

U.S. CHEMICAL SAFETY BOARD

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NDK CRYSTAL

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PUBLIC MEETING

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THURSDAY,
NOVEMBER 14, 2013

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U.S. CHEMICAL SAFETY BOARD MEMBERS PRESENT:

RAFAEL MOURE-ERASO, Ph.D., Chairperson,
U.S. Chemical Safety Board

MARK GRIFFON, Member, U.S. Chemical Safety
Board

BETH J. ROSENBERG, Sc.D., M.P.H., Member,
U.S. Chemical Safety Board

STAFF PRESENT:

DANIEL M. HOROWITZ, Ph.D., Managing Director
RICHARD C. LOEB, General Counsel
HILLARY COHEN, Communications Manager

AMY McCORMICK, Contracting Officer
SANDY GILMOUR, Communications Staff
JOHNNIE A. BANKS, CFEI, Team Lead,
Washington, DC, Office of Investigations
LUCY SCIALLO-TYLER, Investigator

This transcript produced from audio
provided by the U.S. Chemical Safety Board.

1 P R O C E E D I N G S

2 (10:30 a.m.)

3 CHAIRPERSON MOURE-ERASO: And

4 welcome to all of you to the public meeting of
5 the U.S. Chemical Safety Board, the CSB. I am
6 Rafael Moure-Eraso. I am the chairperson of
7 the board. And with me today are the board
8 members, Dr. Beth Rosenberg and Mr. Mark
9 Griffon.

10 Also joining us here is the
11 General Council of the CSB, Mr. Richard Loeb
12 that is here to my right, and a number of the
13 CSB staff that are also here whose efforts
14 have facilitated this meeting.

15 Probably over here is - I will ask
16 Dr. Daniel - Daniel Horowitz to identify
17 himself, our managing director, also Ms.
18 Hillary Cohen for our communications
19 department, and Ms. Amy McCormick that is also
20 here, and also Mr. Sandy Gilmour that is part
21 of our communications staff.

22 The CBS is an independent non-

1 regulatory federal agency that investigates
2 major chemical accidents at fixed facilities.
3 The investigations examine all aspects of
4 chemical accidents including physical causes
5 related to equipment failures, and most
6 importantly, the root cause of the system
7 failures that allowed these accidents to
8 occur.

9 The CSB also makes recommendations
10 on the adequacy of current health and safety
11 and environmental regulations, industrial
12 standards, and safety management systems.
13 Ultimately, we issue safety recommendations
14 which are designed to prevent similar
15 accidents in the future.

16 The purpose of this public meeting
17 today is for the CSB team to present to the
18 board their final report into the
19 investigation or one of our own ***6:54:15
20 investigations of the December 7, 2009, and
21 that refers to the pressure vessel rupture at
22 NDK Crystal Industries located in Belvidere,

1 Illinois, and for the board to vote on the
2 final report and recommendations today.

3 At this time, please allow me to,
4 since we're a safety agency, to go over the
5 mornings - I'm sorry, to go to the morning's
6 agenda. You probably at the entrance saw a
7 copy of the agenda. It looks like this.

8 So, first, we're going to hear the
9 opening statements from the chairperson,
10 myself, and from the board members. Then,
11 second, we are going to hear the report, the
12 formal report of the investigation team. That
13 includes the video that we produced on this
14 accident.

15 Then, we are going to - following
16 the team presentation, we will be - the board
17 will be given an opportunity to ask questions
18 on technical specifics or anything to the
19 board that has presented the report, that the
20 team has presented the report to the board.

21 Thereafter, we will have a public
22 comment period of matters related to the NDK

1 investigations, and also, the board will vote
2 on the report and recommendations from the -
3 the recommendations of the staff of NDK. That
4 will be the last part of the report - the last
5 part of the agenda.

6 This is where, I was saying
7 before, this is where a safety organization,
8 we have to point to useful safety information
9 about this room. Let me indicate to you what
10 are the exits that we have of the room if
11 there were going - something to happen here,
12 there, this is the exit in the back, and there
13 is an emergency exit back here if somebody
14 need it - or two exits, yes. We get very
15 close to this second one here, okay?

16 I also would like to ask you to
17 please mute your cell phones so that we are -
18 the proceedings are not disturbed. And I'm
19 going to proceed with my opening statement.

20 On December 7, 2009, a 50-foot
21 tall pressure vessel violently ruptured at the
22 NDK Crystal plant in Belvidere, Illinois. The

1 violent rupture generated many projectiles.

2 One such projectile, a seven-foot,
3 100 pound steel beam, traveled 650 feet in the
4 air, striking and killing Ronald Greenfield,
5 a member of the public who was a truck driver
6 at the nearby Tollway Oasis.

7 At this time, we want to give
8 thought to the fact that an innocent member of
9 the public, going about his business and
10 taking a break at the Oasis gas station on the
11 tollway was killed. I am invited you to
12 observe a moment of silence in honor of his
13 memory.

14 [MOMENT OF SILENCE]

15 CHAIRPERSON MOURE-ERASO: Thank
16 you. Let us remember that people's safety is
17 paramount. That is why we, at the CSB, do
18 what we do.

19 Under the federal Clean Air Act
20 amendments, which established the Chemical
21 Safety Board, we are required to investigate
22 any chemical accident that causes the death of

1 a member of the public. The final draft
2 report that we will hear today is the result
3 of a multi-year effort to conduct that
4 investigation.

5 Today, the CSB investigators will
6 describe all the factors that led to the
7 catastrophic incident, as well as the proposed
8 recommendations for ensuring greater safety in
9 the future. I thank them for their efforts.

10 This is a small team, and this has
11 been one of many challenging projects that we
12 have been juggling, including, most recently,
13 the explosion of the West Fertilizer in Texas,
14 in West, Texas. That has some similar issues
15 that this NDK investigation.

16 Here are some of the most
17 important findings of this investigation at
18 NDK: first, you are going to find through the
19 report of the staff that there were specific
20 warnings that were made to the company by its
21 insurer admonishing the company of the danger
22 to the public from a pressure vessel rupture.

1 You also will find that internal
2 corrosion inspections that were recommended
3 were never performed on the vessel that
4 ruptured, or any of the other vessels, and
5 that the pressure vessels did not meet code
6 requirements that were granted an exemption to
7 function.

8 But at every level, the risk of a
9 catastrophic vessel failure was overlooked,
10 and public safety literally and figuratively
11 fell through the cracks.

12 As I drove from the airport
13 yesterday to attend this meeting, I took
14 careful note of the remnants of the NDK
15 facility that is visible for everybody that
16 goes on Route 90 east or west.

17 I was very much struck by NDK's
18 proximity to the nearby Belvidere Oasis, a
19 rest stop that is frequented by trucks and all
20 kinds of travelers at every day - at every
21 hours of the day and night.

22 This public meeting is our chance

1 to understand what happened on the day of this
2 fatal accident, and how to prevent similar
3 events from occurring in the future.

4 If anyone in the audience wishes
5 to comment publicly after the investigation's
6 presentations, I will ask you to please sign
7 up on the yellow sheet in the check-in area,
8 and I will call your name at the appropriate
9 time. As a matter of fact, the managing
10 director, Dr. Daniel Horowitz, will facilitate
11 the discussion, the public discussion.

12 I will first call the people - he
13 will first call the people that have signed
14 up, and open the floor to anyone that wishes
15 to speak on the issues related to this
16 investigation. Please note that we will have
17 to limit public comments to three to five
18 minutes each.

19 And I will like to continue by
20 recognizing my fellow board members if they
21 have an opening statements, so I will ask Dr.
22 Rosenberg if she has an opening statement?

1 MEMBER ROSENBERG: Thank you. Let
2 me begin by expressing my condolences to the
3 family and friends of Ronald Greenfield. My
4 heart goes out to them and to the employees
5 and owners of NDK who survived this traumatic
6 event.

7 We, at the CSB, aim to learn from
8 industrial accidents. While the process used
9 at NDK is unique in the U.S., there are
10 recurring themes that this event highlights
11 that are far from unique. Sadly, they are all
12 too common.

13 First, the practice of citing
14 hazardous facilities near people is a problem.
15 Whether the hazardous facility was
16 intentionally cited near a populated area or
17 a town grew up around it, as in the fertilizer
18 plant in West, Texas, these unsafe facilities
19 should be away from places like homes, school,
20 or in this case, a rest stop on a tollway.

21 I believe we investigated at least
22 eight incidents where zoning is an issue. We

1 need to use zoning laws to protect people from
2 hazardous facilities. Smart zoning would have
3 saved this truck driver's life. But zoning
4 doesn't protect the people who work inside the
5 hazardous facilities, which brings me to the
6 second recurring theme, unheeded warnings.

7 There is often an indication that
8 something is wrong before the big explosion
9 happens, but warnings are ignored. In this
10 case, our excellent investigators found that
11 in 2007, a consultant to the insurance company
12 said that the vessels were unsafe, and the
13 insurance company disavowed covering any
14 damage or injuries resulting from operating
15 these vessels.

