Environmental Defense Institute

News on Environmental Health and Safety Issues

May 2023 **Volume 34** **Number 5**

Idaho Cleanup Project has over 10,000 transuranic waste drums, unknown number at risk of deflagration

Currently, while the Department of Energy is emphasizing the end of transuranic waste drum storage at the Radioactive Waste Management Complex at the Idaho National Laboratory, the Defense Nuclear Facilities Safety Board has pointed out that the need for addressing drums that exceed head space gas limits will still require facilities to address the problem. [1]

At least 10,000 waste drums stored at the Idaho Cleanup Project have not been tested for flammable gas levels in the drums. Flammable gases in the waste drums can be generated from radiolysis, chemical reactions and evaporation of absorbed liquids. If the concentration of flammable gases within the headspace of the waste drum reaches the flammable range, then an ignition source could lead to a deflagration that releases radiological material from the drum.

The waste drums are not sampled for gas contents until ready for shipping to the Waste Isolation Pilot Plant (WIPP) in New Mexico. This means that the level of gas buildup (hydrogen or methane) and the risk of deflagration is untested and unknown in most of the 10,000 waste drums awaiting shipment to WIPP.

Drums that have excessive flammable gas levels cannot be shipped to WIPP or any place else. And there is no effective plan for what to do with the problem drums that would remain in Idaho. Waiting for gas levels to decline and/or repackaging the waste has not proven effective in lowering the gas concentrations.

In addition, the DOE has stated that they do not have adequate information for the contents of the 10,000 waste drums in order to prioritize which drums might be of higher risk of non-conforming gas buildup. The State of Idaho Department of Environmental Quality, via its hazardous waste program, has embraced the lack of knowledge of INL waste drum contents even though a deflagration of a single drum poses a very dangerous accident and an event that may not be remediated.

Drums are often kept in fabric enclosures or in no enclosure at all, open to the environment. Neither the Department of Energy nor the Idaho Department of Environmental Quality are protecting workers, the public or the environment.

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[1] Defense Nuclear Facilities Safety Board, Letter to Secretary of Energy Jennifer M. Granholm, Department of Energy, February 24, 2023. With transmittal of Staff Report *Flammable Gas Hazards in Idaho National Laboratory's Nuclear Waste Drums*, dated September 28, 2022.

Importantly, the Department of Energy's safety basis for the transuranic waste drums has used flawed assumptions that greatly underestimate the potential radiological doses to workers and the public. The radiation doses may be well over 100 times higher than estimated in currently approved safety basis documents and would require additional safety controls. The safety analysis ignores permanent contamination of the environment from the long-lived radionuclides.

Revised safety analyses using the newer DOE Standard 5506-2021 [2] would likely increase the release fraction assumed, and increase the radiation doses to workers and the public. The Idaho Cleanup Project has no plan to update RWMC and related safety analyses for waste drums to the recent 5506-2021 standard or the develop needed safety controls.

Furthermore, DNFSB staff observed the current contractor, the Idaho Environmental Coalition, for the Idaho Cleanup Project, in January. The contractor would go through the motions of visual drum inspection, notice waste drums that failed visual inspection criteria for drum integrity, yet not label or identify the drums with integrity issues and then simply discard the inspection record whenever a drum fails an inspection. [3]

Idaho Cleanup Project Citizens Advisory Board Meeting announces IWTU is running with 10 percent radioactive waste

An Idaho Cleanup Project Citizens Advisory Board Meeting was held April 27 in Idaho Falls. [4] The big accomplishment was that after more than a decade of redesign and testing, the Integrated Waste Treatment Unit (IWTU) started treating radioactive liquid of 10 percent and 90 percent simulant on April 11. The transfer of spent nuclear fuel from wet storage to dry storage has been completed. Planning regarding the treatment (or not) of the dry powdery and soluble high level waste called "calcine" is in progress. A public comment period regarding the calcine will be issued in June or July. I gave public comment at the April 27 ICP CAB meeting. [5]

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[2] Department of Energy, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, DOE Standard 5506-2021, 2021.

