Public Comments

CSB's Draft Tesoro Anacortes Refinery Investigation Report

Contents

	Mark George Comments
1	<u>Page 4 – Key Finding #9.</u> *The startup of the NHT heat exchangers was hazardous non-routine work. Leaks routinely developed that presented hazards to workers conducting the startup activities. Process Hazard Analyses (PHAs) at the refinery repeatedly failed to ensure that these hazards were controlled and that the number of workers exposed to these hazards was minimized. (Section 5.2.3)* This is somewhat misleading as written. The exchanger bank that failed (DEF) was not part of the non-routine work that was going on. The non-routine work was on the ABC bank. The point being even if Tesoro had minimized the people in the area – assuming they had classified the ABC startup as non-routine – fatalities would have still occurred. CSB seems to be mixing unrelated events and/or conditions. I think you need to reword this for clarification.
2	<u>Page 4 – Key Finding #10</u> *"…However, the effectiveness of these safeguards was neither evaluated nor documented; instead the PHA merely listed general safeguards…"* It is very difficult for the reader to evaluate this finding without seeing the actual PHA document. Did the PHA mention corrosion? What about the site's mechanical integrity program also required under PSM? What were the hazards or causes identified in the PHA?
3	<u>Page 5 – Key Finding #11</u> Looks the same as Key Finding #10
4	<u>Page 5 – Key Finding #14</u> *The use of the design temperatures contributed to the incorrect conclusion that the heat exchangers were not susceptible to damage from HTHA.* This statement is in direct conflict with your Key Finding #5

	Mark George Comments
5	<u>Page 6 – Key Finding #15</u> *Tesoro procedures did not prohibit or effectively limit the use of additional personnel during the nonroutine hazardous startup of the NHT heat exchangers.* This is the same as Key Finding #4
6	<u>Page 7 – Key Finding #19</u> *The refinery process safety culture required proof of danger rather than proof of effective safety implementation.* What is the evidence for this finding? CSB already concluded that Tesoro assumed they were in the correct temperature range to prevent HTHA corrosion and that they had solved the gasket/leak problem.
7	<u>Page 8 – Key Finding #28</u> *"The draft CSB Chevron Regulatory Report recommends….."* Seems a little premature (and arrogant) to use the Chevron Report as evidence for this and other findings. Didn't CSB reject their own report?
8	<u>Page 11 – Section 1.2.5</u> Same comment as above (Key Finding #28)

	Mark George Comments
9	***The U.S. Environmental Protection Agency*** *Revise the Chemical Accident Prevention Provisions under 40 CFR Part 68 to require the documented use of inherently safer systems analysis and the hierarchy of controls to the greatest extent feasible in establishing safeguards for identified process hazards. Until this revision is in effect, develop guidance and enforce the use of inherently safer systems analysis and the hierarchy of controls to the greatest extent feasible in establishing safeguards for identified process hazards through the Clean Air Act's General Duty Clause.* I would challenge CSB to explain how this would be implemented. You just can't make a regulation that "inherently safer systems" are required to the greatest extent feasible. This would be such a subjective regulatory mess it would only succeed in making things worse. How does the EPA enforce the use of inherently safer systems in existing refineries?
10	Page 20 – Incident Description *Because of a long history of frequent leaks and occasional fires when putting these heat exchangers back into service (Section 5.1), this activity was a hazardous nonroutine operation. By employing this nonroutine operation, Shell Oil and Tesoro avoided a total shutdown of the NHT unit.* A little confusing as written. Is the cleaning or the startup the non-routine operation? Or is CSB lumping them altogether? If they are lumped together then CSB should clarify throughout the report.
11	Page 23 – Top of page *At 12:30 a.m. on April 2nd, while the seven outside personnel were still performing A/B/C heat exchanger bank startup operations, the E heat exchanger on the adjacent, in-service bank catastrophically ruptured.* Kind of interesting. Did the fact that only one bank of exchangers was in service increase the backpressure on these exchangers? Was more flow than normal being pushed through DEF bank? If so could that additional pressure have contributed to the failure?

	Mark George Comments
12	Page 33 – Section 4.1.2 *Post-weld heat treating is a manual activity and therefore low on the hierarchy of controls.65 Consequently, it is a weaker safeguard to prevent HTHA failures than the use of materials that are not susceptible to HTHA damage.* This is awkwardly and possibly inaccurately written. • Even if high alloy material was used wouldn't post-weld heat treatment still be necessary and/or recommended? • Would post-weld heat treatment have prevented the existing Exchanger "E" from rupturing? It appears yes by discussion on pages 40-41 of the report. If the answer is yes that negates much of CSB's argument here.
13	Page 44 – Heat Exchanger Startup Did CSB verify that the relief valve protecting the exchanger was not isolated from the pressure?
14	Page 55 – Section 5.1.4 *During the startup that followed, Tesoro records indicate that no leaks from the heat exchangers occurred.* Doesn't this negate some of the safety culture comments made by CSB?
15	Page 59 - 5.2.3 Tesoro Failure to Control Heat Exchanger Startup Hazards Kind of confusing again. CSB should rewrite to clarify the non-routine work was not being done on the equipment that failed.

	Mark George Comments
16	Page 65 - *A problem common to all of the DHMRs conducted over the 20 years before the April 2010 incident is an <u>inaccurate understanding</u> the extent of stainless steel cladding covering the inside surface of the of the Band E heat exchanger shell wall. Each damage mechanism review documents that the B and E heat exchangers had a protective 316 stainless steel cladding covering the carbon steel wall. However as shown in Section 4.2.1, the 316 stainless steel cladding was installed only on the hottest section (Can 4) of the heat exchanger. The other three sections of the B and E heat exchanger shell walls were carbon steel without any protective cladding*. This would seem to be a pretty important finding by CSB - that corporate knowledge @ Tesoro was incorrect - not negligent as CSB implies throughout the report. That finding seems to be causal to the fire and fatalities. I would recommend the final version of the report explore this further. A common theme in these accidents seems to be that corporate knowledge is often forgotten.
17	CSB Editorial in NYTimes "*Too many corporations are letting essential refinery equipment run to failure*." I would recommend CSB retract this comment. There is no evidence in the report that Tesoro "ran the exchanger to failure." Why does CSB make inflammatory comments like this? You are inferring that Tesoro planned to run that piece of equipment until it catastrophically failed regardless if the consequences. That is how it appears in that editorial. But the report clearly documented that there was in fact PHA's, Mechanical Integrity and DHMR's in place to manage piping and equipment integrity.
18	Throughout the report it is very confusing if operation of the exchanger - particularly the portions without SS cladding - was operating within the understood safe temperature operating range. Please clarify.

	Eric Wiseman Comments
1	I was in the audience last night and I was very impressed with how CSB staff made the presentation and allowed people to have their cathartic moment. Please forward this for consideration in the report as follows. I want to preface by saying I believe my remarks steer clear of the inspection currently under appeal and my input is on a different plane. I have two recommendations:
2	When a fatality, catastrophe, or potential willful activity is perceived for PSM covered facilities, state plans must make an unprogrammed related referral to OSHA or the respective state plan where the corporate office resides. Corporate offices from my experiences can take advantage that OSHA is a fractured system by having so many state plans. Corporate has policies that govern the satellite facilities that transcend state boundaries. The separate corporate inspection is to assess the corporate office under the "Controlling, Correcting, Creating" employer language in all the state plan manuals and OSHA's CPL for Multi-Employers. The examination needs to determine if the corporate office met their duty of care to ensure they had proper steps in place to discover wayward activity at their satellite facilities. Does the corporate office have oversight directives? How do they audit and spot check the satellite facilities? One could hypothetically determine that willful activity resides at corporate vs the satellite facility. This two inspection approach also affords a separate appeal process for the corporate entity under a different state plan or if under OSHA appeal process. I hope you dovetail this recommendation in with what you heard from the gentleman who spoke for the record on corporate offices diversifying the risk to the field which can certainly be concluded as willful activity under "substitution of judgment". This approach for making the referral for OSHA to enter a corporate office also ensures that OSHA has the impetus to refine the PSM standard that all state plans must follow instead of asking state plans to develop their own.
3	Make recommendations that State plans adopt pressure vessel standards that provide subject matter expertise on PSM inspections. Refineries are said to be nothing more than pressure vessel farms. http://www.hsb.com/HSBGroup/History.aspx

	Roddy Erickson Comments
1	The report identifies process issues at Tesoro, in addition to weaknesses in the regulatory system. It is also clear, however, that there are significant process problems within the Chemical Safety Board which impact this Report. Specifically:
2	Adequate measures seem to have been lacking to ensure that a wide range of information would be available to the investigation early enough to adequately feed into the development of conclusions and the Report.
3	One of the speakers at the public session stated that he has seen several old Tesoro documents calling for inspection of the NHT heat exchangers. The Report seems to make no mention of these, nor does it discuss whether such inspections were performed.
4	Another speaker told us that workers at the refineries were not informed of this public session, nor were they provided with copies of the draft Report. As the people most likely to have information relevant to the CSB, surely they should all have been notified well in advance.
5	Another speaker, who now operates the NHT console, gave an explanation for why so many workers were present at the scene of the accident; this is not mentioned in the draft Report, nor does it reference the alarming fact he noted, that twelve hours before the accident about 250 contractors were within 50' of the failed heat exchanger.
6	Another speaker referred to flaws that were found in another refinery system in the post-accident investigation, involving damage to a pressured cylinder near its base. This, also, seems to have no mention in the draft Report, although surely relevant to the question of Tesoro safety and operations.
7	It's good to have a listening session, so as to get feedback and information from the stakeholder community. Probably this should come after a preliminary investigation, so the investigation can inform the discussion as well as vice-versa, but it needs to be early enough to provide input to the investigative cycle. However, this session took place almost four years after the incident, and not long before the final Report will likely be issued. This inhibits the public from adequately providing information to the investigation and Report. (Will any of the items above be thoroughly researched at this late date and incorporated in the Report? Unlikely.)