16 Who decided to ignore this warning
17 and gamble with peoples' lives? What
18 incentives or pressures was he under, or she
19 under, to choose to ignore this warning? And
20 further, should you be allowed to operate a
21 facility that an insurance company has deemed
22 too unsafe to cover?

1 I look forward to hearing the
2 details of the investigation, but I wanted to
3 bring up these issues of citing warnings and
4 using insurance companies as financially
5 interested inspectors, because I think they
6 provide intervention points or levers to
7 prevent such tragedies from occurring. Thank
8 you.

9 CHAIRPERSON MOURE-ERASO: Thank
10 you, Member Rosenberg. Now, I'll ask Mr. Mark
11 Griffon is he has any statement?

12 MEMBER GRIFFON: Thank you, Mr.
13 Chairman. I would also like to offer my
14 condolences to the family and friends of Mr.
15 Greenfield. The type of incident that
16 occurred at NDK Crystal, Inc., is one of the
17 primary reasons that the Chemical Safety Board
18 was established. Accidents at high hazard
19 facilities or processes such as the one at NDK
20 not only pose a risk to workers, but also the
21 environment and the community.

22 This case tragically resulted in

1 the death of one individual. This incident
2 also resulted in other injuries and extensive
3 damage to nearby businesses where some 40
4 employees were working. This raises very
5 serious public safety questions.

6 This is certainly not the first
7 time the CSB has investigated incidents that
8 had off-site consequences. In November of
9 2006, a powerful explosion at the CAI/Arnel
10 facility in Danvers, Massachusetts, resulted
11 in the damage of scores of homes and
12 businesses.

13 In October of 2006, there was an
14 incident in the EQ Hazardous Waste Plant in
15 Apex, North Carolina, where an explosion and
16 fire resulted in the evacuation of
17 approximately 16,000 residents. In November
18 of 2009, an explosion at Silver Eagle Refinery
19 in Woods Cross, Utah, damaged nearby homes.

20 More recently, in March 2011, an
21 incident at Carbide Industries in Louisville,
22 Kentucky, resulted in a confusing order to the

1 local community to shelter in place. In
2 August 2012, a fire at the Chevron Refinery in
3 Richmond, California, resulted in
4 approximately 15,000 people going to local
5 hospitals.

6 And finally, as the Chairman
7 mentioned, in April of this year, a huge
8 explosion at the West Fertilizer Facility in
9 West, Texas, killed 15 people, injured
10 hundreds of people, and damaged homes and
11 schools in the nearby community.

12 All these incidents have one thing
13 in common, they don't stop at the fence line.
14 These incidents impact and involve the entire
15 community. The fix for these types of
16 incidents is not simply a technical fix,
17 better pressure vessels, stronger piping, but
18 rather it's a systems question. What systems
19 are in place to assure there are minimal risks
20 to the communities near these high hazard
21 facilities?

22 Safe facility citing is the most

1 important issue, in my opinion, in this NDK
2 case study, but it's certainly not an issue
3 unique to the NDK incident. The West
4 Fertilizer incident made the issue clear to
5 the nation.

6 I fully expect to see the issue of
7 safe citing studied more comprehensively in
8 the West Fertilizer investigation that are our
9 agency is currently working on.

10 Finally, I want to say that I'm
11 very glad that we're having a public meeting
12 to discuss the incident of the NDK Crystal
13 site. The work the investigative team put
14 into the report is tremendous, and it's very
15 important that we share our findings and
16 recommendations with the public in a public
17 meeting such as this.

18 Having said that, I must note that
19 the report comes to us, the board, almost four
20 years after the incident occurred. This is
21 way too long. This lengthy time to complete
22 a case study, which certainly is not the fault

1 of the investigation team, points to a failure
2 in planning and needs to be addressed.

3 I've asked numerous times for a
4 comprehensive work plan dealing with the
5 backlog of our investigations, and for public
6 meetings to discuss the status of open
7 investigations, but to no avail.

8 The board members and stakeholders
9 need to be updated on the status of
10 investigations, the direction of
11 investigations, the priorities, the planned
12 products, and the timelines for completion.

13 We, as the board, are accountable
14 to the public, and we need to do better and
15 have more timely reports. Thank you.

16 CHAIRPERSON MOURE-ERASO: Thank
17 you, Mr. Griffon. At this time, I would like
18 to introduce Johnnie Banks and Lucy Tyler, the
19 CSB investigative team that produced this
20 report. Ms. Tyler was not able to travel
21 today being with us, and she's joining us
22 through video in the screen that you can see.

1 Mr. Banks, Mr. Johnnie Banks, is
2 the investigations team lead. His team is
3 located in Washington, D.C., and he led the
4 investigation of NDK Crystal. Mr. Banks has
5 worked for 22 years at the Chevron Texaco
6 Corporation Refinery in Richmond, California,
7 prior to joining the CSB.

8 Mr. Banks is a graduate of the
9 University of California Berkeley, and is a
10 certified fire and explosion investigator.

11 Ms. Tyler is a licensed, certified
12 safety professional, and has participated in
13 several CSB investigations, and supported the
14 development of significant recommendations for
15 combustible dust regulations. She holds a
16 Bachelor's of Science degree in industrial
17 health and safety from the Pennsylvania State
18 University.

19 I would like then to ask Mr.
20 Johnnie Banks to take over the microphone and
21 continue the meeting.

22 MR. BANKS: Thank you. Chairman

1 Moure-Eraso, Board Member Rosenberg, Board
2 Member Griffon, Mr. Loeb, ladies and
3 gentlemen, good morning. We're prepared to
4 present the findings from the investigation of
5 a fatal pressure vessel rupture that occurred
6 at the NDK Crystal facility in Belvidere,
7 Illinois.

8 This incident occurred on December
9 7, 2009, and resulted in one public fatality,
10 and there was also one public injury, and
11 significant property damage to NDK and a
12 neighboring company.

13 Before I start, I'd like to
14 introduce the team. I'm Johnnie Banks, and I
15 am the investigator in charge of this
16 investigation. And joining me from
17 Washington, D.C. is Lucy Tyler, who was not
18 able to travel with us to Belvidere today, but
19 played a vital part in the development and
20 bringing of this report to a conclusion.

21 I'd like to also go over the
22 agenda for the presentation. The agenda for

1 today's meeting will include a presentation by
2 the investigation team, which will include an
3 animation of the incident, and a summary of
4 the team's key findings.

5 This will be followed by a reading
6 of proposed recommendations. The board will
7 then have an opportunity to ask questions of
8 the investigation team, and we will then hold
9 a public comment period. Finally, the board
10 will vote on the investigation team's report,
11 and draft recommendations.

12 The CSB deployed to the NDK
13 facility two days after the incident. The
14 investigation team interviewed witnesses,
15 collected company documentation, and
16 participated in metallurgical examinations and
17 testing of failed vessel fragment.

18 As a result of the investigation,
19 the CSB identified several issues that
20 contributed to the incident at various stages
21 of the design and operation of the vessels, as
22 well as deficiencies in vessel oversight and

1 inspections.

2 I'll now summarize the key issues
3 identified. First, there was improper
4 material selection, and excessive wall
5 thickness contributed to the vessel failure
6 mechanism, stress corrosion cracking. In
7 addition, the lack of a regular vessel
8 inspection program by the company and state
9 fire marshal allowed the conditions resulting
10 in the vessel rupture to go undetected.

11 Finally, investigation findings
12 from a previous incident involving vessel lids
13 did not prompt the company to take proper
14 actions to ensure vessels were safe for
15 operation. These key issues will be discussed
16 in further detail in today's presentation.

17 The company overview, Nihon Dempa
18 Kogyo, known as NDK, was founded in Japan in
19 1948. The company produces synthetic crystal
20 quartz used for oscillators and ultrasonic
21 transducers typically found in cell phones and
22 other electronic devices. Over time, NDK

1 expanded its production and marketing
2 globally.

3 The Belvidere facility is the only
4 NDK Crystal production facility in the United
5 States. The plant was built in 2002, adjacent
6 to Interstate 90, about 75 miles northwest of
7 Chicago. The NDK Crystal facility shares a
8 property with NDK America, the sales and
9 marketing portion of the company, and is
10 located in a light industrially zoned area.

11 Here is a photo of the NDK
12 facility two days after the explosion. This
13 was taken across the interstate. The five-
14 story plant housed eight pressure vessels.
15 Nearly all of the building panels on the
16 exterior walls were blown out as a result of
17 the explosion.

18 Here we have an overhead photo of
19 the NDK facility and the surrounding area,
20 with points of interest labeled, including
21 Interstate 90, the neighboring company, and
22 the I-90 toll rest stop where the fatal injury

1 occurred.

2 At this time, I will turn the
3 proceeding over to Ms. Tyler, who will start
4 with the process discussed of the crystal
5 growing process at NDK. Ms. Tyler?