[3] Defense Nuclear Facilities Safety Board, Idaho National Laboratory (INL) Report for February 2023, "Field Observations Related to Waste Processing at AMWTP," at dnfsb.gov

[4] The Department of Energy's Office of Environmental Management, Idaho Cleanup Project Citizens Advisory Board website is at https://www.energy.gov/em/icpcab/idaho-cleanup-project-citizens-advisory-board-icp-cab

[5] The Department of Energy's Office of Environmental Management, Idaho Cleanup Project Citizens Advisory Board website has not been proving meeting minutes nor have my past question submittals been responded to. My comments to the ICP CAB meeting on April 27, 2023 discussed concern over the change to the Idaho CERCLA disposal facility (IDCF) change to include contaminated soil as part of the soil cap; the exchange of aquifer deep well injection and percolation ponds in favor of lined evaporation ponds that assure that all radionuclides are released to the Idaho skies; the lack of a disposal site for the treated sodium-bearing waste, despite decades of DOE hoping WIPP would accept the waste and that DOE's plans to now put surplus plutonium in WIPP further overburdens WIPP; the lack of explanation over the reason for shipping far fewer transuranic waste shipments to WIPP and the several returned shipments back to Idaho and the problem of the now recognized (since about 2020) increase in the failure frequency of the Mackay Dam means that it cannot be excluded from hazardous waste (RCRA) permitting and a Mackay Dam failure can flood several facilities including INTEC. Why hasn't the state of Idaho addressed this? I have gotten no response from DOE regarding

Integrated Waste Treatment Unit (IWTU)

After more than a decade of redesign and testing, the Integrated Waste Treatment Unit (IWTU) started treating radioactive liquid of 10 percent and 90 percent simulant in April. Construction started on the IWTU in 2007. It has been a $6.4 billion project so far, according to *The Idaho Falls Post Register*. [6] The IWTU was originally expected to cost about $500 million to build and treat the waste.

The plan is to next run a 50/50 blend of radioactive liquid and non-radioactive simulant. After that, they would go to 100 percent radioactive liquid and also conduct air emissions testing. However, it has never been clear if any or adequate radiological monitoring will be performed.

Eighteen large canisters were filled so far. These canister are tall, perhaps three times the height of a 55-gallon waste drum. It is unclear how radioactive the canisters will be; however, it appears that these would not be contact handled canisters.

Prior to April 11, the Defense Nuclear Facilities Safety Board monthly report for February described several new problems with the simulant runs for the Integrated Waste Treatment Unit. [7] In addition to the leak of dry material found last December in a canister filling cell, a new leak was found inside a Process Cell, thought to be liquid simulant material. There was also recently a material clog in the Carbon Reduction Reformer Additive Feed Line, possibly of the powdered coal.

Inspection and repair of the IWTU will be infinitely more difficult after radioactive material is introduced into the facility. The work may entail harmful radiological exposures to workers. The monitoring of external radiation exposure and of inhaled particles has not been particularly reliable at Department of Energy facilities, even in recent years.

This accomplishment will now allow the Department of Energy to import more spent nuclear fuel to the Idaho National Laboratory for research. The milestone for completing the treatment of the 900,000 gallons of sodium bearing liquid high level waste was 2012, over a decade ago. The liquid waste was generated during decontamination activities from spent nuclear fuel reprocessing at the Idaho Nuclear Technology and Engineering Center (INTEC) that ended by 1992. The Department of Energy does not say how much newly generated waste has been added. The sodium bearing waste remains classified as “high level waste” despite DOE often asserting that the waste really ought to be “low level waste” that qualifies as Defense-related transuranic waste.

It is expected that the IWTU will ramp up to higher radioactive material and with intermittent operations between equipment repairs, will take 5 years to process the radioactive liquid sodium

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what it has known from the McMillan-Jacobs reports since 2020 and therefore its RCRA permit flood analyses excluding the Mackay Dam failure is inadequate.

[6] Tibby Plasse, The Idaho Falls Post Register, “IWTU starts radioactive liquid waste conversion process,” April 18, 2023.

