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1 **I. INTRODUCTION**

2  
3 Q. PLEASE STATE YOUR NAME AND EMPLOYER.

4 A. My name is Anthony Allen Tipton. I am the owner and operator of New  
5 England Metallurgical.

6  
7 Q. HAVE YOU PREVIOUSLY PROVIDED TESTIMONY IN THIS PROCEEDING?

8 A. Yes. On June 16, 2023, I filed my Direct Testimony on behalf of Northern  
9 States Power Company (Xcel Energy or the Company), that explained my  
10 involvement in determining the root cause of the November 19, 2011  
11 catastrophic failure of Unit 3 at the Sherburne County (Sherco) generating plant  
12 (the Event), culminating in the Thielsch Engineering root cause analysis  
13 (Thielsch Report or Report), attached as Schedules 2 and 3 to that testimony.<sup>1</sup>  
14 I detailed the nature of the Event and identified the equipment involved in it,  
15 described the critical design features of that equipment and discussed its  
16 operational and maintenance history, and ultimately provided my expert  
17 opinion on the root cause of the Event. As I discussed, the primary causal factor  
18 responsible for the stress corrosion cracking and fracture of the Sherco Unit 3  
19 low-pressure (LP) turbine rotor disks was General Electric's (GE) equipment  
20 design.

21  
22 Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

23 A. My Rebuttal Testimony responds to testimony filed by Mr. Richard Polich of  
24 GDS Associates, Inc. on behalf of the Minnesota Department of Commerce  
25 (Department). In particular, I respond to Mr. Polich's misrepresentations

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<sup>1</sup> Tipton Direct, Exhibit\_\_\_\_(AAT-1), Schedules 2 and 3.

1 regarding the Thielsch Report conclusions—and Mr. Polich’s failure to address  
2 the *actual* conclusion presented in that Report.

3  
4 **II. OVERALL RESPONSE TO WITNESS RICHARD POLICH**

5  
6 Q. WHAT OVERARCHING OBSERVATIONS DO YOU HAVE REGARDING MR. POLICH’S  
7 TESTIMONY?

8 A. Mr. Polich presents a distorted and inaccurate picture of both the Thielsch  
9 Report and the root cause of the Event. He misstates the conclusions of the  
10 Report and completely overlooks the importance of operating stresses on stress  
11 corrosion cracking, which will be addressed further below. His testimony  
12 reflects a misunderstanding of the variables that effect stress corrosion cracking  
13 and their interaction, and it appears to be based on ignoring or not  
14 understanding the information available to him—including information within  
15 the Report itself. This suggests a lack of expertise regarding both the subject of  
16 stress corrosion cracking and metallurgical engineering. And despite his  
17 representations to the contrary, Mr. Polich did neither a root cause analysis nor  
18 a failure analysis; rather, he selectively chose excerpts of others’ work in an  
19 attempt to support his unsubstantiated conclusions.

20  
21 **III. THE THIELSCH REPORT**

22  
23 Q. BEFORE TURNING TO MR. POLICH’S CRITICISMS OF THE THIELSCH REPORT, CAN  
24 YOU PROVIDE AN OVERVIEW OF HOW THE REPORT WAS DEVELOPED AND ITS  
25 CONCLUSION REGARDING THE ROOT CAUSE OF THE CATASTROPHIC FAILURE OF  
26 UNIT 3?

1 A. The Thielsch Engineering root cause analysis and resulting Report examined all  
2 physical evidence, plant operating documentation and industry experience to  
3 determine the damage mechanism responsible for the disk fracture and the root  
4 cause of its manifestation. This forensic metallurgical examination, which  
5 occurred over an 18-month timeframe, included (but was not limited to) a  
6 comprehensive review of maintenance/inspection records and water chemistry  
7 data related to Unit 3 that is detailed in the Report. The root cause analysis  
8 identified stress corrosion cracking as the *cause* of the fracture. The Thielsch  
9 Report then examined the potential causal factors *responsible for the stress corrosion*  
10 *cracking*, design (*i.e.*, the suitability of the rotor material for the intended  
11 application and the static design stresses in the finger pinned blade  
12 attachments<sup>2</sup>), operation (*i.e.*, load operation and chemistry), and past  
13 maintenance practices. All three potential causal factors were rigorously  
14 investigated and it was ultimately determined that the original design of the  
15 finger pinned blade attachments made them susceptible to stress corrosion  
16 cracking *under normal operating conditions* and, therefore, was the primary causal  
17 factor, *i.e.*, root cause. The facts and engineering assessment leading to these  
18 logical conclusions are clearly delineated in the Report.<sup>3</sup>