	Roddy Erickson Comments
8	Two related, generic problems are revealed by this accident, but are not adequately discussed in the draft Report. I believe it is likely that the presence of fouling in a three-module counterflow heat exchanger was a primary cause for the operating temperatures to deviate substantially from those in the design, resulting in operating conditions that allowed HTHA to take place. The report places little emphasis on fouling and the likely increase it caused to inlet temperatures for the damaged 'B' and 'E' exchangers, with no mechanism in place to discover the problem.
9	The safety of the NHT heat exchangers was based on their design operating temperature. However, this design was not validated with temperature measurements of the operating unit. Importantly, fouling of the heat-exchanger tubes will cause a shift in the temperature profile along the exchangers; temperatures of the vessel (which has the hot exhaust stream) of the 'B' and 'E' exchangers will rise as the 'A' and 'D' tubes become fouled and less effective. The CSB should require the measurement of actual operating conditions in order to validate safety-related design assumptions; these measurements should be repeated as the operating circumstances vary, e.g., after fouling has accumulated.
10	The NHT unit uses three counterflow heat exchangers in each of the two parallel circuits. In such a configuration, it is not possible to reliably predict a priori the temperature distribution within a set of three exchangers; this will also vary over time as the efficiency of each exchanger changes (e.g., as deposits accumulate in the exchanger tubes). Had there been a temperature gauge at the inlet of the 'B' and 'E' exchangers, it probably would have been discovered that the Nelson-curve limit was being exceeded. Where it is possible for varying device efficiency or other conditions to change the operating conditions of equipment, and where those changes might be relevant to safety-related assumptions, the CSB should require measurement of those operating conditions. Additionally, where series or parallel configuration makes it impossible to accurately predict the conditions in sub-units, measuring devices should be required as needed to permit measurement for each sub-unit.
11	Public comment periods begin with a public meeting. This serves a vital purpose: it allows stakeholders and the public to hear a first round of comments, which can then feed into discussion and research, resulting in important comments later on. For this process to work, participants in the public meeting need to be given the opportunity to first read, understand, discuss, and research the draft report upon which they will be commenting. We were deprived of that opportunity: the draft Report was inexplicably issued less than 24 hours before the meeting, and few participants had access to it until minutes before the meeting began.
12	There should be another public meeting: a formal hearing in Anacortes, based on the final draft, with the text available at least two weeks before the meeting.

	Roddy Erickson Comments
13	Although there are clearly-identifiable stakeholders in this matter, the CSB has failed to communicate to them about even the most important issues. For example, the United Steel Workers was neither notified of, nor given an explanation for, delays which were contrary to assurances they had been given. The USW and the rest of us only learned about the changed status of the Jan 30 meeting when US House member Rick Larsen sent out word in response to a notice in the Federal Register.
14	In an agency with limited resources, of course it will be necessary to set and change priorities in response to events, so I'm not surprised that the Chevron Richmond accident would delay the report for our small town. I do, however, think it is essential for the CSB, when such a shift is made, to *write up an explanation of why one event will now supersede the other, inform us which activities continue and which are on hold, clarify what milestones will indicate that there is now time to return to the deferred investigation, and, especially, to notify the public and stakeholders promptly when an investigation is suspended or resumed.* This did not take place for the Tesoro incident.
15	Inspections seem to be glossed over in the draft Report, which only notes (correctly) that inspections are insufficient to prevent HTHA, and that not all HTHA damage can be detected. However, the aircraft industry demonstrates that relatively small defects can be found; the 'B' NHT exchanger had a 48" long crack, more than 1/3 of the thickness of the wall, which should have been easily detectable. Inspection of the 'E' exchanger a the time of its cleaning would have revealed the HTHA-related damage, avoiding this disaster. Furthermore, we have the report of old Tesoro documents calling for the inspection of these NHT heat exchangers. Surely the question of whether inspections were performed or appropriate should be a major topic for the CSB's report.
16	The CSB draft Report discusses the presence of so many workers in the context of leaking flanges at startup. However, it does not touch on the important broader issue: startup and shutdown are inherently hazardous, yet the valve configuration on this NHT unit clearly requires multiple personnel during startup operations, and the unit is likely to experience temperature and pressure excursions as a result of the slow, clumsy adjustment of manual, 100-turn, "long-winded" valves. Tesoro's written operational procedures did not reflect the need for multiple personnel. Clearly, the valves of this unit should have been controllable from the operator's station, rather than needing personnel to stand in the midst of a unit undergoing startup transients. The CSB should require, and supervise, an industry-wide evaluation of manually operated valves: do they permit units to be operated (including non-routine conditions) in a manner that minimizes temperature/pressure transients, and do they place workers in potentially-hazardous locations when remotely-operated valves could be used instead?

	Roddy Erickson Comments
17	Insufficient attention was given to the unresponsiveness of the American Petroleum Institute to this HTHA-related accident. After almost four years, the API's Nelson curve has neither been updated nor subjected to research. The CSB proposes a new boundary for the use of carbon steel, but this does not address the lack of an adequate API response until now. I also observe that the CSB's new recommended boundary for carbon steel would apply even in cases with zero pressurized hydrogen; such a recommendation will not be taken seriously. One has to question whether it was thought through and drafted carefully; as written, this would recommend against the use of carbon steel under any conditions over 400°F! HTHA only takes place in the presence of hydrogen; in the Board's simulations, the hydrogen partial pressure ranged from about 190 to 350 psia. There should be an interim standard for carbon steel in hydrogen service, accompanied by a vigorous research program.

	Richard Fox Comments
1	In Key findings #15, and other places you talked about the use of additional operators to startup a bank of the exchangers. There was a redesign of the shell inlet block valves that took place in the last unit shutdown that changed how these valves were opened during an online cleaning and I think this was the first time they were used. Prior to this change, sometime after 2008, a single outside operator and inside Boardman could start them up without any further help. The reason they could do this is because there were chain operators on the shell inlets block valves and the outside operator could open both the inlet and outlet block valves from grade and without much effort. With the new shell inlet block valve being located at the top deck of the exchanger structure it would have been a lot of work for a single outside operator to do this task. During the MOC review this should have been caught and corrected in the procedure. I would conclude that there was no need for seven operators to be involved in this startup. Operations should not have allowed this design to be used given the history.
2	In Key findings #16 and other places you talk about the fires and lack of attention to resolving this issue. The only fires that I know about on the exchangers were at the shell inlet block valves. The exchanger heads leaked at times and we used steam hoses to dissipate the vapors but as far as I know there were no fires on them. The shell inlet block valves get coated with material from the reaction process much like the ID of the tubes that you explained well in another part of the report and that made them hard operate and close, this is why they were changed. During unit shutdowns the valves were removed and repaired as a standing order but that may have contributed to the fires because they were located in the vertical part of the pipe which could cause scoring and gasket damage during removal and reinstallation. I am not sure what they found when they did the redesign. The refinery management, operations and engineers have worked on preventing leaks and fires as long as I was around, 1985 until 2011, so to say they were not safety conscious is inaccurate.
3	I came in the night of the fire and from what I saw I don't believe your assumption of where the operators were during startup is accurate as mentioned in 3.3 but I don't think that matters as much as some of the other issues.