6 MS. SCIALLO-TYLER: Good morning.
7 NDK operated eight pressure vessels, called
8 autoclaves, to synthesize the quartz crystals.
9 The purpose of the crystals - the purpose of
10 the vessels, I'm sorry, was to simulate
11 natural geologic crystal growth through high
12 pressures and temperatures. The vessels were
13 forged from a solid bar of alloy steel and
14 heat treated. There is one point of entry at
15 the top of the vessels.

16 Here is a cross-section drawing of
17 the NDK crystal growing vessels. The vessels
18 stood 50 feet tall, with an inside diameter of
19 just over two feet. They weighed 140,000
20 pounds.

21 The walls of the vessels were
22 eight inches thick in the center cylindrical

1 sections, and then were much thicker at the
2 top and the base, measuring over 18 inches
3 thick at the top, and 16 inches thick at the
4 bottom.

5 The process at NDK began with raw
6 mined quartz, or lasca, as depicted in the
7 photo to the right. These baskets were
8 lowered into the bottom of the vessels.

9 Next, operators added a sodium
10 hydroxide and water solution, and then hung
11 sea crystals in racks at the top of the
12 vessel. The sea crystals were thin, pure
13 quartz, with the desired grain structure, upon
14 which the larger synthetic crystals would
15 grow.

16 Operators sealed the vessels, and
17 external heaters raised the inside temperature
18 to 700 degrees Fahrenheit. The boiling
19 contents increased the internal pressure to
20 29,000 pounds per square inch. Over 100 to
21 150 days, the vessels remained at this
22 temperature and pressure while the synthetic

1 crystals grew on the seed racks.

2 Here is a photo of the finished
3 product. Mr. Banks will now hold up a sample
4 of the synthetic crystal. Once removed from
5 the process, the formed crystals were
6 inspected at NDK and sent to Japan for further
7 processing.

8 Now we will move on to a video
9 that depicts the violent explosion of the
10 vessel and its impact on the surrounding
11 community. This animation is an excerpt from
12 a longer safety video about the NDK
13 investigation, and reiterates some of the
14 process information I just presented, in
15 addition to the incident animation.

16 The full length video titled,
17 "Falling Through the Cracks," will be
18 available on the Chemical Safety Board's
19 website www.csb.gov after today's public
20 meeting.

21 [VIDEO BEGINS]

22 NARRATOR: NDK Crystal operated a

1 synthetic quartz crystal manufacturing
2 facility in an industrial area adjacent to
3 Interstate 90 in Belvidere, Illinois. NDK
4 produces large crystals used for a variety of
5 products, particularly electronic devices.

6 The facility housed eight massive
7 cylindrical pressure vessels, with eight inch
8 thick steel walls, standing 50 feet tall.
9 Inside the vessels, raw mined quartz or silica
10 was used with a corrosive sodium hydroxide
11 solution at extremely high pressures and
12 temperatures.

13 The vessels were kept sealed for
14 up to 150 days to allow the growth of large,
15 single crystals of quartz. The silica and
16 sodium hydroxide react with iron in the walls
17 of the steel vessel forming a layer of sodium
18 iron silicate, or acmite.

19 The company believed this acmite
20 coating would protect the vessels from the
21 corrosive effects of the chemicals inside.
22 Over the years, NDK was warned that corrosion

1 might be compromising the walls of the
2 pressure vessels, yet the company continued to
3 operate these vessels without performing
4 recommended inspections.

5 On December 7, 2009, pressure
6 vessel number two was 120 days into a routine
7 150-day crystal growing cycle when suddenly,
8 at about 2:30 p.m., it violently ruptured.
9 Large pieces of structural steel were thrown
10 from the building.

11 One piece was blown 650 feet
12 toward a gas station on the Illinois tollway.
13 Tragically, the building fragment struck and
14 killed a driver who was walking back to his
15 truck.

16 A large piece of the pressure
17 vessel tore through an exterior wall of the
18 NDK facility, skipped across a neighboring
19 parking lot, and struck the wall of an
20 adjacent automotive supply company where
21 nearly 70 people were working. One was
22 injured.

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[VIDEO ENDS]

MR. BANKS: Go ahead, Lucy.

MS. SCIALLO-TYLER: To summarize, the incident at NDK resulted in one public fatality, a truck driver who was struck by the flying building fragments, and an injury to an employee working at the neighboring business.

There was also severe property damage to the NDK Crystal production facility, the adjoining NDK office area, the neighboring automotive supply company, and several nearby parked automobiles.

Now I will discuss the findings of the metallurgical testing and examinations that were conducted as part of our investigation. To investigate the immediate cause of the vessel failure, the CSB first had to determine if the failure was due to a process upset during the crystal run or a problem with the pressure vessel itself.

The investigation team reviewed control system data for the vessel two

1 production run and found no evidence of a
2 temperature or pressure excedent that would
3 have caused the vessel to rupture. Also, the
4 vessel's rupture discs did not activate, which
5 suggests that the vessel suddenly failed
6 during the run, possibly due to a problem with
7 the vessel construction.

8 As a result, the CSB entered a
9 joint metallurgical testing agreement with
10 other agencies and interested parties to
11 physically examine the failed steel vessel in
12 an attempt to characterize what caused the
13 wall to suddenly give way and result in a
14 violent explosion.

15 Here is a photo of the 8,600 pound
16 vessel two fragment recovered from the damage
17 at the neighboring facility. It's about eight
18 feet long and four feet wide. This piece was
19 used for all the metallurgical testing
20 conducted as part of the investigation.

21 If you recall the cross section
22 vessel from the earlier drawing and the video,

1 this piece came from the bottom portion of the
2 cylinder just near the base where the wall
3 thickness starts to make the transition
4 between eight to 16 inches thick.

5 The CSB found strong evidence of
6 cracking near the inner diameter of the vessel
7 fragment. These cracks led to large flaws,
8 one of which resulted in the catastrophic
9 failure in December 2009. Stress corrosion
10 cracking, or SCC, was the likely failure
11 mechanism that caused the cracks.

12 Stress corrosion cracking is
13 caused by the combination of applied stresses
14 such as the high operating pressure inside the
15 vessel, and a corrosion environment. The
16 sodium hydroxide and water solution, generally
17 known to damage some steels, was degrading the
18 vessel wall over time, and likely resulted in
19 the development of the stress corrosion
20 cracks.

21 Here is a micrograph of a crack
22 found on the fracture surface of the 8,600

1 pound steel fragment from vessel two. The CSB
2 had independent metallurgical experts from
3 NIST, or the National Institute of Standards
4 and Technology, review the testing data.
5 According to NIST, the branching of these
6 cracks is a telltale sign of stress corrosion
7 cracking.

8 A mineral called acmite, or sodium
9 iron silicate, is naturally formed during the
10 crystal growing process, and rapidly coats the
11 inner walls of the vessels. Presence of
12 acmite has been well documented in crystal
13 growing operations since the 1950s.

14 The purpose of the acmite is to
15 improve product quality by preventing
16 impurities in the vessel walls from
17 contaminating the product quality of the
18 synthetic crystals. The acmite also forms a
19 barrier between the caustic environment and
20 the inner surface of the vessels.

21 NDK relied on this acmite layer to
22 protect the inner walls from corrosion by the

1 caustic sodium hydroxide. High strength, low
2 alloy steels, such as the material chosen for
3 the NDK vessels, are inherently susceptible to
4 stress corrosion cracking, especially under
5 these conditions. Metallurgical testing
6 suggests the acmite was not protecting the
7 vessel, resulting in environmental damage to
8 the inner wall.

9 Testing also revealed that
10 chemical elements such as titanium and
11 aluminum, known impurities found in the lasca,
12 and sulfur and chloride were present on the
13 inner surfaces of the cracks. Therefore, the
14 process fluid was able to penetrate the
15 surface cracks on the vessel.

16 This indicates the cracks were
17 preexisting, and the acmite layer may have
18 been removed by unintended surface scratching
19 or mechanical abrasions during the loading and
20 unloading of the vessels, allowing the inner
21 surface of the vessels to come in contact with
22 the degrading environment inside.

1 The 2009 rupture was not the first
2 indication that there were problems with
3 stress corrosion cracking in the vessel. In
4 2007, another vessel experienced a high
5 pressure leak of hot caustics from the vessel
6 lid operation. No one was injured, but there
7 was significant damage on the 5th floor of the
8 NDK production building.

9 Metallurgical testing showed
10 evidence of stress corrosion cracking as the
11 mechanism of failure that contributed to the
12 2007 leak, suggesting the acmite layer was not
13 protecting the inner surface of the vessel lid
14 from the caustic solution.

15 As a result of the 2007 lid
16 failure investigation, metallurgical
17 consultants and the insurance company
18 recommended that NDK not place the vessels
19 back into service as four of the eight vessel
20 lids showed evidence of cracking.

21 They recommended thorough
22 inspections of all the vessels based on

1 recognized industry practices, and warned that
2 a catastrophic failure may be imminent in a
3 letter directed to NDK.

