



Herman

That's the moment the politics turn. Not because of a memo. Because there were fishermen.



Corn

So the fallout from one accidental overrun did more to stop the superweapon than any analysis ever did.



Herman

By a distance. Eisenhower capped total megatonnage for the nineteen fifty-eight Hardtack series at fifteen megatons, total, for the whole series, which killed SAC's sixty megaton test dead. That's the practical end of it.



Corn

So the sixty megaton bomb dies because of a test that overshot four years earlier.



Herman

That's the causal chain, yes.



Corn

Then there's the moral argument, and I want to get the tone right here, because it's easy to be cynical about it and I don't think cynicism is quite right.



Herman

In nineteen fifty-seven, an AEC commissioner named Thomas Murray appealed to Eisenhower directly, asking whether weapons of that scale were consistent with moral law with regard to the moderate and discriminate use of force in warfare. That's the actual question he put to the President.



Corn

And the study that came back.



Herman

A Pentagon and AEC study concluded it was not appropriate to develop, largely because of expected adverse publicity. But the same study also concluded that the moral aspects of using large weapons do not differ from the use of any weapon with mass destruction potential.



Corn

So the reasoning is, we're not going to build it because of how it looks.



Herman

The stated reason for not building it was how it looks. And the moral reasoning, where they actually engaged with it, was that a big bomb isn't morally different from a small bomb. Once you accept mass destruction as a category, size stops being the question.



Corn

Which is arguably the most honest thing anyone wrote in the whole decade.



Herman

I think it might be.



Corn

And then the treaties close the door.



Herman

The nineteen fifty-eight test moratorium, and then the Limited Test Ban Treaty in nineteen sixty-three, which banned atmospheric testing. Once you can't test in the atmosphere, you can't test a ten gigaton weapon. There's nowhere to do it.



Corn

You literally cannot do it in a hole.



Herman

You cannot do it in a hole.



Corn

So the door closes for three separate reasons at once. The physics said it was a bad deal, the fallout politics said it was toxic, and the treaty made it untestable.



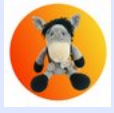
Herman

And underneath all three, there's a fourth thing, which is that the strategic establishment had already decided. Norris Bradbury, who ran Los Alamos, argued in fifty-four that the strategic end of the scale was pretty much fleshed out and all the diversification should happen at the lower end. Tactical weapons. Smaller, more precise, more numerous.



Corn

In fifty-four. The same year as the proposal.



Herman

The same year. So the counterargument was already on the record when Teller stood up.



Corn

Which means Sundial wasn't just ahead of its time. It was behind it.



Herman

And Teller himself moved in that direction too, eventually. He pushed for small bombs, things that would fit on submarine launched missiles.



Corn

The father of the hydrogen bomb ends up arguing for warheads that fit on a submarine.



Herman

The father of the hydrogen bomb ends up arguing for warheads sized to a delivery system. Which is the whole shift in one sentence. The yield stops being the point. The delivery becomes the point.



Corn

And the Mark 41 was the high water mark. Twenty-five megatons. After that, the largest thing in the American arsenal is about nine megatons. The W-53.



Herman

About nine. And that's it. Nobody went bigger.



Corn

Except they kept talking about it, which is the part I can't let go. Even after the Tsar Bomba, when the White House was calling the Soviet bomb pointless terrorism, Seaborg was briefing Kennedy in October of sixty-one on what it would take to build a hundred megaton American bomb.



Herman

Thirty thousand pounds, six feet in diameter, twelve feet long, possible in six to twelve months at the highest priority.



Corn

Six to twelve months.



Herman

That's the timeline he gave the President.



Corn

So the public position is that the Soviet bomb is pointless, and the private position is a memo with a delivery date.



Herman

And Livermore was re-evaluating weapons in the fifty to one thousand megaton range at the same time. There was an Air Force Council decision in fifty-nine to postpone establishing a position on hundred to thousand megaton weapons, and the conclusion was that a thousand megaton weapon might be feasible but not desirable.



Corn

Feasible but not desirable. That's a bureaucracy declining to have an opinion in the most expensive possible way.



Herman

And Khrushchev's version of the same thing is better than anything we'll come up with. He said, let the hundred megaton bomb hang over the capitalists like a sword of Damocles. And then in the same breath, he said they weren't going to explode it, because even if you set it off in the remotest place on earth, you're likely to break your own windows.



Corn

He built the ultimate deterrent and immediately explained why it was unusable.



Herman

In the same interview. It's the whole category in two sentences.



Corn

So the last piece is the institutional one. Why did anyone keep proposing these things when every argument against them was already on the table.



Herman

A Sandia scientist in sixty-two described it better than I can. He said the Soviet test started thinking in this country that there must be a good application for these things that had escaped our attention. And that the military would like to see the development of a few very high yield bombs, and would even feel good if a few were in the stockpile, even though no known targets justify such weapons. That's the sentence. That's the whole phenomenon. It's not a strategic argument. It's a feeling. It would feel good to have them.