	Richard Fox Comments
4	The startup procedure order of events was followed but the time line for warm-up was not. Per the startup procedure the earliest the valves that were being opened would have been 4:00 am. The exchangers need *at least eight hours* to heat up before they should be put on line. The engineer that you talk about in 5.1.2 helped set that timing to prevent the heads from leaking. Startup lines were installed in the early 2000's to aid in doing a controlled warm-up, the first ones were to small so larger diameter piping was added, the startups after these were installed resulted in very little or no leaks. The design of the startup lines allowed the operator to warm the exchangers up without leaving grade. The night of the fire the tube inlet piping was not installed and fitters had to be called in to install it, so the earliest the exchangers could have been started warming was 8:00 pm.
5	In 5.1.4 you mentioned that the gaskets could be re-used, a far as I know we never re-used gaskets.
6	These exchangers are not common in a refinery, single pass, with bellows. What I am trying to say is there are all kinds of exchangers and this style is not used unless needed. The operators come from all kinds of different backgrounds, they are given a crash course in refining, 4 to 6 weeks, assigned a unit and trained for another 2 to 4 weeks, pass a written test and field walk and then either side saddled or turned loose depending on how there exams go to run the unit. In Zone A there are 6 outside jobs and 3 board jobs. If you continue training and apply yourself you can have a *basic* grasp of operating in 3 to 4 years, this really depends a lot on the individuals and their past experiences. There is only so much you can lean when the units are operating normal; you really learn how to operate in shutdowns and startup, unit upsets etc. If you "shine" you may be considered supervisor material and ask to work a temporary position, this gives you more opportunity to have a different exposure prospective to operating and you get to go to supervisor training. Once you do this for a while you can become a supervisor. Supervisors don't have to operate the units, they have trained operators for that, just supervise, I do not know what units Lew was qualified on but that would be in his record. Superintendents and Managers don't have to know the units either and yet they make the decisions for operating. Chemical engineers help run the units and make decisions but most of them have never "operated". I have a lot of respect for them but when it comes to operating, they lack experience, it's not their job. At the time of the accident the shift supervisor had 9 operators working for him, running about half of the process units, doing a non-routine job of putting an exchanger bank on line. He took his whole outside crew to do this job, and we have a report telling us what happened. Nothing mentioning the human error/management issue or corrections that need to be addressed. Have you ever heard of ICS, and the components of that? Span of Control? There was human mistakes made that night and before that night that are not addressed but need to be. We can't correct human errors unless they are addressed. Do you realize there were no outside operators left to operate the rest of the units in Zone A for over an hour? Training and supervision/management needs to be looked at. Operating in a refinery is not like operating a #2 shovel, a truck, or flying a plane, and yet there is very little required.

	Richard Fox Comments
7	When management fills jobs sometimes a heartbeat is all that is required, PHA's are an example. Do the requirements for filling the positions have enough definition?
8	Section 7 talks about regulatory issues and lack of oversight. I would suggest that you get some operating personnel that understand refining to participate, it is great to have educated people doing this work, but people that get their hands dirty will have a different perspective and maybe they would be able better communicate with the operators. I have seen many incomplete teams and the outcome is usually the same, incomplete.

	Timothy O'Toole Comments
1	Section 4 of the report does a fine job in describing how the incident occurred. If the Nelson curves are changed appropriately, this type of incident may never happen again. It is very much human nature to see any line drawn as defining a point not to cross. If these lines are in the right place, industry will keep to the safe side. Also, it makes sense to prove you are below HTHA temperature levels by actual instrument monitoring. This section and the associated recommendations makes me hopeful for an outcome that improves safety.
2	Section 5.1) It isn't clear to me from the report if the head leaks ever resulted in a fire. I haven't found anyone here who has experienced this. It seems more likely the fires were a result of leaks on the reactor effluent side where hydrogen was present.
3	Section 5.1.1) I have a somewhat different take on this due to my experience in the industry and knowledge of my fellow operators. Exchangers can leak when put in service and this increases the hazard, but less safe doesn't necessarily equal unsafe. This sounds like the leaks were substantial and I have no doubt several people were involved with the decision to continue putting the bundles in service. I realize it works better for your narrative to call this complacency, but I believe it was a judgment call made by competent people who saw the risk as acceptable.
4	Section 5.1.1) In the third paragraph you state "the unit was not shut down." Shutting down an entire unit and possibly associated units for a leak that can be isolated would make us less safe.
5	Section 5.1.2) The TOP program was useful in refocusing efforts on the head leaks when returning bundles to service. There was a complacency about these leaks and we needed to increase our efforts to prevent them. Because there are no details on the fourteen investigated incidents, it's unclear if there is any relevance to this report.

	Timothy O’Toole Comments
6	Section 5.1.3) There is no truth to the idea that extra people were in the area to man steam lances. You can’t claim complacency about the leaks then say we needed seven people because of the big, scary leaks. Steam lances are rarely held by people and are usually propped against a piece of equipment or are tied in place. I’ve talked to several operators who have put those bundles on by themselves and I fully believe Matt Bowen would have had no issues with doing it alone that night. The reason the entire team was there was a clash of cultures. Team 2, of which I was a member for many years, liked to work independently and would ask for help if they needed it. Lew, their new supervisor, came from a team that tended to all go out as a group when there was work to do. Because of the culture he was used to, he had everyone come up and help in order to build esprit de corps. This was reasonable as there was no way for operations to foresee the hidden dangers in the bundle in service. I should add that at least one and probably two operators would have remained in the crude unit if a board operator was present. When we worked in the same building we always kept people close enough to respond to any issues and a whole team wouldn’t have gone up to the hill. The industry has been moving towards separating the people who control the process and the people who touch the equipment for years. This reduces communication where it matters and makes us less safe. It only applies in this instance in relation to the numbers, but I hope you keep it in mind for future investigations. I have no issue with Tesoro not doing a full hazard review when adding steam stations. More stations mean I don’t have to drag a hose as far. I think you look a little foolish suggesting a full hazard review.
7	Section 5.1.4) I can’t say for certain but the lance in Figure 29 doesn’t look like it was used the night of the incident but was only staged in case it was needed. The paragraph on gasket usage is strictly agenda driven. To say Tesoro “noted” the manufacturer said a gasket could be reused and then hide in a footnote there was never any intention to do so is incredibly deceptive. It has never been a practice here to reuse gaskets.

	Timothy O'Toole Comments
8	Section 5.2) You use the term "hazardous nonroutine work" throughout the report and I have no doubt it plays well in the press, but it isn't particularly accurate. By the definitions you use, tying my shoes is nonroutine work and if I do it in the unit it's hazardous. Indeed, any maintenance must be classified as nonroutine by your definition. The truth is we often take exchangers out of service to clean them and we are very experienced at doing so. Doing this is riskier than leaving them in service but less risky than shutting down an entire unit. I might also mention the term "startup" as quoted in this section more likely means an entire unit startup. Even though we use the word "startup" in our bundle procedures, in local usage we would say "return a bundle to service," not "start up a bundle."
9	Section 5.2.1) I disagree strongly with the idea of using a "minimum number" of personnel as a requirement. When I go out to do a job I haven't done before, I'll take someone who has as another set of eyes. If I'm turning a sticky or long-winded valve, I'll get help because I will be more alert to hazards if I am not fatigued. If I know someone will train soon on the job I am working, I'll take him out to get some hands-on experience. If it's three in the morning and a coworker needs to get moving to remain alert, he might come out and help me. All these things make me safer. I'm not saying we should bring a busload of kindergarteners through on a field trip during bundle switches, but numbers decisions need to be made by the ones in the field. If it isn't safe enough for seven, then it isn't safe enough for one.
10	Section 5.2.2) This section seems to imply that cleaning bundles while the unit remains running is a bad idea. It makes much more sense to cycle a couple dozen flanges and a few bundles through the temperature changes required to clean them than to do the same to thousands of flanges in a unit shutdown. Well over a hundred people are working in an active unit preparing for a full shutdown. Having a bundle crew pull a bundle for cleaning is much safer.
11	Section 5.2.3) I disagree with most of this section due to many of the objections stated above. It shows how agenda, misinterpretation, and ignorance of operations can lead to unfounded conclusions. Unquestionably the companies I've worked for have made decisions that decrease my safety, but so have regulators and underwriters. Oversight by regulators is very much a needed thing but we need to realize the view from the outside isn't necessarily the clearest.
12	Section 5.3) This is the first part in this section that references HTHA, the cause of the incident. Failing to identify the possibility of HTHA is Tesoro's major error and I would have liked to see this stressed rather than read a screed on "poor company process safety culture."