4 The consulting company warned NDK
5 in their August 2007 letter that a
6 catastrophic rupture could occur as exhibited
7 in the first excerpt from that letter, which
8 I will now quote. "Unfortunately, far more
9 catastrophic scenarios are possible.

10 If a crack were to grow to a
11 critical size in which the stress intensity of
12 the crack tip exceeded the failure toughness
13 of the high strength steel used in the
14 vessels, a catastrophic rupture could occur."

15 The letter went on to specifically
16 list the scenario in which a member of a
17 public, or anyone who might happen to be at
18 the Belvidere Oasis, could be at risk for
19 serious injury or death.

20 "We are bringing this letter to
21 your attention because as professional
22 engineers registered in the state of Illinois,

1 we have an obligation to protect the welfare
2 of the public.

3 In this case, the public would
4 include the employees of NDK Crystal
5 Incorporated, any visitors in or around the
6 NDK facility, and anyone who might happen to
7 be at the Belvidere Oasis on the northwest
8 toll road, if one of these two vessels were to
9 fail catastrophically." A strikingly similar
10 scenario occurred in December of 2009.

11 The incident in 2007 was the first
12 indication of an issue with the vessels,
13 either the protective capability of the acmite
14 layer was compromised, or another general
15 damage mechanism was occurring in the vessel
16 material.

17 But despite these warnings, NDK
18 repaired the lids and placed the remaining
19 vessels back into service without identifying
20 the origin of the stress corrosion cracking,
21 or thoroughly examining the impact this was
22 having on the interior of the vessels.

1 NDK had no regular inspection
2 program for the interior of the vessels, and
3 no certified inspectors ever entered vessel
4 number two throughout its service life.
5 Documentation revealed NDK was planning on
6 replacing the vessel, but had not done so by
7 the December 2009 incident.

8 Now I will discuss the regulations
9 and agencies that govern NDK and its pressure
10 vessel operation. The table shown here
11 represents different levels of oversight,
12 federal, state and local, that regulated
13 worker and public safety as it applied to the
14 NDK facility.

15 OSHA, the Occupational Safety and
16 Health Administration, and the EPA,
17 Environmental Protection Agency, provide
18 federal oversight. Both OSHA and EPA
19 conducted inspections of the NDK facility
20 after the December 2009 incident and issued
21 citations.

22 There were no specific regulatory

1 standards or programs that regulate the
2 process at NDK such as the OSHA process safety
3 management program or the EPA risk management
4 program. OSHA cited NDK mostly for general
5 industry safety violations.

6 Within the state of Illinois, the
7 Office of the State Fire Marshal boiler and
8 pressure vessel safety division regulates all
9 the pressure vessels in the state. The
10 vessels at NDK were subject to the
11 requirements of the division.

12 And at the local level, the City
13 of Belvidere Building and Zoning Department
14 established zoning and permitting for the
15 construction and operation of the NDK Crystal
16 facility in 2001 and 2002.

17 Within the state of Illinois, the
18 Division of Boiler and Pressure Vessel Safety,
19 which is part of the Office of the State Fire
20 Marshal, regulates the construction,
21 installation, inspection, operation, and
22 repair of all boiler and pressure vessels in

1 the state.

2 The Illinois Pressure Vessel
3 Safety Act establishes the rules for the
4 division, and adopts the requirements set
5 forth in the American Society of Mechanical
6 Engineers Boiler and Pressure Vessel Code and
7 the National Board Inspection Code.

8 Shortly after the first three
9 vessels at NDK were manufactured, the vessel
10 fabricator could not certify that the vessels
11 met the requirements of the ASME code.
12 Specifically, the material was not meeting the
13 toughness properties required by ASME for that
14 type of material.

15 NDK petitioned the state of
16 Illinois for an exemption that would allow the
17 operation of those vessels without an ASME
18 code certified stamp. The division
19 coordinated an independent review of the
20 vessel design specifications and granted
21 permission for the operation of the vessels
22 under the rules of the state Pressure Vessel

1 Safety Act.

2 In reviewing the design and
3 operation specifications for the NDK vessels
4 as part of the approval process, the division
5 of pressure vessel safety did not identify the
6 NDK vessel contents, specifically the sodium
7 hydroxide solution, as corrosive to the steel
8 materials of construction.

9 They classified the vessel as non-
10 corrosive. And as a result of this
11 classification, the vessels were not subject
12 to internal inspections normally required for
13 vessels with corrosive contents under the
14 state Boiler Pressure Vessel Safety Act.

15 In addition, the vessel
16 manufacturer recommended annual inspections to
17 the state as part of the petition process.
18 However, the state did not conduct internal
19 inspections, nor did they have a process to
20 ensure NDK was performing the recommended
21 internal inspections on the three vessels that
22 did not meet the ASME code required

1 properties.

2 When the state did conduct vessel
3 inspections in 2003, 2006 and 2009, they
4 inspected only external and accessible
5 surfaces of the vessels.

6 Now I'll move on to the city of
7 Belvidere. The land NDK occupies, originally
8 undeveloped agricultural land, between
9 Interstate 90 and Route 20 in Belvidere, was
10 zoned in 1996 as light industrial, office, and
11 research space for economic development.

12 In 2001, NDK petitioned the city
13 of Belvidere, the Planning and Zoning
14 Commission, and the Building Department, for
15 permission to build the NDK facility, and
16 permission was granted. The 1994 Belvidere
17 zoning code was the governing document at the
18 time the facility was zoned, and established
19 what types of industry were permitted in light
20 versus heavy industrial zones.

21 In reviewing the 1994 Belvidere
22 zoning code, the CSB determined that the type

1 of production at the NDK facility, that
2 includes the operation of eight heavy pressure
3 vessels at extremely high temperatures and
4 pressures, is more closely aligned with the
5 uses permitted only in heavy industrial zones.

6 According to the code, heavy
7 industrial zones would be grouped in a zone
8 separate from residential and commercial
9 activities, such as the highly populated
10 Tollway Oasis across the interstate from NDK.

11 Light industrial uses include
12 manufacturing and production processes such as
13 automotive repair shops, lumber yards, office
14 buildings, and warehouses. This would lessen
15 the potential to have impact on the
16 surrounding areas.

17 Heavy industrial uses listed in
18 the code include the storage and manufacturing
19 of products such as coal, coke, and tar,
20 fertilizers, metals, rubber and paint
21 manufacturing, and oil and petroleum refining.

22 The city of Belvidere did not

1 identify NDK as a risk to public safety in
2 2001, and no off-site consequence analysis was
3 conducted to consider the impact of a vessel
4 rupture on the nearby interstate and tollway
5 rest stop.

6 Furthermore, the documentation NDK
7 submitted to the city did not include details
8 of the pressure vessel process, which may have
9 led to a more in depth review of the potential
10 risks.

11 The current issue of industrial
12 zoning and land use planning remains a focal
13 point for current and future CSB
14 investigations, as exhibited by the NDK
15 investigation, and more prominently in the
16 recent West Fertilizer ammonium nitrate
17 storage facility explosion in West, Texas,
18 where 14 people were killed.

19 There may be an opportunity to
20 improve zoning codes and ensure industrial
21 facilities are zoned properly, and commercial
22 and residential areas are not built up around

1 industrial facilities that have the potential
2 for significant off-site consequences.

3 Now we will move on to the
4 industry codes and standards that apply to the
5 pressure vessels used at NDK. The American
6 Society of Mechanical Engineers, or ASME, is
7 a professional organization that develops
8 standards for industry.

9 The boiler and pressure vessel
10 code provides the requirements for the design,
11 fabrication, and inspection of boilers and
12 pressure vessels, and is generally accepted as
13 the code that governs the rules for these
14 components.

15 The ASME boiler and pressure
16 vessel code was adopted by the state of
17 Illinois in 1976. Section 2, Part A, of the
18 boiler and pressure vessel code includes
19 material specifications for pressure retaining
20 components.

21 It covers the requirements that
22 govern the material selection and construction

1 of forged and heat treated high strength steel
2 vessels like the ones used at NDK. The code
3 has a recommended wall thickness limitation
4 for blind end vessels, or vessels with one
5 open end, and that limit is seven inches
6 thick.

7 However, the NDK vessels were
8 designed with an eight inch thick wall in the
9 center portion, and the top and the bottom of
10 the vessels got as thick as 18 inches.

11 Evidence from the 2007 and 2009
12 incident metallurgical examinations suggest
13 that the excessive wall thickness at NDK
14 resulted in improper manufacturing, and
15 contributed to the metallurgical damage
16 mechanism that led to those failures.

17 Now, one would assume that a
18 thicker steel would mean a stronger steel, or
19 a steel that is less susceptible to damage or
20 fracture, but there is an important safety
21 reason that these limitations exist in some
22 applications.