Corn

That's the arms race reduced to a mood.



Herman

And I don't think it ever went away. It just stopped being about yield.



Corn

So we've established that Sundial was a real proposal that was never going to be built, and that the reason it was never going to be built has almost nothing to do with whether it was possible. But what would it actually do if you detonated it? And why didn't America build it?



Hilbert

Ten thousand two hundred.



Hilbert

Ten thousand two hundred megatons. The number in the committee minutes is ten thousand two hundred. You've both been saying ten thousand.



Herman

The minutes do say ten thousand two hundred.



Hilbert

They do. And I looked at the file the way the file should be looked at, which is that it's ten thousand two hundred and Rabi's dismissal is on the same page, which is the funniest thing in the archive. A man calls it an advertising stunt three lines under the exact figure.



Corn

You've read the file.



Hilbert

I've seen the file. I wasn't supposed to see the file. I was filing.



Corn

You were filing.



Hilbert

I was filing. That's a long story about a job I don't want to get into. But the thing I actually wanted to say is that you both attributed the Backyard line to Serber's blackboard, and you're right, and you buried it.



Herman

Buried what?



Hilbert

Backyard was a real entry. It wasn't just a joke on a wall. That line got into a formal filing. Somebody had to sign the bottom of the page that said Backyard next to a delivery method. That's the story. That's the whole story.



Corn

How do you know it was a formal filing and not the wall.



Hilbert

Because I've seen it. It's one page. It's a page I've seen with my own eyes. I took a photo of it.



Herman

You took a photo of a classified document.



Hilbert

I took a photo of it with a flip phone, which was the mistake, because the photo is unreadable. You can see the shape of the page. You can see where the words are. You can't read any of the words. So I've been carrying around a memory of a page for, what, thirty years now, and I know what it says and I can't prove it.



Corn

And you're certain it said Backyard.



Hilbert

I'm certain it said Backyard. I'm not certain about anything else on it. I'm certain about Backyard.



Herman

Do you still have the phone?



Hilbert

I still have the phone. That's not the problem. The problem is the photo.



Corn

So a government document somewhere has a delivery method listed as Backyard, and the only proof is a blurry photo on a flip phone that no longer displays anything.



Hilbert

And I think it's funnier than the blackboard. The blackboard is a joke between physicists. The filing is a joke that went through the mailroom.



Herman

The joke went through a bureaucracy.



Hilbert

The joke went through a bureaucracy, and somebody typed it, and somebody else read it and didn't stop it. That's the part you both missed.



Corn

You've been sitting on this for the entire episode.



Hilbert

I've been sitting on it for thirty years. The episode was just the excuse.



Herman

So you agree with the analysis, you just think we put the punchline in the wrong place.



Hilbert

I agree with all of it. I agree he was serious. I agree it was a bad deal. I just think the funniest thing in the whole thing isn't the number. It's the form.



Corn

The form.



Hilbert

You've got a piece of paper with the end of the world written on it in the same handwriting as a supply requisition.



Corn

That's the thing that actually happened, and we put it in the middle of the episode as an anecdote.



Hilbert

You put it in the middle as an anecdote. It's the headline.



Herman

It's a better closer than anything we had.



Hilbert

It is. And the second-best thing in the archive is that nobody ever went back and changed it. It just sat there.



Corn

Well, whether or not that document exists, the story of Sundial raises some bigger questions about the Cold War and the logic of the arms race.



Herman

It does. And I want to land on something that a Sandia scientist wrote in sixty-two, about the military wanting a few very high yield bombs in the stockpile even though no known targets justified them. Because that's the honest ending. No known targets. And they still wanted them.



Corn

That's the whole thing, isn't it. The physics argued against it, the fallout made it politically impossible, the treaty made it untestable, and the reason anyone kept proposing it anyway is that a very large number is satisfying in a way that a correct one isn't.



Herman

The scaling argument is the part I keep coming back to. Blast radius goes as the cube root of yield, weight goes as the yield. Every step up the ladder is worse than the one below it. The physics itself was the strongest argument against ever building the thing, and it lost for years to people who wanted the number on a page.



Corn

Then there's the cutting room floor, and I've got one. The Castle Bravo crater. Ivy Mike, which was the actual first thermonuclear test in fifty-two, left a crater two hundred feet deep and a mile across, and it took out an entire island. Elugelab is just gone. It's not on the map anymore, because a bomb removed it.



Herman

Which is the only time in history that's happened.



Corn

As far as I know. One test, one island, no longer a feature of the earth.



Herman

I'll take that as the closer.



Corn

Thanks to producer Hilbert Flumingtop. This has been My Weird Prompts, the human-AI collaboration podcast. If you enjoyed this one, leave us a review and subscribe.



Herman

We'll be back soon with another weird prompt.

SOURCES

What the research for this episode read before the script was written. Primary sources first.

1. **Wikipedia, Sundial (weapon)**
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