	Timothy O'Toole Comments
13	Section 5.3.1) In this short section the word "nonroutine" is used eleven times, apparently with the belief that if you repeat something enough it becomes true. It doesn't.
14	Section 5.3.2) The emphasis on the number of people in the area misses the point. This bundle was going to come apart at some point because of HTHA. It might have been caused by a power dip, a change in feed, or just failed because of the weakened welds. There easily could have been dozens of people in the area. Operators working together as a team is one of our best tools to maintain safety in this industry.
15	Sections 5.3.3-5.3.4.1) These sections identifies the shortcomings that led to the bundle failure. They also gives solutions that will work in the real world. Thank you for this.
16	Section 5.4) There is a cynical side of me that thinks the conclusions may have been in place at the beginning of the investigation. I hope not. In any case, as they are based on a misinterpretation of the reason for the presence of seven operators, they are not entirely accurate.
17	Section 6) The moment you realized you were going to suggest a change in the Nelson curves there should have been a CSB announcement. To rely on industry alone, especially when you are critical of them in your report, isn't enough. This shouldn't have waited four years.
18	Section 7) I agree our current system of oversight is weak. Washington State L & I has done audits here in the past and it has always been obvious to us they have neither the knowledge nor the experience to aid in our safety in any way. We need qualified regulators because it is easier to risk someone else's life than your own, especially if they live in another state. I have seen decisions made at all levels of the company that increased our risk because the decision makers saw some benefit to their careers. The flip side is it's easier to spend money in someone else's pocket, especially if the pocket is seen as deep and you can vilify its owner. Industry, regulators and workers all have an interest in safety and need to work together to ensure it. Only the company has an interest in keeping costs down, so I'm curious as to how "reasonable" is defined when speaking of "ALARP." I do know that the more adversarial the program is the less effective it will be.

	Carl Ingram Comments
1	Page 3, Section 1.2.1 (2) Was the fact that the failure occurred in the "E" heat exchanger the region of a bi-metallic weld and cracking was found in the same region in the "B" heat exchanger considered as a contributing cause? While CSB's assertion that the main mechanism for failure is HTHA seems well supported, the difference in thermal expansion coefficients in the two different types of metal combined with being subjected to repeated heat cycles over a long period of time is a likely explanation for why this region would be more susceptible to HTHA (see bubble diagram on page 77 of the draft report for various factors affecting HTHA) and why the "E" heat exchange failed in this region.
2	Page 3, Section 1.2.1 (4), Footnote 13 and Appendix C Although correctly categorizing the results as estimates, Section 1.2.1, footnote 13 and some statements in Appendix C portray an incomplete understanding about the nature and limitations of engineering calculations, mathematical models, and computer modeling software. Even with perfectly known and accurate inputs, all of these analysis tools provide results that are in error to some extent. This is primarily due to impossibility of accounting for all of the large number of variables impacting the physical phenomena being modeled. There is a saying within community that builds scientific models that, "All models are wrong, some are useful." The job of a scientist or engineer is to quantify the error to a point that the reader can understand what the significance of the error is with respect to the conclusions that are reached. CSB's modeling, as shown in Appendix C, has accounted for sources of error in input parameters by varying the input parameters to come up with a region of likely operating conditions relative to the carbon steel Nelson curve. If the developer of the Aspen HYSYS © software can provide estimated error bars for model within the software, this should be enough information to state that the errors in Appendix C calculations were considered but determined to not be significant to the conclusion reached that the failed region of the heat exchanger was likely operating below the Nelson curve. Additionally, the presence of the CSB recommended curve on Figure 47, page 135 (and figure 33 on page 80) elsewhere in the report) citing API Technical Report 941 also suggests an incorrect belief that absolute and certain protection can be obtained. The presence of this recommendation is contradictory the critiques the Nelson curves found in Sections 1.2.1 (3) and 6.1.3 (especially the last paragraph shown on page 77) of the draft report.

	Carl Ingram Comments
3	Page 4, Section 1.2.1 (6) and (7) and Page 36, Section 4.1.4 These statements may be inadvertently be interpreted as discouraging inspection, controlled experimentation, or laboratory analysis that would need to be done to determine the degree confidence in higher chromium steel materials. Saying that these steels are "safer" doesn't answer this question. The Nelson curves for the higher chromium steels were still derived in the same manner as the carbon steel curve and HTHA damage is cumulative. Ignoring the question of how much "safer" these materials are may only lead to the next failure in future (say 60 or 70 years from now) rather than 39 years that the previous heat exchangers operated.
4	Page 4, Section 1.2.1 (7) I would suggest changing the word "not" to "less." This makes the statement more accurate (i.e. doesn't give the expectation of absolute protection) and consistent with Section 1.2.1 (8).
5	Page 4, Section 1.2.2 (10) I think the statement "….the effectiveness of these safeguards was neither evaluated nor documented" is a key point. (see comment 36) However, recommendation 2010-08-I-WA-R8 seems to contradict the report's general emphasis on placing the "burden of proof" for safety on refinery operators. Specifically, recommendation 2010-08-I-WA-R8 places the burden of doing an "extent of condition" review for the HTHA aspects of this accident on the Washington (WA) Division of Occupational Safety and Health (DOSH) with no parallel recommendation given to the refinery operators either directly or through the API. While WA DOSH may choose to spot check these verifications, they should not bear the burden of doing the complete verification process. Please also refer to page 9, findings 28(c) and 28(d) of the draft report.
6	Page 5, Section 1.2.2 (13) and Page 7, Section 1.2.2 (19) I would suggest changing the phrase "design operating data" to "design operating parameters." Data are typically the results of measurements which might come from testing a design, material, or a product but are not the design itself.
7	Page 6, Section 1.2.2 (15) and pages 59-62, Section 5.2.3 Discussion of this topic is very confusing throughout the report. The discussion of limiting personnel in hazardous operations is not made distinct from the need to identify whether an operation is so hazardous that it must be done remotely or cannot be done at all. As written, these Sections seem to suggest it would have been okay to do the hazardous startup operation with one person. With the benefit of hindsight provided by the accident, it was not safe to have any personnel in the vicinity of the deteriorated heat exchangers while they were operating.

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8	Page 6, Section 1.2.2 (18) This section could benefit from some clarification. My understanding from reading the rest of the report is that: (a) The heat exchangers had a documented history of leaks dating back to at least 1997. These leaks may or may not have been related to design issues. Fixes for the leaks were attempted but most were unsuccessful. (b) The heat exchanger design was responsible for tube fouling which required frequent maintenance. This frequent maintenance was seen as "normal" and no attempt was made to address the design issues related to tube fouling prior to the accident which increased the exposure of personnel to a hazardous environment "routinely" during the frequent shutdown, cleaning and restart processes. (c) Only Tesoro's post-accident replacement of heat exchangers addressed design issues. As written, the section suggests that Tesoro had attempted to address design issues with the heat exchangers before the accident but the rest of the report suggests only that engineering efforts were made to correct the (most likely age-related) flange leaks without any changes to the design. See also comment 23.
9	Page 7 Section 1.2.3 (20), Page 8, Section 1.2.3 (26), and p.119 section 8.4, 2010-08-I-WA-R10 and 2010-08-I-WA-R11 The emphasis on counting "shall" and "should" statements in the API document is at odds with other sections of the report and does not provide adequate context to understand the issue with how API documents are written. The single "shall" statement in API RP 941 deals with what versions of other referenced standards are considered part of the "publication." The document was clearly written only for information and guidance and is carefully caveated as such. As written, Section 1.2.3 (20) suggests (perhaps unintentionally) that if more of the "should" statements were "shall" statements, effective performance would follow. This is clearly not the overall intent of the report based on the citation of ANSI/AIHA Z10 on page 81 and from item "a" in each of the recommendations 2010-08-I-WA-R10 and 2010-08-I-WA-R11. I would suggest that Sections 1.2.3 (20) and (26) be re-written to drop the discussion of "shall" and "should" statements and instead explain the issue as the lack of a performance standard to manage HTHA risk. I consider the current use of the word "permissively" to be a borderline pejorative that obscures the issue. Stating that the current documents do not establish minimum requirements is adequate to make the point.

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10	Page 7, Section 1.2.3 (21) 2nd sentence The use of the word "empirical" in this section is a little misleading. Empirical data can actually be very valuable if that data comes from a well-designed experiment with carefully controlled variables. The best basis for the curves would be the use of a scientific basis validated by high-quality empirical data. The point that I believe the draft report is trying make is that the empirical data used to develop the Nelson curves did not come from well designed, carefully controlled experiments. I would suggest replacing the existing language in this section with the language used in the last sentence of Section 1.2.1 (3).
11	Page 7, Section 1.2.3 (21) 3rd sentence I don't see any support for this statement elsewhere in the report. The statement may be true but the point can be made more effectively by replacing this sentence with the language from the first sentence of quote from API TR 941 shown in Section 6.1.3 on page 78.
12	Page 7, Section 1.2.3 (23) and 2010-08-I-WA-R10 and 2010-08-I-WA-R11 Given the weaknesses in derivation of the Nelson curves, (see last paragraph on page 77 of the draft report) does CSB consider the curves for materials other than carbon steel to be valid and not require re-evaluation? If yes, what is the technical basis of this opinion? If no, the re-evaluation of curves for material other than carbon steel should become part of the recommendations.