19  
20 Q. MR. POLICH CRITICIZES THE THIELSCH REPORT, IN PART, BY STATING THAT THE  
21 REPORT ONLY IDENTIFIED A “CONTRIBUTOR” TO THE FAILURE, NOT THE “TRUE  
22 ROOT CAUSE.” HOW DO YOU RESPOND?

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<sup>2</sup> As previously explained in my Direct Testimony, I use the term “finger-pinned” to describe the attachment between the rotor disk and the blade that GE, and others, refer to as a “finger dovetail.” The terms, however, are interchangeable.

<sup>3</sup> Thielsch Report, Tipton Direct, Exhibit\_\_\_\_(AAT-1), Schedule 2, pp. 92-96 (pp. 90-94 of the Report).

1 A. Mr. Polich misstates (or misunderstands) the conclusion of the Thielsch Report;  
2 accordingly, his disagreement with that misstated conclusion is inconsequential.  
3 For example, Mr. Polich claims that the Thielsch Report found the Event was  
4 caused by “pre-existing [stress corrosion cracking] . . . likely caused by sodium  
5 hydroxide.”<sup>4</sup> In other words, Mr. Polich claims the Thielsch Report blamed the  
6 root cause on chemistry. This is wrong. In fact, the Report expressly states that  
7 “[i]t is concluded that the steam chemistry was not a significant factor  
8 contribut[ing] to stress corrosion cracking of the LP L-1 disk finger pinned  
9 blade attachments.”<sup>5</sup> Instead, the Report clearly states that the primary cause of  
10 the stress corrosion cracking was “the high static stresses generated during  
11 normal operation. . . [which] are *solely a function of the original design*. . .”<sup>6</sup>  
12 In other words, after carefully scrutinizing all potential operational factors,  
13 including chemistry and past maintenance practices, the Thielsch Report found  
14 that the root cause of the Event was the “original design” by GE of the turbine.  
15  
16 As I explained in my Direct Testimony, “the design stresses at the LP L-1 finger-  
17 pinned blade attachment area of the LP L-1 rotor disks were sufficiently high  
18 to render the rotor material susceptible to caustic stress corrosion cracking  
19 under normal operating conditions.”<sup>7</sup> Put differently, the *as-designed* operating  
20 stresses were sufficient to result in stress corrosion cracking even in “pure”  
21 laboratory water.

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<sup>4</sup> Polich Direct, p.19.

<sup>5</sup> Thielsch Report, Tipton Direct, Exhibit\_\_\_\_(AAT-1), Schedule 2, p. 94 (p. 92 of the Report).

<sup>6</sup> Thielsch Report, Tipton Direct, Exhibit\_\_\_\_(AAT-1), Schedule 2, p. 95 (p. 93 of the Report). (Emphasis added).

<sup>7</sup> Tipton Direct, p. 16.

1 Notably, Mr. Polich *never addressed* the Thielsch Report’s actual conclusion, and  
2 he *never discusses* the primary role of the design of the Unit 3 LP turbines in the  
3 catastrophic failure of Unit 3. It is unclear how Mr. Polich purports to have  
4 conducted a rigorous root cause analysis when he failed to consider this  
5 significant, potential causal factor. Based on my more than 40 years of  
6 metallurgical experience, where I have performed over 300 failure analyses and  
7 root cause analyses of gas and steam turbines, it is my opinion that Mr. Polich’s  
8 failure to even consider the design of the low-pressure turbine L-1 disk finger  
9 pinned blade attachments as a potential root cause of the Event casts  
10 considerable doubt on the rigor of Mr. Polich’s analysis.