[7] Defense Nuclear Facilities Safety Board, Idaho National Laboratory (INL) Report for February 2023, “Leak Develops within Integrated Waste Treatment Unit (IWTU) Process Cell, at dnfsb.gov

bearing high level waste. Actual air emissions have yet to be fully tested and evaluated. The IWTU burns pulverized coal and may also release radioactive and chemical emissions.

There is no slated disposal site for the treated sodium bearing waste. The Department of Energy has increased the slated number of these large canisters, far larger than a 55-gallon drum, from 700 to at least 1200 canisters. Since the 1990s, the Department of Energy has been hoping the Waste Isolation Pilot Plant (WIPP) would accept this waste. And the hope continues, despite any progress in getting WIPP to accept this waste. The Department of Energy's pursuit of WIPP for disposal of large amounts of surplus weapons plutonium will complicate the breaching of commitments to New Mexico (read more about the DOE's National Nuclear Security Administration (NNSA) surplus plutonium plans in the February 2023 EDI newsletter).

Idaho CERCLA Disposal Facility Expansion

Non-CERCLA waste is now destined for the Idaho CERLCA Disposal Facility but this only touches the surface of needed decommissioning disposal facilities that will be needed at the Idaho National Laboratory (INL). Future non-CERCLA waste from existing and planned nuclear facilities are not being planned for. The soil cap is to now use contaminated soil below the top layer of clean soil. This reminds me of the many weeks of moving contaminated soil at the Idaho National Laboratory's Advanced Test Reactor Complex, and Test Area North. The heavy equipment moving the soil contributed to very high airborne radiological contamination, blowing far and wide — and deliberately not acknowledged as doing so.

High Level Radioactive Calcine Waste

The powdery calcine radioactive high-level waste resulting from spent nuclear fuel reprocessing and unsafely stored above the Snake River Plain Aquifer was documented in a NEPA decision, that was an Idaho Settlement Agreement milestone, to be treated by "hot isostatic processing." At the last CAB meeting, vitrification was discussed. Vitrification can involve airborne radiological emissions and not necessarily prevent the migration of radionuclides. It should be noted that for many years, the DOE claimed that they were going to study disposal of the calcine in deep bore holes in North or South Dakota. Neither state wanted this research to be conducted. Such drilling destabilizes the ground and would increase the likelihood of earthquakes. The highly soluble calcine was never a good waste form for a repository such as Yucca Mountain, either.

Treatment of Sodium Bonded EBR II Fuel or HALEU

The DOE Idaho Site Major Agreement Milestones map provided at the meeting listed several years of an item added in 2019 for the treatment of sodium bonded EBR II driver fuel pins. This work is conducted at the Materials and Fuels Complex and there are milestones for each year between 2022 through 2028. The is the treatment of the highly enriched (in uranium-235) EBR II fuel is typically referred to as the "high assay low enriched uranium" or HALEU project. This treatment is highly polluting of the Idaho skies and releases about 170 times what INL typically

releases. This project was slipped in without the public understanding the harm from the extensive radiological airborne polluting this will cause.

Idaho Environmental Coalition (IEC) Safety Performance

The ICP CAB meeting gave an abbreviated one page summary of safety status, listing the number of Department of Energy Occurrence Reports, 10 ORs for 2023 so far, for the cleanup project. It was so abbreviated, in fact, that it was curious. No description was included in the presentation and very few words were offered to summarize the Occurrence Reports.

It was stated that one of the Occurrence Reports was a violation issued by the State of Idaho Department of Environmental Quality. I had to learn on my own that this was for failure to perform scheduled radiological HEPA filter maintenance at the Advanced Mixed Waste Treatment Project and violated the INL Sitewide Permit with the state for hazardous waste.

Another Occurrence Report was due to detecting a large amount of radioactive contamination on a radiation worker's boot, in excess of 10 times the 10 CFR 835 amount, 10,500 disintegrations per minute (unidentified alpha) contamination.

Completely unmentioned was the dropping and damage of waste boxes when a forklift encountered uneven ground at INTEC. Also unmentioned was the Occurrence Report concerning errors that caused several workers to become nauseous and sickened due to improper carbon monoxide monitoring during demolition activities at NRF.