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13	Page 7, Section 1.2.3 (24), Recommendations 2010-08-I-WA- R1, 2010-08-I-WA- R2, 2010-08-I-WA- R3, 2010-08-I-WA-R10 and 2010-08-I-WA-R11 and multiple other places. The lack of a clear definition(s) and the draft report's use of the multiple terms "Inherently Safer Materials", "Inherently Safer Design", "Inherently Safety Technology" and "inherently safer systems analysis" as apparent synonyms for one another mean that recommendations 2010-08-I-WA-R1 and 2010-08-I-WA-R2 , 2010-08-I-WA- R3, 2010-08-I-WA- R10, and 2010-08-I-WA-R11 are unlikely to be practicable and enforceable. Additionally, The use of the terms ""greatest extent practicable," "as low as reasonably practicable," "greatest extent feasible" to define actions that would constitute "compliance" with this design concept will likely present legislators, regulators, operators, and jurists in this country with the same challenges that confronted those same entities in the UK many years ago. I would strongly suggest that the report limit and define use of the terms to those that will give the best the chance for implementation. The term "as low as reasonably practicable" has enough historical and legal discussion behind it to be a candidate term. The term "inherently safer systems analysis" has the potential to be defined and explained in the context a performance-based standard where such an analysis could be used to meet a goal of determining and controlling the risk of operations.
14	Page 7, Section 1.2.3 (24) and page 35 Figure 17 The report's characterization of using of higher chromium steels to control the risk of the HTHA mechanism as an example of "Inherently Safer Materials" or "Inherently Safer Principles" is highly debatable based on Trevor Kletz's explanation of "Inherently Safer Design." In his book, *By Accident….a life preventing them in industry* Kletz explains the concept of "Inherently Safer Design" as follows: I had spent years (by this time) ten years urging people to control hazards by adding on protective equipment before I realised that that it would be better to remove the hazards, by intensification or in other ways such as: • substitution: using non-flammable and non-toxic materials instead of hazardous ones; • attenuation: using hazardous materials in the least hazardous form, for example, explosives powders can be handled as slurries; • limitation of effects by changing designs or reaction conditions rather than adding on control equipment. For example, it is better prevent overheating by limiting the temperature of the heating medium than relying on a high temperature trip.

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	The third bullet of Kletz's description could be construed to support draft report's characterization of use higher chromium steels to limit HTHA as these steels change the reaction conditions. However, use of higher chromium steels could also be interpreted as adding on control equipment while not changing process conditions. At this point, it is helpful distinguish between hazard sources (e.g. process materials) and hazard mechanisms (e.g. corrosion attack driven by process materials). Kletz's examples of "Inherently Safer Design" deal primarily with the minimization, substitution, and moderation of hazard sources and the simplification of plant design to be tolerant of operator error. Thus, the use of high chromium steels is more correctly a "passive safeguard" (design feature) as shown on Figure 17 to resist the HTHA mechanism. The does not change the hazard source and has, at best, a tenuous connection to tolerance of operator error. (i.e. if operator error resulted in the heat exchangers being run higher than design temperature, these steels would better resist HTHA) Both the Center for Chemical Process Safety (CCPS) control definitions (which uses the term "inherent") and ANSI/AIHA Z10 would classify the use of higher chromium steels as a (passive) engineering control. The point of this comment is not to definitively categorize the use of higher chromium steels as one thing or another but rather to illustrate that the term "inherently," as used in the draft report, could confuse (rather than support) the implementation of the recommendations as discussed in comment 13 above.
15	Page 8, Section 1.2.3 (25) Page 82, Section 6.2, second paragraph and footnote 182 and recommendation 2010-08-I-WA-R11 Reading Section 6.2 and footnote 182 casts a certain amount of doubt on the report's implication about the equation in API RP 581 found in Section 1.2.3(25). (i.e. that the equation is non conservative) Specifically, footnote 182 states that calculations were done using the "design operating conditions" (a statement supported by comparison of the listed conditions to figure 47 in Appendix C). Because the report concludes that the actual operating conditions of the heat exchanger were likely varied from the design, it would be useful to re-do the calculation using the likely range of actual conditions. In any event, I would suggest pointing out in Section 1.2.3 (25) that the calculated parameter of 4.53 was on the borderline of next higher risk category and that API represents the relationships in their standards as guidance. Given all of the synergistic factors that could have impacted failure of the heat exchanger, the risk parameter should have been viewed only as one piece of information to make an overall risk-based decision, not a definitive answer.

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16	Pages 9 and 10, Section 1.2.4 (28), Table on pages 88 to 91, and pages 115 and 116, section 8.2 If the recommendation for a "safety case" approach goes forward, I would suggest that you summarize the reason for recommendation of the "safety case" approach to California in the Tesoro report rather than leaving the reader to look it up the Chevron report. Making direct reference to the table on pages 88 to 91 in the draft Tesoro report would also help the reader better understand how changing the nine characteristics of the current regulatory regime might help lower the rate of similar accidents. This said, I think that the report's failure to perform a root cause analysis (see comment 36) does not help the reader understand what the key causal factors in the Tesoro and similar accidents were. Without this information, it is not clear whether the recommendations would effectively address the causal factors. As written these sections of the report are merely a broad description of an idealized future state for the regulatory regime and provide no context as to factors (e.g. economics) that influence the accident prevention efforts of refinery operators. As such, the report provides little help for government entities to identify and prioritize the few things that could be done to have the most positive impact on preventing future accidents. Additionally, in providing an idealized description, the draft Tesoro report does not acknowledge issues and history with the proposed regulatory elements that might also help understand how to prioritize recommendations. More specifically, with respect to recommendation 2010-08-I-WA-R4 on pages 115 and 116, in addition to the
16, cont.	potential barriers mentioned on page 11 of the draft Chevron Richmond report, some additional considerations include: Items "a" and "b" - (1) Neither the draft report nor CSB has been clear about whether the preparation of a "safety case" is an operating license process as used by Nuclear Regulatory Commission with "safety analysis reports" where failure to comply with specific technical requirements in the report would require approval by the regulator to continue normal operations or whether the "safety case" would place greater emphasis on the management and organization aspects but not be a "licensing" or "approval" process as described by James Reason in Chapter 8 of his book *Managing the Risks of Organizational Accidents.* The HSE publication cited in footnote 185 makes the process seem more like ANSI/AIHA Z10 or OHSAS 18001 certification process than the licensing and permissions system that was mentioned by the CSB Chairperson at the January 30, 2014 meeting in Anacortes WA. (2) No matter what the attempt to maintain the refinery operator as the responsible party for managing their risks; the regulator will be placed in a difficult spot with 'safety case'. Quoting from Reason, Chapter 8: "The situation for the regulator would become even more difficult should one of its overseen organizations suffer a major accident. The subsequent investigation could turn one of two things: either that the organization's performance was in compliance with its Safety Case, or that the accident was due in part to violations of the Safety Case. The former could be judged as stemming short-comings in the regulator's evaluation process – the Safety Case should not have been approved in the first

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	place – while the latter is likely to be viewed as failure of regulatory surveillance. Damned if they do and damned if they don't!" (3) In the idealized risk analysis process, safety professionals work hand-in-hand with the designers of the industrial processes and process equipment to ensure that the safety controls become an integral part of the operation. That is not what happened when the requirement for PHA's were introduced by the PSM rule in 1992 mainly because most of the plants doing PHAs were already built. This made the process on doing PHAs one of deciphering the history evolving processes and reverse-engineering of existing equipment, often without benefit of same level of documentation that current ISO 9000 series standards would drive today. The economic pressure on people performing the PHAs to use the analysis to show that existing plants and processes were safe rather than making as objective an analysis as practicable which could require potential expensive changes to plant equipment (and to a lesser extent work processes) was very real. The same conditions will exist when preparing any "safety case" under any new regulatory regime.
16, cont.	Items "c" and "j" – Please refer to comment 17, item 3 for some perspective on the challenges facing regulatory verification of safety case elements. Item "g" – Looking at potential examples of successful reduction in major accidents typically turns up more factors than just the regulatory model. The most applicable example that I can think of would be the improvement in offshore accidents rates in UK after the Piper Alpha disaster in 1988. In addition to new regulations passed in 1992 applying "safety case' requirements to offshore oil installations, a notable feature of this improvement was an industry-driven campaign known as "Step Change in Safety (SCIS) started in 1997. The broad safety and environmental goals appear to have been significant in the improved safety record. It further suggests that the U.S. could change its regulatory regime dramatically but, until refinery operators commit to improved accident prevention efforts, changes in the regulatory regime could be more about going through the motions of compliance than actual improvement. (see also Enclosure 2) Item "h" – As interesting as the history is, it does not address how companies might engage their employees in improving safety rather than just having "involvement" (PSM-rule wording). Although I strongly believe that workers should have stop-work authority, this authority creates several derivative problems such as the authority to restart work once it is stopped and the prevention of retaliation of against workers who stop work (i.e. "whistleblower" protection). As described by this item, workers would hold an authority that they would be reluctant to use as it could adversely impact their own economic and career interests. Failing to incentivize plant managers to support their workers in exercising stop work authority and, more important, to stop work themselves would likely result in the authority being used much less than it should be.