11  
12 Q. MR. POLICH ALSO CRITICIZED THE REPORT’S EVALUATION OF THE COMPANY’S  
13 WATER CHEMISTRY PRACTICES AT UNIT 3 AS “NOT VALID” AND “WITHOUT  
14 MERIT,” STATING THAT “THIELSCH NEVER VERIFIED THE WATER CHEMISTRY  
15 MONITORING PRACTICES OR EQUIPMENT CALIBRATION PRACTICES OF SHERCO  
16 3.”<sup>8</sup> HOW DO YOU RESPOND?

17 A. Company witness Mr. David Daniels provides the Company’s response on  
18 water and steam chemistry issues. However, I would note that the Thielsch  
19 Report included a thorough review of all available water chemistry data to  
20 include boiler water sodium content from grab samples from 1987 until the  
21 Event, electronically archived boiler water sodium content from 2001 until the  
22 Event, boiler water cation conductivity from 2000 until the Event, cation and  
23 sodium content at the condensate pump discharge from 2000 until the Event  
24 and cation conductivity at the economizer inlet from 2000 until the Event. The  
25 data reviewed indicated that the cation conductivity and sodium content at the

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<sup>8</sup> Polich Direct, pp. 51-52.





1 Based on this, it appears Mr. Polich has identified three potential root causes:  
2 (1) failure to maintain proper steam chemistry; (2) failure to perform timely  
3 inspections; and (3) failure to recognize the potential for stress corrosion  
4 cracking to occur in the LP turbine.

5  
6 Q. WHAT IS THE BASIS FOR MR. POLICH'S CLAIMS?

7 A. In contrast to the work performed for my root cause analysis and the Thielsch  
8 Report, it does not appear that Mr. Polich performed any in-depth, first-hand  
9 analysis. Rather, he has used bits and pieces of the Report, together with  
10 unrelated industry experience, such as EPRI studies on stress corrosion cracking  
11 of LP blades and stress corrosion cracking of disk keyways in nuclear power  
12 turbines, to create a narrative that simply does not reflect reality.

13  
14 Q. ARE ANY OF THE FACTORS IDENTIFIED BY MR. POLICH THE ROOT CAUSE OF THE  
15 FAILURE?

16 A. No. While other Company witnesses more fully address Mr. Polich's  
17 misstatements, misunderstandings, or misrepresentations on some of these  
18 matters, it is critical to recognize that Mr. Polich completely ignores the fact  
19 that, due to GE's turbine design of this unit, the *as-designed operating stresses* are  
20 sufficient to result in stress corrosion cracking even in "pure" laboratory water.  
21 The Thielsch Report analyzed the operating stresses in the finger pinned blade  
22 attachment and found that they were greater than that sufficient to cause stress  
23 corrosion cracking in such "pure" water. The operating stresses are *solely* a result  
24 of the original manufacturer's design. This means that stress corrosion cracking  
25 of the L-1 disk was inevitable and the *design* was the root cause of the failure.  
26 Once again, Mr. Polich mentions not one word regarding the stress analysis by  
27 Thielsch Engineering, the peer-reviewed and published data regarding stress

1 corrosion cracking threshold stress for the L-1 disk material, or the importance  
2 of operating stress on stress corrosion cracking. Mr. Polich's complete failure  
3 to address this issue indicates a lack of knowledge and understanding on his part  
4 regarding stress corrosion cracking and the effect of critical variables.

5  
6 Q. HOW DOES MR. POLICH'S FAILURE TO ADDRESS THIS ISSUE FURTHER IMPACT HIS  
7 TESTIMONY?

8 A. In addition to calling into question the entirety of his testimony, Mr. Polich's  
9 failure to recognize the fundamental design issue of the LP turbines used at  
10 Sherco Unit 3 completely undermines his testimony regarding water chemistry.  
11 Mr. Daniels explains that the Company's chemistry practices were reasonable.  
12 However, since the as-designed operating stresses in the finger pinned blade  
13 attachment were greater than that sufficient to cause stress corrosion cracking  
14 in "pure" laboratory water, the entire subject of water chemistry is in some ways  
15 an academic exercise.