1 Vessels that are too thick may not
2 achieve the optimal properties during the
3 heating and cooling processes that take place
4 during manufacture, for these limits ensure
5 proper heat treatment for heavy walled
6 vessels, and reduce the susceptibility for the
7 types of damage mechanisms identified in our
8 metallurgical examination.

9 Section 2 of the boiler and
10 pressure vessel code lacked strict limitations
11 for pressure vessel wall thicknesses for the
12 types of steel used at NDK. The seven inch
13 thickness limit is a typical maximum section
14 size for that type of forged material, and
15 it's not a required property like some of the
16 other requirements that exist for ASME code
17 compliance.

18 And the code does not include
19 additional guidance for the heat treatment of
20 vessels with larger wall thicknesses or wall
21 thickness variations. However, the ASME has
22 made some changes to the boiler and pressure

1 vessel code that impact the future
2 construction and operation of vessels similar
3 to NDK's.

4 In a subsequent issuance of the
5 boiler and pressure vessel code since the NDK
6 incident, the ASME revised Section 8, Division
7 3, the code for high pressure vessels, to
8 allow the appropriate enforcing authorities,
9 such as the state, to prohibit the use of
10 alloy steel used at NDK with aqueous contents
11 like the sodium hydroxide and water solution,
12 because the material is more susceptible to
13 environment stress corrosion cracking when in
14 contact with those environments.

15 As a result, another type of alloy
16 steel with properties less susceptible to
17 stress corrosion cracking would have to be
18 used in the future for this type of process.

19 Now I will list the key findings
20 identified in the CSB investigation of the NDK
21 Crystal incident. Key finding one: stress
22 corrosion cracking likely caused the

1 catastrophic failure of the high pressure
2 crystal production vessel at NDK Crystal
3 Incorporated, fatally injuring a member of the
4 public 650 feet away at a highway rest stop.

5 Key finding two: NDK relied upon
6 the in-process formation of an acmite coating
7 inside the production vessel to protect the
8 low alloy, high strength steel from caustic
9 sodium hydroxide use in the process. However,
10 NDK did not verify the integrity or the
11 effectiveness of this coating, and the caustic
12 chemicals promoted stress corrosion cracking
13 that weakened the vessel.

14 Number three: The board of boiler
15 and pressure vessel safety did not conduct
16 internal inspections of the NDK vessels as
17 required under state regulations for pressure
18 vessels subject to internal corrosion.

19 Instead, the state says it relied on the
20 company to perform internal inspections, but
21 did not verify whether these were actually
22 occurring.

1 The state conducted three
2 certificate inspections of the vessel that
3 failed in 2003, 2006, and 2009, less than
4 three months prior to the incident, but these
5 inspections focused only on accessible
6 external surfaces.

7 Key finding four: In 2007, NDK
8 learned that stress corrosion cracking was
9 occurring in four of the eight pressure vessel
10 lids at the facility. A consultant to NDK's
11 insurance company warned NDK of serious
12 reservations about returning the vessels to
13 service after this discovery, and specifically
14 cited the possible danger to members of the
15 public at the nearby rest stop in case of a
16 catastrophic vessel failure.

17 Key finding number five: Despite
18 the insurance company warning, NDK did not
19 perform recommended non-destructive
20 examinations of all the vessels prior to
21 returning the vessels to service.

22 Key finding six: NDK did not

1 perform annual internal inspections as
2 recommended by the vessel designer when the
3 vessels were initially constructed.

4 Key finding seven: Temper
5 embrittlement, or some other form of heat
6 treatment embrittlement, cannot be ruled out
7 as a contributing factor in addition to the
8 stress corrosion cracking. The vessels
9 exceeded the ASME wall thickness
10 recommendations for closed end forging, which
11 may have resulted in improper heat treatment
12 during the manufacturing process.

13 And key finding eight: The ASME
14 boiler and pressure vessel code does not have
15 specific wall thickness limitations for
16 pressure containing components.

17 And now Mr. Banks will return to
18 read the investigation team's proposed safety
19 recommendations. Thank you.

20 MR. BANKS: Thank you, Ms. Tyler.
21 It dawned on me when I was asked to hold up
22 the finished product that I was behind this

1 podium, and some of you may not have been able
2 to see it, so this is what it looks like.
3 This is the finished product.

4 I'll now give you an overview of
5 the recommendations process. It's our
6 agency's primary tool to improve industrial
7 safety practices and programs, and these
8 recommendations can be issued to not only the
9 entity where the incident occurred, but to
10 federal and state regulatory improvements,
11 industry and company. It addresses industry
12 and company practices, and to trade
13 associations, and standards and outreach.

14 The recommendations directly
15 address incident findings and causes. It
16 focuses on management systems to improve and
17 prevent recurrence. We have a recommendations
18 department that is tasked with following these
19 recommendations through to closure, and they
20 monitor and issue updates that can be tracked
21 on our website, www.csb.gov/recommendations.

22

1 The first of the recommendations
2 for this incident are directed to the American
3 Society of Mechanical Engineers or ASME. It
4 reads, "Revise the ASME boiler and pressure
5 vessel code to include specific material
6 thickness limitations for the design of
7 pressure containing components to ensure heat
8 treatment and avoid environmentally induced
9 damage mechanisms.

10 Clarify required vessel wall
11 thickness limitations for SA-723 steel in the
12 following code sections: A: ASME, BP, VC,
13 Section 2, Part A, Material Requirements, and
14 B: ASME, BP, VC, Section 8, Division 3,
15 Article MKM-400, Material Design Data."

16 The next recommendation is
17 directed to the National Board of Boiler and
18 Pressure Vessel Inspectors, or NBBI, and we
19 urge them to communicate the findings of this
20 case study to pressure vessel inspectors in
21 all 50 states.

22 At a minimum, send the information

1 such as an article summarizing the
2 investigation to each member who is a pressure
3 vessel inspector, and to post a direct link to
4 the NDK case study on the National Board's
5 website.

6 Recommendation number three is to
7 the Office of the Illinois State Fire Marshal
8 Boiler and Pressure Vessel Safety Division,
9 and it urges them to prohibit the use of
10 existing pressure vessels at the NDK facility
11 for crystal growing operations.

12 Also, to the Illinois State Fire
13 Marshal Boiler and Pressure Vessel Safety
14 Division, we recommended that they develop and
15 implement state requirements and procedures to
16 ensure pressure vessel approval process
17 accurately, identifies vessels that may be
18 subject to corrosion or similar deterioration
19 mechanisms, and ensure regular inspections in
20 accordance with the state requirements.

21 To NDK Crystal Incorporated, we
22 recommend that they, for the design and

1 operation of any new NDK Crystal facility
2 using a hydrothermal or equivalent crystal
3 growing process, that it ensures that the
4 facility uses a process that is rigorously -
5 that rigorously demonstrates to be inherently
6 safer than the existing process. For example,
7 they're using lower temperature and pressures,
8 and less corrosive conditions.

9 Also to NDK Crystal, we urge them
10 to implement a program to ensure the ongoing
11 integrity of any coating used on the new
12 process vessels. Employ an expert, for
13 example a coating expert, certified by NACE or
14 the National Association of Corrosion
15 Engineers, to design the program.

16 Also to NDK Crystal, we urge them
17 to implement an annual inspection and
18 corrective action program to ensure vessels
19 remain resistant to environmentally induced
20 damage mechanisms based on the inspection
21 guidelines set forth in the American Petroleum
22 Institute or API standard 510 pressure vessel

1 inspection code.

2 And finally, to NDK Crystal, we
3 ask them to provide a copy of this study to
4 the city of Belvidere building and zoning
5 department, and the Illinois Boiler and
6 Pressure Vessel Safety Division.

7 The concludes my portion of the
8 presentation. I'll now turn the proceedings
9 back over to the Chair and the Board. Thank
10 you.

11 CHAIRPERSON MOURE-ERASO: Thank
12 you very much, Mr. Banks. Now I'll continue
13 with the agenda. I'm going to ask the board
14 members if they have any questions for Ms.
15 Tyler or Mr. Banks. So, we'll start with
16 Board Member Griffon.

17 MEMBER GRIFFON: Sorry, I got to
18 put the mic on. This one probably is more
19 directed to Lucy, but I'll - either one of
20 you. In the findings, you talk about stress
21 corrosion cracking was the likely cause, but
22 in the report you also indicate that temper

1 embrittlement can't be ruled out.

2 Can you tell me what effect
3 determining that immediate cause, if any, had
4 on your ultimate recommendations, and how you
5 narrowed it down to SCC, stress corrosion
6 cracking, being the more likely cause?

7 MS. SCIALLO-TYLER: Sure, though
8 our expert metallurgists concluded that stress
9 corrosion cracking was the likely failure
10 mechanism, they also found evidence of temper
11 embrittlement as a failure mode.

12 And temper embrittlement, though
13 it really wasn't explained in the presentation
14 this morning, there is more detail in our
15 report, but it's a property that is inherently
16 present in alloy steels of this type that are
17 heat treated and quenched as part of the
18 manufacturing process.