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17	Page 9, Section 1.2.4 (29) and Page 12 Section 1.2.5 (39) and Page 83, Section 7.0 last bullet and Page 85 Section 7.2 and Page 89 row 1 At first glance the conclusion that four people are not enough to provide regulatory oversight for 265 PSM covered facilities in Washington State seems reasonable. However, the report's recommendation suggests an ideal situation which is unlikely to come to pass. I suggest that CSB discuss the specific aspects and impacts of regulatory staffing and oversight that would have to be considered with a "safety case" approach. This may give the reader some ability to start match staffing needs against what changes to the regulatory regime are actually made. Specifically: 1. The time and effort required to review and approve safety case documents - When the U.S Department of Energy (DOE) implemented a similar "safety basis" process under 10 CFR 830 Subpart B, the personnel resources were significant despite having had contract directives in place with essentially the same requirements for many years previously. 2. The time and effort required to oversee the Management of Change as it impacts "safety case" documents – A large portion of the 10 CFR 830 Subpart B implementation effort was associated with keeping up with the review and approval process for changes that impacted documented safety Analyses (DOE's "safety case" document) using the Unreviewed Safety Question process which is analogous to what WA DOSH regulators would be faced with under a "safety case" approach with Management of Change requirements. With or without the "safety case" approach, this area likely needs increased resources. 3. The time and effort needed to verify effective implementation of "safety case" controls and safeguards – There are major challenges in verifying performance in the when using traditional audit protocols such as Appendix I of ANSI/AIHA Z10. Effective evaluation of operator risk reduction performance will rely on extensive field work as much as desk reviews of the PHA submissions. My personal experience in doing regulatory oversight is that the most reliable way to verify that safety controls are implemented and effective is to observe of the performance of actual (not just preparations or rehearsals or static conditions in a facility) work. The U. S. Nuclear Regulatory Commission (NRC) and DOE have Resident Inspector and Facility Representative Programs which put oversight personnel inside the facility so that work can be evaluated as it happens. The feasibility of doing this with refineries is unclear. During the eight years that I worked as a DOE Facility Representative overseeing nuclear and explosives facilities, the observation of actual work was the single most useful tool and, at times, the only effective tool, I had to determine actual safety performance. It was also, by far, the most labor intensive oversight technique requiring detailed research in preparation, (usually) multiple observations, and multiple follow up activities extending for months afterward. With or without the "safety case" approach, this area likely needs increased resources. 4. The benefit of using performance indicators - Because it is not possible for regulators to be everywhere or oversee

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	everything, it has always been necessary for regulatory agencies to "sample" the aspects of regulated work that they will review. CSB's recommendation to develop and use leading and lagging indicators (2010-08-I-WA-R5, page 116) provides a potentially powerful tool to perform effective sampling with. Both unfavorable and unexplained favorable trends in leading and lagging indicators could highlight increased risks to regulators. Note that these indicators would need to differ somewhat from those that are already reported per API RP 754.
18	Page 9, Section 1.2.4 (29), last sentence. I would recommend you review the language of the last sentence of Section 1.2.4 (29) and consider making it consistent with Section 7.7.4 (i.e. only one has a technical background). As written, it is possible to conclude that the three specialists who are not chemical engineers could have a combination of education, knowledge, and experience in fields such as metallurgy, chemistry, heat transfer, etc. that would be very relevant to PSM. In making this statement, I assume that CSB has considered the experience and knowledge (not just the educational background) of the three specialists who are not chemical engineers. Additionally, I assume that CSB is considering that the need for human and organization factors expertise (not just technical expertise) is a large part of effective safety oversight.
19	Page 11, Section1.2.5 (34) Third sentence Based on CSB's video animation of the Chevron accident and the draft CSB report of that accident (see first sentence of second paragraph on page 8 of Chevron draft report), this sentence isn't completely incorrect. Chevron had identified the corrosion of the piping and the thinning of the pipe walls as a hazard. Chevron incorrectly assessed the risk of the hazard as evidenced by delaying (or miscommunicating) internal recommendations to replace the entire #4 sidecut piping.
20	Page 11, Section 1.2.5 (37) I would suggest replacing the word "prevent" with the words "evaluate and minimize the risks of." As written, the word "prevent" suggests an absolute effectiveness in controls whereas, even with better materials, corrosion mechanisms will still be present, just at lower rate.
21	Pages 11 and 12, Sections 1.2.5 Another similarity between the two accidents is the age of equipment that failed. (39 years for Tesoro and 36 years for Chevron) While age alone cannot be considered a predictor of failure, the combination of various types of stresses and corrosions placed on the equipment by years of service and, in the Tesoro case, exposure to repeated heat cycling could

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	be a relevant point, particularly when tied to causal factors beyond what are currently shown in Figure 37. Appendix C for the draft Chevron Richmond report contains summary of aging equipment issues of UK offshore installations. Based on the age of the heat exchangers, comments made at the public meeting held by the CSB in Anacortes, WA on January 30, 2014 about the condition of Tesoro plant, it appears to me that age of equipment and the need to perform some type of "extent of condition" for the potential of age-influenced failures are significantly underrepresented factor in the draft report. Also, it would be useful to better understand the large proportion of failures in mechanical integrity resulting releases that is shown in Appendix A of the Chevron Richmond draft report. This may well be another common factor appropriate for discussion in the Tesoro report.
22	Page 13 and 14 Section 1.3 and Pages 114 to 121, Section 8.0 I am disappointed CSB's failure to engage the U.S. Department of Labor's (DOL) Occupational Safety and Health Administration (OSHA) to consider revision of the PSM standards in this draft report and the Chevron Richmond draft report, particularly since there is an open Request for Information (RFI) on this standard that suggests that a rulemaking process is forthcoming. In the CSB's accident report on the 2005 BP refinery explosion in Texas City, three recommendations (2005-4-I-TX-R5, 2005-4-I-TX-R8 and 2005-4-I-TX-R9) are directed at OSHA and but deal only the need for the National Emphasis Program (NEP), tools for more effective enforcement and inspection or the current PSM standard, and amending to standard to address the MOC portion. In CSB's report on titled *Reactive Hazard Management*, recommendation 2001-01-H-1 was directed at OSHA to amend the PSM standard, to achieve more comprehensive control of reactive hazards but is purely a question of the scope of PSM coverage. Review of the twenty recommendations that have been made to OSHA by CSB to date reveals that there are no recommendations directed at OSHA to study the "safety case" approach which would parallel the draft recommendations made to the states of California and Washington. In the absence of other information, it would appear that CSB is engaging in political strategy of asking the relatively "progressive" (with respect to labor and environmental issues) "state OSHA" states of California and Washington to take a different path from the more "conservative" states overseen by Federal OSHA such as Texas and Louisiana. I personally do not welcome the prospect of an uneven economic playing field created by inconsistent rules from state to state. Even Washington and California are likely to wind up with different regulatory approaches. In California, the combination of having the sixth largest economy in the world and a large consumer base located near their ocean ports makes it less vulnerable to the economic impacts of increasing the costs of regulation. The continued community opposition to Chevron's expansion of the Richmond refinery is an example. In contrast, the recent interactions between the Boeing Co., the Machinists Union, the Washington Governor's Office, and Washington Legislature over where the 777X will be built

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	demonstrate the influence that a single major project can have in Washington. Also, review of EPA's data of major incidents occurring in RMP (and by extension PSM) covered facilities for a five year period from 2008 to 2013 does not suggest that California or Washington are states with accident higher risk than other states. I would strongly suggest that CSB consider why it is making its "safety case" approach recommendations only to the states of California and Washington. If the reason is that these states have had recent accidents, then the recommendation is a too narrowly focused and reactive approach to preventing reoccurrence which excludes roughly 87% of the nation's refineries.
23	Page 56, Section 5.1.4, last paragraph shown on page 56 and footnote 108 I would suggest changing words "gasket failures" to "flange leaks." The two terms are not synonymous. The title and first paragraph of Section 5.1.4 and the rest of footnote 108 (excluding the first sentence) do an excellent job of explaining the flange leak mechanisms and the measures that are normally taken to address these problems. They also make it clear that not all flange leaks were caused by gasket failures although gasket damage is a common symptom of many flange leaks. As an aside, CSB's assertion that, by itself, a single startup cycle without leaks does not provide high confidence that future cycles will not have leaks is further supported by the age of the equipment. My experience with flange joints, heat exchangers and high-temperature/high-pressure piping systems in general is that as they get older, there are a variety of mechanisms such as corrosion that change the internal stresses in the components and cause subtle distortions in joint mating surfaces with respect to one another. These problems seem most apparent during transient conditions. I do not think this point needs to be added to the report.
24	Page 58, footnote 117 Using the URL shown in footnote 117 results in a "not found" error. I found the report at the following URL: http://tsocorp.com/wp-content/uploads/2014/01/Anacortes_final_report.pdf