16  
17 Q. DO YOU HAVE ANY OTHER CONCERNS WITH MR. POLICH'S TESTIMONY  
18 REGARDING STRESS CORROSION CRACKING, IN GENERAL?

19 A Yes. Mr. Polich testifies that stress corrosion cracking requires three  
20 components, "... susceptible material, corrosive environment, and high  
21 stress."<sup>11</sup> This statement shows a lack of understanding regarding stress  
22 corrosion and metallurgy in general. Stress corrosion cracking does not require  
23 the environment to be corrosive nor does the stress need to be "high." The  
24 term "high stress" is seldom used in engineering because it is undefined. In any  
25 event, the materials used, environment and stress levels were all thoroughly

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<sup>11</sup> Polich Direct, p. 22.

1 analyzed as part of the root cause analysis and presented in the Thielsch Report.  
2 Mr. Polich does not mention the subject of operating stresses or disk material  
3 at all in his testimony. Instead, he myopically focuses on water chemistry. Had  
4 he examined the subject of design stresses in the finger-pinned blade attachment  
5 areas of the L-1 disks and understood the implications with respect to stress  
6 corrosion cracking, it would be clear that his focus on water chemistry was  
7 misplaced. The rigorous root cause analysis performed by Thielsch Engineering  
8 confirmed that the design stresses at the L-1 finger pinned blade attachment  
9 area were sufficiently high to render the rotor material susceptible to stress  
10 corrosion cracking *under normal operating conditions*.

11  
12 Q. DO YOU HAVE ANY RESPONSE TO MR. POLICH'S OTHER CLAIMED ROOT CAUSES  
13 OF THE EVENT?

14 A. Company witnesses Mr. Herbert J. Sirois and Mr. Timothy P. Murray discuss  
15 the subject of timely and appropriate inspections in greater detail. However, I  
16 would note that at the time of the failure, there were no Technical Information  
17 Letters (TILs) or General Electric Knowledge bulletins (GEKs) from General  
18 Electric indicating the need for steam turbine operators, during routine major  
19 inspections, to perform a blades-off, magnetic particle inspection of the finger  
20 pinned blade attachments on the L-1 disks for units with drum boilers. Nor  
21 were there any EPRI guidelines regarding the need for such inspections on units  
22 operating with drum boilers. There had been no reports of problems with units  
23 operating with drum boilers related to finger pinned blade attachment area of  
24 L-1 disks. In short, there was no reason to expect stress corrosion cracking of  
25 the finger pinned blade attachment of L-1 disks that would have warranted  
26 further inspections of the internal fingers prior to the failure. To suggest  
27 otherwise is simply hindsight. And regarding Xcel Energy's alleged knowledge

1 of stress corrosion cracking risks, Company witness Mr. Sirois and others  
2 explain why Mr. Polich’s general statements are meaningless and that Xcel  
3 Energy, in fact, expended substantial effort to understand this issue.  
4

## 5 V. CONCLUSION

6  
7 Q. PLEASE SUMMARIZE YOUR TESTIMONY.

8 A. The Thielsch Report was the culmination of a nearly 18-month, thorough and  
9 comprehensive examination of physical evidence, plant documentation,  
10 interviews with key personnel, industry guidance, and industry experience. After  
11 reviewing all potential causes of the failure, the Report’s conclusion was clear:  
12 the primary causal factor responsible for stress corrosion cracking and fracture  
13 of the Unit 3 LP turbine rotor disks was GE’s equipment design—specifically,  
14 the issue of the as-designed operating stresses in the finger pinned blade  
15 attachment that were sufficient to result in stress corrosion cracking even in  
16 “pure” laboratory water. In contrast, Mr. Polich failed to perform a detailed,  
17 first-hand analysis and instead cherry-picks from the Report and misrepresents  
18 the Report’s conclusions—while completely failing to address the Report’s  
19 *actual* conclusion. Mr. Polich’s complete failure to address these important  
20 issues, combined with his lack of understanding about stress corrosion and  
21 metallurgy generally, underscores that he lacks the knowledge and experience  
22 needed to offer root cause analysis opinions.  
23

24 Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY?

25 A. Yes, it does.