19 And our metallurgists concluded
20 that temper embrittlement may have been acting
21 in addition to the stress corrosion cracking,
22 and this is based on some of the testing that

1 they did. And just looking at some of the
2 mechanical properties of the vessel, they only
3 found evidence of it, but weren't able to say
4 that it was the most likely scenario.

5 I think that the stress corrosion
6 cracking was a little bit more evident in some
7 of the tests that they performed. And another
8 part of that is the fact that the vessel
9 fragment itself, the 8,600 pound piece, was
10 the only piece that they examined.

11 They didn't look at the thicker
12 regions of the vessel. And the one thing that
13 we learned as part of our investigation is
14 that the manufacturer - I'm sorry, actually I
15 think the vessel fabricator, was having
16 problems with quench cracks during the
17 fabrication of the first - the initial first
18 two vessels, which were eventually discarded.

19 And that, in conjunction with some
20 of the findings from the vessel lid failure,
21 we concluded that due to the excessive
22 thickness of the vessel, the thicker regions

1 may not have achieved the appropriate grain
2 structure or the properties during the heating
3 and quenching process, and it may have
4 increased the susceptibility of the vessel to
5 crack under those very stressful, internal
6 stress process conditions.

7 MEMBER GRIFFON: Thank you. And
8 the second part was assuming you can't rule
9 out the one, how important would that be to
10 determine which one, in terms of your ultimate
11 recommendations? In other words, was it
12 necessary, or would it have likely resulted in
13 similar recommendations that you have here?

14 MS. SCIALLO-TYLER: I think that,
15 at least for the recommendations that we made
16 to ASME, we kind of wanted to address both
17 aspects of that. So, they had previously made
18 changes to the code to prohibit the use of
19 that type of steel or those types of
20 environments, so that kind of rules out the
21 whole stress corrosion cracking issue.

22 But, part of our recommendation to

1 ASME addresses that wall thickness issue that
2 may have contributed to the temper
3 embrittlement that was noted by our expert
4 metallurgists. So, our recommendation is kind
5 of two-fold in that it addresses both aspects.

6 MEMBER GRIFFON: All right, thank
7 you. And I have a few more, but I'm willing
8 to alternate if we -

9 CHAIRPERSON MOURE-ERASO: Yes,
10 Member Rosenberg?

11 MEMBER ROSENBERG: Thank you,
12 Chairperson Moure-Eraso. I wanted to ask the
13 team, is the permitting process connected in
14 any way with insurance coverage?

15 MS. SCIALLO-TYLER: The permitting
16 process for the -

17 MEMBER ROSENBERG: To operate
18 these vessels.

19 MS. SCIALLO-TYLER: For the
20 construction of the facility, or are we
21 talking about the vessel certification
22 process?

1 MEMBER ROSENBERG: Yeah, exactly,
2 to operate the vessels.

3 MS. SCIALLO-TYLER: Well, I can
4 say that I know that as part of the Boiler and
5 Pressure Vessel Safety Act, there are some
6 responsibilities for the insurance agencies as
7 far as notification. Would you like me to
8 expand on that?

9 MEMBER ROSENBERG: I'm just
10 wondering, is there a way we can use either
11 insurance coverage or the permitting process
12 to guarantee more safe operation of these
13 vessels?

14 MS. SCIALLO-TYLER: Well, what I
15 can tell you is one thing that we learned by,
16 you know, reading the Boiler and Pressure
17 Vessel Safety Act, at least in the state of
18 Illinois, that the insurance agencies that
19 insure facilities that have boiler and
20 pressure vessels do have responsibility as to
21 notify the chief inspector if they are
22 involved in an auditor inspection of a

1 facility and notice a risk, and actually
2 suspend their coverage of the risk.

3 So, that's one way that I know
4 based on, you know, the state rules, that the
5 inspector would be involved with the
6 permitting, if you will, of the pressure
7 vessels.

8 MEMBER ROSENBERG: Okay, thank
9 you.

10 CHAIRPERSON MOURE-ERASO: Let me
11 add one and then I'll come back you, Mark.
12 Who knew in NDK about the warning from the
13 insurance company, and when were they informed
14 of the warning? And also, why do you think,
15 and I'm asking either of you, the company
16 ignored these warnings of the insurance
17 company?

18 MS. SCIALLO-TYLER: Okay, I can
19 answer that, Johnnie, but feel free to weigh
20 in whenever. Based on the documentation the
21 CSB reviewed, only NDK, and the insurer, and
22 the consultants that did the work and issued

1 the initial letter, knew of the warning at
2 that time.

3 And to answer the second part of
4 your question, why did they ignore the
5 warnings from the company? Well, from what we
6 learned, that NDK did not feel that the
7 failure scenario listed in the consultant's
8 letter would produce the same outcome as
9 stated in the warning.

10 NDK was planning to purchase new
11 vessels. However, they had not done so by the
12 time of the fatal accident. But we also
13 learned that this was not the only
14 recommendation from the NDK insurance company
15 that NDK received and remained unfulfilled at
16 the time of the incident.

17 It was noted by the insurance
18 company that their safety program was somewhat
19 informal, lacking formalized job training,
20 standard operating procedures, and an injury
21 and incident notification and investigation
22 program.

1 So, this is kind of part of a
2 trend there, you know, a consistent trend in
3 their performance with, you know, their
4 approach to internal safety.

5 CHAIRPERSON MOURE-ERASO: Thank
6 you. I have another question. The - was the
7 zoning as, you know, the classification of the
8 NDK production as a light industry, have an
9 impact on the accident that happened? I mean,
10 if they would have been classified as a heavy
11 industry, do you think that would have an
12 effect on the zoning and this could have been
13 prevented?

14 MS. SCIALLO-TYLER: It's kind of
15 hard to say just because the way in which the
16 vessel exploded and the distance that the
17 fragment traveled was such a random event.
18 But, I think that the facility may have been
19 located in a different place because the heavy
20 industrial zoning portion is in another area.
21 It could have been located farther away from
22 any sort of commercial activity.

1 I'm not quite sure if it would
2 have been further away from the interstate.
3 But it was noted that, you know, when we
4 looked at the initial zoning and permitting
5 for that facility, that it was put into light
6 industrial, and we didn't feel that the type
7 of process there really classified as light
8 industrial. It was more heavy industrial.

9 CHAIRPERSON MOURE-ERASO: Thank
10 you.

11 MS. SCIALLO-TYLER: And was there
12 a second part of your question?

13 CHAIRPERSON MOURE-ERASO: No, I
14 mean, it was right. I think you answered it.

15 (Laughter)

16 MEMBER GRIFFON: Lucy, I'll give
17 you the second part of the question. Did the
18 team consider making recommendations for
19 changing that code, in other words, how they
20 classified light or heavy or -

21 MS. SCIALLO-TYLER: Yeah, we
22 looked at the 1994 Belvidere zoning code, and

1 of course the code has changed considerably
2 over the years. And the current version of
3 the code does have more strict requirements
4 for heavy and light industrial zones. There's
5 performance standards for heavy industrial
6 zones.

7 So, there's definitely a little
8 bit more oversight with regard to public
9 safety listed in the code now versus 1994.
10 However, I'm not quite sure, you know, if
11 someone similar to NDK were to come to
12 construct and operate a facility, you know,
13 how the city of Belvidere would approach that
14 zoning. But I will say this, the code has
15 changed somewhat.

16 MEMBER GRIFFON: Okay, and I have
17 a - going in a slightly different direction
18 with this question. But, did - in the course
19 of the investigation, did you guys - do you
20 have any number - I'm just curious, like the
21 numbers of these types of pressure vessels,
22 and I don't even know how they're necessarily

1 classified.

2 But pressure vessels that operate
3 at these high pressures in Illinois or in the
4 United States, I mean, do we have any sense of
5 the breadth of this hazard?

6 MS. SCIALLO-TYLER: I can say that
7 as far as, you know, the number of heavy
8 pressure vessels like, you know, the
9 temperature or the pressure that NDK was
10 operating at, I don't have a number on that.

11 MEMBER GRIFFON: Okay, all right.
12 And the only other thing was I know -

13 MS. SCIALLO-TYLER: I mean, I can
14 also add that, you know, that we do know that
15 there's another process similar to NDK that
16 does operate in the country, but their process
17 and the pressures that they use, though
18 they're pretty high, are not quite as high as
19 NDK's.

20 MEMBER GRIFFON: All right. And
21 then just my last question, I know, it was
22 mentioned, and I realize that this operation

1 isn't covered under process safety management
2 regulations, but did the team look at whether
3 these type of pressure vessels should be
4 included in a process safety management type
5 of regulation, or have similar components as
6 the process safety management rules such as
7 process hazard analysis, those kind of
8 components?