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25	Pages 70-72, Section 5.3.4.1 It would be interesting to know whether there was a process in place to internally review the PHA and assumptions and, if so, what it was. Because the PHAs were being done on equipment that was designed and installed many years previously, they were not part of a design process per se but there are similarities. In the time frame when the heat exchangers were designed and built, standards such as ISO 9001 and ANSI/AIHA didn't exist. These standards now require the use of design review processes. Although this observation is made with 20/20 hindsight, it seems possible that a thoughtfully designed internal review process for the PHAs could have resulted in a review and challenge to these assumptions - particularly with respect to the last assumption shown on page 72 of the draft report. Of course, just challenging assumptions does not necessarily lead to changing the conclusions of the analysis. See also comment 36.
26	Page 72, Section 5.3.4.1, paragraph below the "Materials of Construction" balloon Similar to comment 14, the use of the phrase "any hazards caused by materials of construction" is confusing. In this case, the hazard source is the naptha running through the system and the hazard mechanism is HTHA. The materials of construction are not the "cause" of the hazard but rather a passive control that was assumed to resist the mechanism – most likely without ever identifying the actual mechanism or building off of the assumption shown on page 71. I would suggest re-wording the sentence to read, "Using this assumption contributed to the PHA teams not considering the susceptibility of materials to failure from damage mechanisms such as HTHA."
27	Page 87 I suggest assigning a number to the table that starts on this page so that it can be easily referred to by other parts of the document.
28	Page 87 and Page 90 Second Row This characterization of the current regulations may not be complete or accurate. Page 51, Section 5.1 of the draft report states that documentation of heat exchanger leaks goes back to 1997. Unless the hazards of startup of the leaking (i.e. malfunctioning) heat exchangers and attendant safeguards were covered in the PHA (a point not covered in the draft report), the continued leakage of the heat exchangers should have triggered an MOC well before installation of the steam lances as a change to equipment and procedures under 29 CFR 1910.119 (l) (1) and (2) and WAC 296-67-045 (1) and (2). If the PHA had previously covered the hazards of the leaking heat exchangers, then Tesoro would have been correct in limiting the scope of the MOC evaluating the steam lances but incorrect to perform the startup process contrary to their written procedure without changing the procedure and performing an MOC to covered that change in procedures.

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	This issue of mistaking a physical change in plant as the main hazard to be evaluated rather than recognizing the physical change as a symptom of potentially larger more central hazard is actually quite common. In the U.S. DOE Unreviewed Safety Question process (part of DOE's "safety case" like approach under 10 CFR 830 Subpart B) this type of mistake is commonly seen but is usually detected with correction driven by the regulator. It is not clear whether CSB is recommending that regulators oversee only MOC procedures that set the MOC process or review and approve each individual MOC. Some oversight of individual MOCs would be necessary if CSB is recommending is that the approval authority for the PHAs should be the regulator. Finally, I disagree with CSB's interpretation of current regulations in the second row of page 90 which suggests that an employer could characterize work as being "non-routine" and make themselves exempt from the PHA requirements of WAC 296-67-017 (1) and only subject to WAC 296-67-017, Appendix C guidance.
29	Page 88 – Second row, third column, first sentence and page 89 second row This sentence appears to be a matter of semantics. 29 CFR 1901.119 (e) (1) and WAC 296-67-017 (1) state: The employer shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this standard. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. A DMHR is just a subset of the overall PHA. It is not clear why calling out a DMHR as a prescriptive element in the regulations is any different from requiring refinery operators to perform a PHA and demonstrate to regulators that the PHA is complete and the safeguards are effectively implemented.
30	Page 90, first row and page 92, first row of table With respect to the "Incident Investigation" section, I don't see where this carried over to the recommendations. Given that the lessons from other incidents are, to an extent, "free" information, I think it is important for this be in the recommendations. Ultimately it would seem that companies that insure refinery operators would be interested in this information as a way of assessing their risk if they do not already. These sections are adequate as written but could be much more powerful if they were tied to the cultural aspects of the causal analysis in Figure 37 and Appendix A. See also comment 36.

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31	Page 116, Section 8.2, Recommendations 2010-08-I-WA-R5 and 2010-08-I-WA-R6 I find the tone of the recommendations to Washington elected officials created by the “shall” statements to be disrespectful. CSB does not direct the legislature on how (or when) to do their job. I strongly suggest changing the word “shall” in this recommendation to “should consider.” In general, the “all or nothing” tone of this recommendation increases the likelihood that “nothing” will be accepted.
32	Page 116, Section 8.2, Recommendation 2010-08-I-WA-R5 It is unclear how this recommendation differs from the reporting process that started in 2011 under API RP 754. The API document was developed and the reporting process implemented in response to recommendations made by CSB from their investigation of the 2005 BP Texas City Refinery Explosion and Fire. Review of the API RP 754 indicators in Tesoro’s Social Responsibility Reports and Chevron’s Corporate Responsibility Reports suggests that they are being compiled in a manner which obscures the performance of an individual plant or site. Therefore, there appears to be role for either a set of indicators that is distinct from current implementation of API RP 754.
33	Page 117, 2010-08-I-WA-R7 This is one of many areas (although perhaps the most pronounced) where the draft report shows bias in the way that it portrays the practice of engineering as being precise, objective and rule-following. I would strongly recommend reading the first three paragraphs in section titled “Engineering Culture” in Chapter 6 of Diane Vaughan’s book *The Challenger Launch Decision* and revising (or dropping) this recommendation to provide a more realistic portrayal of engineering practice. As written, the recommendation 2010-08-I-WA-R7 seems to suggest the good engineering will follow from more specific rules and regulations on how to do good engineering. Representing the possibility of the practice of engineering being sufficiently defined by mandates is not good service to the regulated organizations, regulatory bodies, or the general public. Note that the draft report’s recommendation as written is distinctly different from OSHA’s 29 CFR 1910.6 *Incorporation by Reference* of the mandatory provisions of national consensus standards. These standards are written as much as possible to limit mandates to what must be done and to minimize mandating how something should be done. Further, it is important to note that, meeting the mandatory provisions of series of standards is only another version of the “minimum compliance” approach, appropriately criticized elsewhere in the draft report. Additionally, this is another area where directing the recommendation at the state of Washington rather than OSHA could have several negative unintended consequences in the long term. Equipment is often designed, built and used in different

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	states or even countries and can be traded or sold for use in different geographic areas. The potential for different, competing, and conflicting requirements across jurisdictional boundaries is increased by having each state pick their own standards.
34	Page 118, section 8.3 The title of this section does not correctly reflect the organization these recommendations are directed to. I would suggest changing the title to, "Washington State Department of Labor & Industries –Division of Occupational Safety and Health"
35	Page 119, Section 8.4, 2010-08-I-WA-R10 (a) and Page 119, Section 8.4, 2010-08-IWA-R11 (b) (sic) (by the report numbering system this should be "I-WA" not "IWA") This recommendation suggests that there is combination of requirements that will prevent HTHA in all cases and API has only to write them into the standard as "shall" statements. Based on the quotes from API TR 941 found on page 78 of the report along with the caveat in from Section 3.2 of API 941 about using the Nelson curves, it is apparent that that there is no known set of conditions that can be enumerated where a "minimum compliance approach" will prevent HTHA. Some conditions are known which will minimize the risk of HTHA but no piece of equipment can be expected to last forever when subjected to cyclical elevated temperatures, elevated pressures, and a corrosive environment.
36	Page 123, Figure 37 and Appendix A and pages 73 and 74 Section 5.4, Table on pages 87 - 92 This analysis falls short of getting to root cause(s) in accordance with CSB's stated mission or past its past reports such as the report for the 2005 BP Texas City Refinery Explosion and Fire. Without this information, I have little confidence that the report's central recommendation to take a "safety case" approach to the regulatory regime would effectively address the causes of the accident. Based on the causal analysis in the draft Tesoro Anacortes report and Appendix C of the draft Chevron Richmond report, the recommendation for a broad shift in the regulatory regime to a "safety case" approach seems to stem from a correlation between use of the approach in other countries with better (as much as can be discerned with available data) safety records without specifically stating the logic for establishing specific causal relationships between accident and elements of the "safety case" approach. More to the point, Appendix C of the CSB's draft Chevron Richmond accident report lists the following "obstacles that may hinder transition" and "significant challenges" with transition to "safety case" regime. These factors clearly present at this time and, absent either legislative action or a change in availability of insurance that dramatically increases the costs of