The downplaying of these occurrence reports indicates that Idaho Environmental Coalition does not understanding the meaning of transparency. It also signals that IEC may not be ready to take timely and appropriate corrective action.

Transuranic Waste Shipments to WIPP

Only 150 shipments of transuranic waste were shipped to WIPP last year, rather than the planned 257 shipments.

Last year, Idaho Environmental Coalition was very slow to take corrective actions after at least two transuranic waste shipments to WIPP were returned to Idaho.

WIPP also had to pause Idaho's shipments of transuranic waste. Two of the four CAB meetings scheduled for last year were abruptly cancelled and the waste shipment problems were never described during 2022 despite problems with WIPP shipments beginning before last year's April meeting. Now WIPP is requiring expensive drum overpacks for transuranic waste from Idaho. Less expensive soft-sided overpacks are being investigated. Also in 2022, the Environmental Protection Agency also issued permit violations to the Idaho Environmental Coalition, over the serious operational problems at the Advanced Mixed Waste Treatment Project. This violation was also not discussed at any CAB meeting despite occurring in January through March of 2022.

Los Alamos National Laboratory safety problems topic of meeting in Santa Fe with NNSA's Jill Hruby

A live meeting was held in Santa Fe, New Mexico on April 4 with the Department of Energy's National Nuclear Security Administration (NNSA) Director Jill Hruby.

The meeting was attended by about 200 people and was arranged in order to ask questions of NNSA Director Jill Hruby. Some of the attendees wore gas masks, which was either for the concern over radioactive emissions, or possibly of the risk of more gaslighting excuses from the NNSA over why glaring safety problems at the LANL were not being addressed.

The NNSA is cancelling needed safety upgrades at LANL, delaying needed safety analysis and hazard controls, and failing to address legacy radioactive waste at LANL all while greatly ramping up nuclear weapons pit production and on top of that, adding the work of surplus plutonium disposition at LANL to overfill the WIPP Defense waste facility, also in New Mexico. The consequence of a severe radiological release from LANL would be devastating to the public and communities near LANL and the NNSA is accepting far higher potential accident radiological releases than DOE regulations allow.

Read more in the Environmental Defense Institute newsletters for December 2022, January 2023 and February 2023 and also in my public comment on the draft Surplus Plutonium Disposition Program Environmental Impact Statement (DOE/EIS-0549).

NuScale continues redesign of facility, claims it is safe but refuses to discuss its risk assessment in safety review meeting

As part of U.S. Nuclear Regulatory Commission processes, reviews are conducted by a committee for the Advisory Committee on Reactor Safeguards (ACRS). The NuScale Subcommittee reviews look over NuScale documents and ask questions. When the clock runs out, the committee can be expected to rubber-stamp its approval no matter the unanswered questions or the lack of documented design features.

The exercise has highly educated people involved but there is no accountability for completeness of the ACRS review or follow-through on problem areas identified. Basically, the ACRS is toothless and their review should not be regarded as comprehensive.

Some of the ACRS discussions are open to the public and documented in publicly available transcripts. Portions of the meeting are deemed "proprietary" and are withheld from the public.

Discussions of the probabilistic risk assessment (PRA) for NuScale have been available in the publicly available transcripts. PRA consultants make statements like gravity would have to fail for fuel damage to occur. They emphasize how low the risk estimates are, that are based on assumptions about what the design will be like. Unique and untested equipment is assumed to operate well and without special aging or degradation concerns, based on wishful thinking. Design approval will be based on misplaced confidence that, somehow, the unique and never

before used equipment, such as the valves on the NuScale reactor modules, will not have reliability problems. Transcripts from one such meeting held May 14, 2019 are documented in ML19184A134 available at the NRC.gov ADAMS database.

In a recent meeting, even after it was pointed out that discussing the risk assessment was allowed in the public portion of the meeting, NuScale insisted on not answering any questions about its recent risk assessment updates except in the closed session. (See NRC.gov ADAMS ML23066A022, February 2023.)

Hydrogen release from zirconium-water reactor has prompted redesign of biological shielding for the NuScale modules. The light-water reactor fuel NuScale plans to use is susceptible to zirconium-water reaction, yet there is no large containment like Three Mile Island's containment that experienced hydrogen burn the afternoon of the TMI Unit 2 accident. The ability to contain melted, relocated core in a NuScale module is also a concern.