9 MS. SCIALLO-TYLER: Yeah, the team
10 examined this, and basically it came down to
11 the fact that the, you know, what puts
12 processes under or to be covered under the PSM
13 standard is based on the chemical quantity or,
14 you know, the capacity -

15 MEMBER GRIFFON: Right.

16 MS. SCIALLO-TYLER: - of the
17 vessels to have a certain amount of a highly
18 hazardous chemical or a flammable material.
19 And these vessels did not contain enough, you
20 know, enough of a hazardous quantity of
21 chemicals or hazardous materials. They would
22 not be covered.

1 So, I think that, you know, it is
2 worth examining that, you know, there are some
3 aspects of the PSM program that might have
4 been somewhat beneficial with regard to the
5 operation and inspection of these vessels,
6 such as process hazard analysis or a robust
7 mechanical integrity program that would have
8 encompassed some of the recognized and
9 generally accepted engineering practices that
10 govern the inspection of pressure vessels such
11 as the API codes.

12 MEMBER GRIFFON: And I raise it
13 realizing the threshold quantities wouldn't
14 have been met in this case, and I think that
15 might be a limitation of our process safety
16 management rule, but also we've learned
17 recently it, you know, even in the UK they
18 have similar restrictions on their high hazard
19 facility regulations. So, it's just something
20 I thought is interesting maybe to consider out
21 of this case. Thank you.

22 CHAIRPERSON MOURE-ERASO: Thank

1 you. I have one last one, Lucy.

2 MS. SCIALLO-TYLER: Okay.

3 CHAIRPERSON MOURE-ERASO: Could
4 you sort of expand a little of what is the
5 safer process that could be used to produce
6 this silica crystals? What is the difference
7 between the safer process and this process?
8 I mean, can you give some details?

9 MS. SCIALLO-TYLER: Sure, I mean,
10 we've briefly researched other crystal growing
11 operations in the United States. We've found
12 only one other company that makes synthetic
13 crystals similar to NDK's, and they're located
14 in Ohio. We learned that the company uses
15 vessels that are smaller and thinner, and they
16 run at lower temperatures and pressures than
17 the ones used at NDK.

18 And though we did not do an in
19 depth analysis of the overall risk associated
20 with this process, it appears that it may be
21 an alternative to the NDK process which
22 requires such a high amount of pressure and

1 temperature inside the vessels which
2 ultimately can pose a risk to worker and
3 public safety.

4 CHAIRPERSON MOURE-ERASO: Do you
5 remember the numbers? I'm curious about the
6 difference between the pressures and
7 temperatures from NDK and this Ohio process.
8 What was the difference in numbers? The
9 question again, I wonder if you remember the
10 numbers, I mean, how much lower was the
11 pressure and how much lower was the
12 temperature?

13 MS. SCIALLO-TYLER: I'm sorry, I
14 don't quite have that information available,
15 but - I would have to check back for you.
16 It's in our report.

17 CHAIRPERSON MOURE-ERASO: Okay,
18 yeah, thank you. I'm just curious. Thank you
19 very much. So, there is not any more
20 questions from the board, okay. So, I would
21 like to call the CSB managing director, Dr.
22 Daniel Horowitz, to ask him to facilitate the

1 public comment if you would to. I understand
2 you have a list. So, Dr. Horowitz?

3 DR. HOROWITZ: Thank you, Mr.
4 Chairman. If you've signed up, that's great.
5 If you haven't signed up, it's not too late.
6 You're certainly welcome to comment as well.
7 It's a - okay. It is a -

8 SPEAKER: Daniel, you might want
9 to pull the mic over.

10 DR. HOROWITZ: Okay. It is a
11 small group, so you're all welcome to comment
12 if you wish. First commenter is Crispin Hales
13 of Hales and Gooch, Limited, and I believe
14 representing Traveler's Insurance. Dr. Hales,
15 could you step up to the microphone? And
16 could you please spell your name for the
17 transcript? Thank you.

18 DR. HALES: Yes, it's Crispin
19 Hales, C-R-I-S-P-I-N H-A-L-E-S. And really,
20 this is a personal thing that I've been
21 involved in many investigations, and I really
22 appreciate what the CSB has done on this

1 particular investigation and the way it's been
2 presented to us today, and the detail in which
3 you've gone into this particular failure.

4 It's absolutely crucial within the
5 U.S. that we take note of these type of
6 accidents. And again, very sad that a person
7 had to lose their life in order for this to be
8 looked at in this kind of detail that we're
9 looking at it today. Thank you.

10 DR. HOROWITZ: Thank you, Dr.
11 Hales. And next is John Morawetz of the
12 International Chemical Workers Union. John,
13 could you spell your name, please?

14 MR. MORAWETZ: John J-O-H-N
15 Morawetz M-O-R-A-W-E-T-Z. A few questions
16 similar to the board asking questions. One
17 is, is it in the report, I'm not sure, I
18 didn't see it, were there workers at the
19 facility in a control room when this incident
20 took place?

21 DR. HOROWITZ: I think we can
22 answer that. Lucy, were you able to hear, or

1 Johnnie, were you able to hear that?

2 MR. BANKS: Yes, there were.

3 There were workers at the site.

4 MS. SCIALLO-TYLER: Yes, yes,
5 there - I think there may have been, and I
6 believe it's in the report, I think there may
7 have been about five or six workers in the NDK
8 Crystal facility present, and then over in the
9 NDK America, the adjoining office area, I
10 don't remember the exact number, but there was
11 a pretty high number of office workers that
12 were there that day.

13 MR. MORAWETZ: And how far was
14 that facility, was the office area from the
15 vessel that erupted?

16 MS. SCIALLO-TYLER: It was in the
17 same building, if you will, it was just an
18 adjoining building. So, I mean, I probably
19 couldn't give you an estimate on the number of
20 feet, but, you know, I would say like less
21 than 100 feet away.

22 MR. MORAWETZ: And was it in a

1 sort of protected environment, explosive
2 proof, or anything like that better
3 constructed? Basically, were these workers at
4 risk, and more importantly, is this in the
5 report? I haven't had a chance to read the
6 detail in the report yet.

7 MS. SCIALLO-TYLER: I can say that
8 the - that there was - that there were no
9 injuries. There was some pretty significant
10 damage to that office area as a result of the
11 rupture. I mean, there was a lot of broken
12 glass. There was a lot of disturbed
13 furniture, walls, loss of power. So, the
14 office area that does connect itself, you
15 know, the NDK America office area was severely
16 damaged by the vessel rupture.

17 MR. MORAWETZ: And more
18 importantly, is that covered in the report?

19 DR. HOROWITZ: Not specifically in
20 terms of the office area, John, but it does
21 talk in general that this facility and the
22 other facilities were not prepared for this

1 sort of catastrophic scenario. Clearly I
2 think that comes across through the whole
3 investigation.

4 MR. MORAWETZ: There's a
5 particular personal reason why I would raise
6 that.

7 DR. HOROWITZ: Yeah, go ahead.
8 Why don't you - if you can, give us your
9 comment - give us your questions. At the end,
10 we'll try to -

11 MR. MORAWETZ: Okay, well, in
12 particular, in September 2012, we lost two
13 members in Memphis, Tennessee, where a vessel
14 erupted. They were in the control room. They
15 were not protected and they both died. So,
16 it's a particularly important issue for us.
17 And I would urge the board to put that in the
18 report, in the case study. I know it's not a
19 full report.

20 Otherwise, you know, in
21 particular, it's interesting that the truck
22 driver is called the public, although I

1 understand it's not a member of the work force
2 at this facility, I assume he was a driver, he
3 was at work.

4 And in particular, I've talked to
5 Lamont Byrd, the head of the Teamsters Union
6 Health and Safety Department, and they have a
7 concern about truck drivers who go in and out
8 of facilities, as well as the whole issue of
9 siting, that clearly this facility was so
10 close to any area, gas pumps, and all the rest
11 of it, that vividly you show in the video is
12 included, and its exit at work.

13 If I can just transition with time
14 being short, and I believe this comment is
15 going to be submitted to you. I have a
16 comment I'd like to read into the record on
17 behalf of the steel workers.

18 "On behalf of the" - and I got
19 this, this morning. "On behalf of the 850,000
20 United Steel Worker Members, we appreciate the
21 opportunity to provide a comment for the
22 record even though we were unable to attend

1 this public meeting in person.

2 The USW has had no direct
3 involvement with the NDK Crystal incident.
4 However, we certainly are very interested in
5 some issues the incident raises. This
6 incident involved an off-site facility, off-
7 site injuries, and damage to off-site
8 property.

9 The CSB is currently investigating
10 several incidents involving off-site
11 consequences that the USW is directly
12 involved, including the recent incident at the
13 Chevron facility in Richmond, California,
14 where approximately 15,000 people from the
15 surrounding community went to the hospital
16 after the crude unit fire.

17 The USW is very concerned about
18 incidents directly affecting the workers, but
19 also we understand that high hazard facilities
20 also pose a risk to the community and the
21 environment.

22 The USW is looking forward to the

1 CSB's findings and recommendations related to
2 safety siting and reducing the risk to the
3 communities in which our members work.