Fault tree modeling of the load handling equipment for NuScale was prepared without a design. This enabled the PRA consultants to predict a low risk of load drop without any information being available to the ACRS about the actual design, which may not exist. The lifts will routinely lift the reactor modules, each weighing over 700 tons. A NuScale reactor module that is not vertically oriented may fail its natural circulation scheme. The load handling safety is also affected by the building structure that holds the load handling equipment. Carefully selected analysts are coming up with favorable results for NuScale that are not or cannot be scrutinized.

It appears that no risk assessment has been prepared for the spent nuclear fuel pool, which is susceptible to a zirconium-water fire which may be able to release millions of curies. So, even though a single NuScale reactor module may be only 5 percent of the size of a large light-water nuclear reactor, the accumulated spent fuel in the pool will be for all 12 (or 6) reactor modules.

The heat exchangers for the NuScale design entail an arrangement never before used in any plant and may greatly increase the likelihood of a steam generator tube rupture that would release radionuclides to the environment. Steam generator tube ruptures can result in fuel melt in light-water reactors and the radionuclides are not held up inside containment but escape to the environment. The NuScale reactor module design has fewer pumps but it still have the same steam generator lines of feedwater makeup and turbine steam that are outside of containment, just like Three Mile Island Unit 2 or the San Onofre station. NuScale's makeup and letdown piping connected to the NuScale reactor module also lead outside of containment.

Because there is no place for the spent nuclear fuel to go, the spent nuclear fuel will be staying onsite indefinitely. Yet, there is no safety assessment of the long-term risks of dry storage and no accident consequence analysis for the dry canisters which each hold an enormous radionuclide inventory inside a ¼ inch thin-walled canister susceptible to chloride-induced stress corrosion cracking. A study of a variety of small modular reactors concluded that the spent fuel would exacerbate disposal problems and require far more space in a repository by factors of 2 to

30 compared to existing large reactors. [8] With existing and projected spent nuclear fuel from existing reactor, the U.S. already needs two deep geologic repositories the size designated for Yucca Mountain, but does not have even one repository. [9]

The NuScale safety review by the ACRS is incomplete, as is NuScale's touted very low risk based on assumptions and modeling in NuScale's probabilistic risk assessment. NuScale is adhering to a policy of not disclosing just how unsafe (and incomplete) its design is or how overly optimistic its risk assessment is.

Three Mile Island Unit 2: What most people don't know about the 1979 nuclear reactor meltdown (Part 1)

Revisiting the causes and consequences of the nuclear accident at Three Mile Island Unit 2 that began on March 28, 1979 highlights many surprising facts.

Most reports would repeat the conclusion that very little radioactive material was released from the TMI-2 accident, all based on very spotty radiation monitoring conducted by the electrical utility at fault for the accident. Most reports would repeat the refrain that worker radiation exposures had not exceeded regulatory limits. And many accounts would mainly blame the operators on shift for making mistakes that would cause the accident.

Three Mile Island Unit 2, Some Highlights of Problems that Led to the Accident

First, lets look at the TMI-2 accident. Much emphasis, and rightly so, has been placed on the stuck open pressure-operated relief valve (PORV) [10] and the failure of the operators to notice the PORV had not closed after relieving high pressure associated with the transient. The control room light indicated that the signal had been sent for the PORV to close. Yet, the PORV had not closed and primary coolant inventory was leaving via the open PORV to tanks inside containment.

Also emphasized was the focus of the operators on the pressurizer level and the mistaken belief that if the pressurizer had water in it, so did the reactor core.

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[8] Lindsay M. Krall, Allison M. Macfarlane, and Rodney C. Ewing, *PNAS*, "Nuclear waste from small modular reactors," Received June 26, 2021, Published May 31, 2022, https://doi.org/10.1073/pnas.2111833119.

[9] United States Government Accountability Office, Report to Congressional Requesters, COMMERCIAL NUCLEAR WASTE – Resuming Licensing of the Yucca Mountain Repository Would Require Rebuilding Capacity at DOE and NRC, Among Other Key Steps, GAO-17-340, April 2017. https://www.gao.gov/assets/690/684327.pdf This 2017 GAO report stated that "nearly 80,000 metric tons of spent nuclear fuel are being stored at 75 reactor sites in 33 states. The Nuclear Waste Policy Act of 1982 limited the amount of SNF/HLW in the first repository to 70,000 metric tons heavy metal of which commercial SNF is limited to 63,000 MT and DOE waste is limited to 7 MT. Commercial nuclear power plants in the U.S. produce roughly 2,000 MT per year.

[10] The pressure relief valve (PORV) is called by other names. It is called the electromatic relief valve (EMOV) in NUREG-0600 and other places for the Babcock and Wilcox design, but the industry often refers to the valve at the top of the pressurizer with the more general terminology of the PORV. This valve is actuated by a setpoint that is a lower pressure than the safety relief valves also at the top of the pressurizer that are to protect from a more serious overpressure.

It has been acknowledged that operator training at other B&W nuclear reactors regarding a stuck open PORV and the inadequacy of using the pressurizer level to ascertain reactor coolant level in the reactor vessel should have been but were not shared with TMI-2. Had previous experiences with other B&W reactors been fully understood, documented and shared, the TMI-2 accident would likely have been prevented.

Less emphasized is just how many upsets TMI-2 had experienced in its one year of operation prior to the accident. There had already been an event that closed all the valves to the condensate polishers. There had been events that actuated the high-pressure injection (HPI) flows when not needed and which required subsequent cleanup of chemical injection. There had been water in instrument air lines. And there was excessive primary coolant leakage in progress at the time of the TMI-2 accident that management had not wanted accurately disclosed or it would have required the plant to shutdown. There were a multitude of problems at TMI-2 involving the plant's design and very importantly, how shortcuts were being taken at the plant in order to save money.

It is rarely mentioned that the sudden closure of all of the valves to condensate polishers on the normal feedwater to the steam generators kicked off the TMI-2 accident involved a **known vulnerability.** It was known that loss of instrument air would suddenly close all of the valves to the polishers, knocking normal feedwater offline. And it is rarely mentioned that this sudden valve closure caused a serious pipe whip that could have killed or injured workers that morning.

The Technical Specifications for a nuclear reactor are those requirements deemed essential to safety and there can be penalties for violating Technical Specification requirements. It is rarely mentioned that the alignment of auxiliary feedwater pumps was required by Technical Specifications to be ready, should condensate feed be interrupted, nor that TMI management had changed procedures to allow auxiliary feedwater pumps to all be taken out of service during power operations. This violated the Technical Specifications. **TMI management had approved procedures that allowed closing all of the block valves from the auxiliary feedwater pumps during power operations despite this violating its Technical Specifications.**

Maintenance had been performed on the auxiliary feedwater pump system had been conducted just a few days prior to the accident. This maintenance had been conducted during power operation, and had involved closure of the block valves isolating auxiliary feedwater pumps. Lights on the control room panel had indicated the unsafe and closed position of the auxiliary feedwater pump valves. Yet, no one had noticed these lights among all the indicator lights on the control room panels.

TMI reactor operators appear to not have ensured the proper valve lineup at the beginning of the shift. TMI reactor operators did not document check-offs to assure proper valve lineup following the completion of maintenance. Personnel interviewed would state that the block valves had been returned to the proper open position following maintenance. But at TMI, no documentation was retained that the auxiliary pump valves had been properly opened after the maintenance was retained for this or any other maintenance. There is the possibility that

inadvertent operator action could have mispositioned the valves, but it seems likely that the valves had remained closed following the recent maintenance. **TMI did not keep records as to the checking of proper valve configuration following maintenance that was conducted during power operations, nor were beginning of shift plant configuration status conducted.**

The closed block valves on the auxiliary feedwater pump outlets prevented the flow of emergency feedwater to the steam generators. When the auxiliary feedwater pumps to the steam generators were needed and pronto the day of the accident, the auxiliary pumps started up as they were supposed to. But none of the operators noticed for several minutes, until the steam generators had boiled dry, that the block valves were closed, preventing the auxiliary feedwater pumps from supplying water to the steam generators.