4 We also wish to submit into the
5 record" - and I assume they'll it to the board
6 - "our continued and repeated concern
7 pertaining to time limits to the CSB
8 investigation reports. The investigation
9 being discussed today is nearly four years
10 old.

11 The Tesoro investigation is almost
12 four years old, and is not the only long
13 delayed CSB report. At a CSB public meeting
14 in January of 2012, the USW asked for the CSB
15 to hold a public meeting to discuss the
16 problems associated with the backlog of CSB
17 reports.

18 On November 8, Mike Wright of the
19 USW submitted a letter to the CSB board
20 members requesting clarifications on
21 commitments made by CSB board chair, Moure-
22 Eraso, at the USW's 2013 health safety and

1 environment conference in Pittsburgh. I
2 request that letter to be included in the
3 record of this meeting.

4 The letter asked for clarification
5 on the completion dates, and focused on
6 several open investigations which involved USW
7 representative workers, including the April
8 2010 Tesoro investigation, the 2009 Citgo
9 investigation, the 2010 Horsehead zinc
10 investigation, and the apparent commitment by
11 the board chair to initiate a study on all
12 U.S. oil refineries that use hydrofluoric
13 acid.

14 We again urge the CSB to hold a
15 public meeting in Washington, D.C., to review
16 and discuss the backlog of investigative
17 reports, providing an opportunity to update
18 interested stakeholders on these important
19 issues."

20 And let me also say that the
21 Teamsters wrote to me saying that the
22 Teamsters are also concerned about safety in

1 these facilities. Our members both in
2 trucking and rail operations deliver materials
3 to manufacturing facilities, and they have
4 pressurized vessels on site.

5 Let me just add that I think the
6 point that they raise about CSB meetings are
7 important. I think the board should discuss
8 and have a plan, and goals, and time lines on
9 the back log. I think we appreciate this
10 report being completed, being one of the older
11 reports, and we're pleased that's happening.

12 Also, in terms of goals on the
13 general cases that are outstanding, clearly
14 one big one that's not mentioned by the steel
15 workers is Deepwater Horizon. As I think
16 everybody in the room is painfully aware, it
17 takes a lot of staff time and resources, and
18 I would urge that that could be wrapped up.
19 I hope there are some goals, certainly before
20 the fourth anniversary of that disaster, that
21 that can be addressed or put to bed and behind
22 you.

1 And lastly, I would hope that -
2 I'm not sure, and it maybe a question for you,
3 Daniel, is whether usually are preliminary
4 findings or PowerPoints that are distributed
5 before the meeting? That would be helpful for
6 those of us to attend the meeting to make
7 informed comments at the meeting and get more
8 out of it.

9 Similarly, it's nice having a
10 video feed I would hope for some of us. I
11 know for some interested parties, that it
12 would be helpful to have a phone-in line where
13 people can comment. Thank you very much.

14 DR. HOROWITZ: Thank you, John.
15 And in answer to your earlier point, we're
16 also concerned about the issue of control room
17 siting. We've made a number of
18 recommendations actually from other cases.

19 Johnnie Banks was involved with
20 the Carbide Industries investigation that we
21 completed actually earlier this year. Two
22 workers there were actually killed in a

1 control room that was not safety sited.

2 Also, our STEREOGENICS? ***8:15:56
3 cases. DELEC? was a case that the prior
4 chairman had dropped, but the other three
5 cases, there are reports on our website, and
6 so, you can see those recommendations. And we
7 certainly share your concern about that issue.
8 And thank you for traveling here for the
9 meeting.

10 Next is Dr. William J. O'Donnell
11 with O'Donnell Consulting Engineers. Dr.
12 O'Donnell? And I understand you're the chair
13 of the ASME subcommittee involved in writing
14 standards for this particular area.

15 DR. O'DONNELL: Yeah, that's
16 right. I am chairman of the subgroup on
17 fatigue strength for the last 45 years. And
18 I can say that this vessel did not meet our
19 requirements, but the requirements may not
20 have been as explicit as they appear to us to
21 be, in particular in the area of stress
22 corrosion cracking, which is the problem here.

1 This vessel didn't meet safety
2 margins for stress corrosion cracking. In
3 fact, the safety margins were very close to
4 one. And I'm not allowed, by the way, to
5 speak for the code. The code has 1,000
6 volunteers, and they don't like one person
7 speaking for them.

8 So, I'm speaking as a person who
9 is published in this field, and who is
10 recognized sort of for these fatigue cracking,
11 stress corrosion cracking, crack growth,
12 metallurgy, those areas. I spent the last 50
13 years of my life in those areas.

14 And I want to say that I think
15 that this investigation was extremely well
16 conducted. I couldn't believe that all of
17 these metallurgical issues got pulled in by
18 the team. They went to other parts of the
19 government to get this expertise. They got
20 it.

21 They got very good reports from
22 them. They converted it into this draft

1 report, which usually when you get a report
2 from a metallurgist, nobody can read it but
3 the metallurgist, and they have converted this
4 into common sense that everybody can
5 understand what the hell happened.

6 I think it's extremely well
7 balanced, the report. It doesn't surprise me
8 that it took four years. It's taken us four
9 years. We're trying to tie up any loose ends
10 that still may be in the code ***8:18:29.

11 And codes and standards are
12 usually written by engineers for use by
13 engineers, and are sometimes not the best.

14 So, I really was quite impressed
15 with the report, and ***8:18:53.

16 And they were hoping the acmite
17 layer was going to be okay, but they didn't do
18 any testing of it, and that, in my mind, does
19 not meet code. ***8:19:18.

20 So, I really am complimenting the
21 investigative committee going out and getting
22 all the different expertise they needed and

1 putting them together in the right way. It
2 was really a remarkable achievement.

3 And I really only have one - being
4 an engineer, of course, I mean, we get very
5 meticulous, and there was - the one thing I
6 would like to see changed in the
7 recommendations was the one that was put up
8 here, the R5 that was up on the board.

9 And the R5 said that they want NDK
10 Crystal to ensure that the facility uses a
11 process that is rigorously demonstrated to be
12 inherently safer than the existing process.
13 That ain't good enough. Being safer than zero
14 is not, you know. From an engineering point
15 of view, that's not what you want to do.

16 I think if you change that to say,
17 "demonstrated to meet the safety margins of
18 the ASME code for stress corrosion cracking,"
19 you know, that basically in the ASME code is
20 a factor of three against bursting of pressure
21 vessels.

22 And you can do a rigorous stress

1 corrosion cracking analysis, and you can get
2 the damn safety margins, and those safety
3 margins should meet code safety margins. So,
4 that's really my only, you know, in all of
5 this great work that was done here, that's the
6 only thing I would change in the
7 recommendations. I think it was extremely
8 well done.

9 We heard a lot of stories from
10 different people in the beginning of this
11 thing, why this thing occurred that were
12 technically sound. The board did not bite on
13 any of those. Some of those were brought to
14 my committees. We said, "No, the physical
15 evidence doesn't support what you're
16 claiming."

17 And I was very much afraid that
18 they - that some people who were claiming
19 these things would convince the board that
20 they were true. So, one of the reasons I'm
21 here was to make sure that doesn't happen.

22 (Laughter)

1 DR. O'DONNELL: So, thank you very
2 much.

3 CHAIRPERSON MOURE-ERASO: Thank
4 you.

5 DR. HOROWITZ: Thank you, Dr.
6 O'Donnell. We appreciate it. Is there anyone
7 else who did not sign up who would like to
8 comment? Well, I think that's it, Mr.
9 Chairman.

10 CHAIRPERSON MOURE-ERASO: Thank
11 you, Dr. Horowitz. So, we move to the board
12 consideration of the product. So, I make a
13 motion. I move that the board approve the NDK
14 Crystal Incorporated Belvidere, Illinois high
15 pressure vessel rupture case study identified
16 as CSB Investigation Number 2010-04-IL for
17 Illinois, and all associated video products.
18 Do I hear a second?

19 MEMBER ROSENBERG: I second.

20 CHAIRPERSON MOURE-ERASO: Is there
21 any discussion, more discussion of this?

22 (NO AUDIBLE RESPONSE)

1 CHAIRPERSON MOURE-ERASO: So, I
2 ask for general council to please proceed with
3 the vote.

4 SPEAKER: The question is on the
5 floor. Thank you, Mr. Chairman. I will take
6 the roll. Member Rosenberg?

7 MEMBER ROSENBERG: Aye.

8 SPEAKER: Member Griffon?

9 MEMBER GRIFFON: Aye.

10 SPEAKER: Mr. Chairman?

11 CHAIRPERSON MOURE-ERASO: Aye.

12 SPEAKER: There you have it.

13 (Laughter)

14 CHAIRPERSON MOURE-ERASO:
15 Excellent. So, I guess the matters of this
16 meeting have been all covered, and I declare
17 this meeting finished.

18 (Whereupon, the meeting adjourned
19 at 12:01 p.m.)

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