It is rarely mentioned that boiling the steam generators dry was believed to have failed steam generator tubes in one of two of the reactor's steam generators, steam generator B. A steam generator tube rupture would allow radioactivity in the primary coolant system to leave containment via the steam generator turbine steam or feedwater lines. A steam generator tube rupture can be among the most serious radiological releases from a reactor accident. Why, I wonder, is this so rarely mentioned in reports about the TMI-2 accident?

The operators made mistakes the day of the accident. They could have determined that they were boiling the steam generators dry, earlier than they did. They could have determined that the PORV had not reclosed and was stuck open, earlier than they did. And they would have been better off leaving the HPI pumps both on, rather than shutting off one and throttling the other. However, they were following their training which had emphasized the need to throttle back HPI injection. Their training had wrongly emphasized reliance on the pressurizer to be assured that the reactor core was covered with coolant water, despite many months of time that the U.S. Nuclear Regulatory Commission knew this mindset was unsafe. Procedures did not cover what to do when the core was becoming uncovered (or no longer covered with primary coolant water) nor what to do when the primary coolant pumps could no longer operate due to cavitation from the high temperature primary coolant that was at a low pressure. [11] [12] [13]

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[11] U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, *Investigation into the March 28, 1979 Three Mile Island Accident by Office of Inspection and Enforcement*, NUREG-0600, Date Completed: July 1979, Published: August 1979. Findings of the investigation are signed by Victor Stello, Jr., 821 pages with many details not discussed elsewhere.

[12] Nuclear Regulatory Commission Special Inquiry Group, Mitchell Rogovin and George T. Frampton, Jr., *Three Mile Island – A Report to the Commissioners and to the Public*, NUREG/CR-1250V1, August 1979.

[13] Electric Power Research Institute (EPRI), *Analysis of Three Mile Island – Unit 2 Accident*, SAC-80-1, NSAC-1, EPRI-NSAC—80-1, March 1980. Note that "This report was prepared by the Nuclear Safety Analysis Center (NSAC) operated by the Electric Power Research Institute, Inc. (EPRI). Neither the NSAC, EPRI, members of EPRI, other persons contributing to or assisting in the preparation of the report, nor any person acting on the behalf of any of these parties (a) makes any warranty or representation, express or implied with respect to the accuracy, completeness or usefulness of the information contained in this report, or that the use of any information, apparatus, method or process disclosed in this report may not infringe privately owned rights; or (b) assumed any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report." In other words, this report is as unreliable to the safety of

The control room at TMI-1 had over 1000 lighted indications and always about 100 lighted indications. The control room had a system for printing out alarms and equipment operation. Once requested for printing, the data was automatically deleted from the control room's computer memory. And the printouts were slow and sometimes over 2 hours behind what was happening. Also, if indications were off-scale, the printout, for temperatures, for example, would simply print question marks. The problems of the unwieldy control room interface had been identified but NRC had approved it and it would have been costly to modify.

The accident at TMI-2 began at 4 am. The first fifteen seconds were trending like a typical turbine trip transient. The attention of the shift supervisor had been on planning for the restart of the Unit 1 reactor, rather than the status of the Unit 2 reactor. After the first 15 seconds, plant conditions did not trend as expected and the emergency procedures did not fit the circumstances.

Although the operators did not know it at the time, by 5:50 am, coolant was lost to the extent that coolant was only to the top of the core. By 6:10 am, coolant had dropped 5 ft below the top of the core and the core was melting — and the operators did not know it. Almost 50 percent of the core was damaged, some of it relocating to the bottom of the reactor vessel.

This is Part 1 of a series about the 1979 Three Mile Island Accident.

Articles by Tami Thatcher for May 2023.On May 2, 2023, I added the highlights of my comments at the ICP CAB in a footnote, and added key references for the Three Mile Island Part I article. As I continue the TMI-2 series, I will expound on the key references for material.

human health and the environment as U.S. Department of Energy or U.S. Nuclear Regulatory Commission reports.