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	<u>accidents, would likely render any regulatory change to the "safety case" ineffective for the foreseeable future.</u> Specific factors cited in on page 111 of the draft Chevron Richmond report that present are: 1. Major stakeholders not being committed to process, unconvinced of the need 2. The safety case report could be treated as "check-the-box" exercise 3. Documented safety management system does not reflect reality 4. Attempting to justify existing controls rather than to seek opportunity to improve 5. Insufficient workforce involvement in the process To try to address the causes this accident and prevent similar accidents, emphasis should be placed on the corrective actions that will create a performance standard with the hazards analysis and control implementation processes that regulators can enforce. The supporting information for statement underlined above, which you can chose to read and respond to or not, is contained in Enclosure 2. Enclosure 2 concludes that, based on publically information, Tesoro, Chevron, and by extension other refinery operators do not appear to see any need for significant improvement to their accident prevention efforts. Therefore, their current behaviors and public statements predict the five challenges from the Chevron Richmond report listed above as being significant and relevant. Given the amount of time that has passed since the accident (nearly four years), the need to finish the report, and do something to improve the situation in the near term; an in-depth root cause analysis appears to not be practicable. **Possible Effective Approach** To try to address the causes this accident and prevent similar accidents, emphasis should be placed on the minority of corrective actions which can have to greatest effect on the prevention of similar accidents. From review of the report, there are two general areas where opportunities are repeatedly seen (admittedly in hindsight) to prevent the accident which are: 1) Verification of the effectiveness of controls; and 2) Failure to learn from previous events. 1. <u>Verification of the effectiveness of controls</u> – No matter what is written on paper in a hazards analysis, technical paper,

	or technical standard, two central risk management questions have to be, "How are the safety controls actually working?" and, if safety controls are working, "What is the confidence level that safety controls will continue to work over time?" These questions can only be answered if there is objective, observable, and repeatable evidence of how that control or safeguard works under actual conditions that is collected and re-evaluated over time. Standards for HTHA and other failure mechanisms (particularly corrosion) will always contain less information than desired to make good engineering decisions and perfect information is unattainable (refer back to comment 33 reference to Vaughan). However, the quote from WA DOSH NEP review shown on page 97 that states, "In general, the refinery maintains corrosion control documentation that attempts to identify corrosivity data and potential failure mechanisms" provides a very clear indication that regulators knew the actual effectiveness of such measures was not verifiable (hence the carefully caveated language) but had no mechanism to issue a citation. It could be possible to drive a more reliable implementation of safety controls if regulations could be put in place that require: (i) refinery operators to verify PHA controls; (ii) provide this verification to regulators upon demand; and (iii) allow regulators to re-verify these controls. The following specific areas would have to be addressed: a. For active engineering controls – The function of control would have to be periodically tested under realistic conditions and critical maintenance and inspection requirements identified and performed. b. For passive engineering controls or features – The features would be required to be inspected for deterioration and shown to be effective based on data taken from controlled experiment or from similar services with clearly defined conditions. Note that this would preclude relying solely on the use of higher chromium steels to resist HTHA without an additional verification mechanism. c. For process operating conditions – Conditions assumed by analysis would have to be verified by direct measurement of the actual process. The potential for measurement error would have to be addressed by a calibration program. d. For administrative controls – Procedural steps that implement administrative controls would have to be verified be periodic and random observations from internal independent assessors. 2. <u>Failure to learn from previous events</u> - While this may seem a "reactive" rather than proactive measure, it is clearly an opportunity to improve safety that has not been exploited to even a small fraction of its potential. Also, looking at precursor events dealing with losses of mechanical integrity could actually be considered proactive. Tesoro's response to The HTHA risk before and after the Anacortes accident appears to be quite typical. (i.e. the risk of an event that hasn't occurred or has occurred at another site is underestimated) If an evolving process could be put in place that screens and compiles common technical causal information from major refinery incidents and accidents and refinery operators were required to regularly (e.g. annually) evaluate the applicability of this causal information and report their findings and

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additional preventive actions to regulators for approval, it could be possible to drive improved safety performance even without complete "buy-in" from refinery operators. Note that the information from accidents and incidents can be plentiful and overwhelming and the goal of this process would not be to address everything but rather to group and prioritize a minority of areas that could maximize improvements to risk.

Further, there is an overarching theme in the both Anacortes and Richmond draft reports of a "minimum compliance" approach to safety by refinery operators. Neither the current regulatory process nor the draft report's recommendation for a "safety case" approach explicitly state how this situation could change. Addressing this issue requires changing: a) How regulators respond to non-compliance information; and b) Incentives for continual improvement.

a) How regulators respond to non-compliance information – Problems that are identified by refinery operators and corrected in reasonable time frame have to be given a "safe harbor" from enforcement or there will incentives to withhold information and continue on the path of "minimum compliance." Conversely, identification by regulators of non-compliances due to inadequate hazards analyses or verification or effective control implementation has to be a consistently and reliably cited and enforced. Critically, both the "safe harbor" and enforcement processes would have to allow regulators to direct refinery operators to either suspend or curtail operations or implement interim compensatory measures if a non-compliance represents a significant risk of causing an accident. The judgment of risk is necessarily somewhat subjective but could be consistently applied by using a risk matrix such as that found in ANSI/AIHA Z10.

b) Methods of driving continual improvement – It is widely (although not universally) recognized that efforts to continually improve performance are necessary to be successful in any endeavor. Merely trying to maintain a current level of performance is, in concept if not words, the exact definition of "complacency." The world changes as time passes and this makes continual improvement efforts necessary to just keep up with change. As stated in Enclosure 2, Tesoro and Chevron publically exhibit some "complacency" or "overconfidence" about the risks of serious accidents in their statements and behavior. This may or may not reflect their internal efforts. However, it does suggest that some incentives to improve are necessary. The process described under item 2 above in this comment "Failure to learn from previous events" is a regulatory driven continuous improvement process for verifying the effectiveness of safety controls. Similarly regulators will have to continually improve their processes of oversight of effective verification safety controls (refer back to comment 17). This will be necessary to provide incentives to refinery operators to continually improve their implementation of safety controls.

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37	Page 123 Figure 37 It would helpful to get the language used in Figure 37 were consistent with statements elsewhere in the report. In the long horizontal box in the Tesoro section of Figure 37, it is stated that Tesoro assumed HTHA was not “possible.” Whereas, the fourth paragraph of Section A.3 states that corrosion experts had concluded HTHA was not “probable” and Section 1.2.2 (13) on page 5 states that a review did not identify HTHA as a “credible” failure mechanism. If the word “possible” is retained in Figure 37, it should be supported better in the rest of the report since “possible” is a very “absolute” word.
38	Page 141 Appendix F This appendix lists the incorrect URL for the Chevron report. The correct URL (as of this writing) is shown at the end of footnote 26 on the bottom of page 9 of the draft report.

	Western States Petroleum Association (WSPA) Comments
1	The Western States Petroleum Association ("WSPA") is a non-profit trade association representing companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California, Arizona, Nevada, Oregon, Washington and Hawaii. WSPA members are significantly affected by the efforts of the Chemical Safety Board (CSB) and are regularly called upon to respond to and implement CSB's recommendations. WSPA appreciates the opportunity to provide these written comments on the draft CSB Tesoro Anacortes Refinery accident report.
2	In the Tesoro Anacortes Refinery accident report the CSB recommends that the state of Washington "develop and implement a step-by-step plan to supplement the existing process safety management regulatory framework with the more rigorous safety management principles of the "safety case" for petroleum refineries in the state of Washington". WSPA believes introducing Safety Case into existing regulatory oversight could have unintended consequences and burdens associated with it. The Process Safety Management (PSM) standard represents a consistent and well-understood framework that has been used by manufacturing facilities throughout Washington and the rest of the United States for over two decades. Changing the regulatory approach to include Safety Case principles without a better understanding of what is gained from that action would add complexity and uncertainty with no demonstrated benefit that is readily understood. This added complexity may even increase risk due to conflicting priorities created by the potential overlay of new regulations. WSPA supports efforts to enhance the existing PSM regulatory program before pursuing or adding the introduction of an entirely new and different regulatory approach.
3	The former Chair of the CSB, John Bresland, submitted comments just two months ago in response to CSB's recommendation of Safety Case for petroleum refineries found in the draft regulatory report on the Chevron Richmond refinery incident in California. In his letter, Mr. Bresland emphasized his reservations regarding the CSB's Safety Case recommendation, stating, "there is no empirical evidence demonstrating that the Safety Case regime is more effective than any other regulatory scheme, including the existing federal PSM standard." Mr. Bresland also raised concern that, "efforts to implement sweeping regulatory changes will introduce significant uncertainty and potentially degrade safety performance without any corresponding assured benefit." He then went on to cite Dr. Nancy Levison, of the Massachusetts Institute of Technology, who is a recognized expert in the field of safety and regulation and recently published a paper questioning the ability of the Safety Case to improve process safety. Mr. Bresland also referenced Dr. Sam Mannan, of the Mary Kay O'Connor Process Safety Center at Texas A&M University, who has stated similar concerns - "'considering the big difference between OSHA PSM and HSE Safety Case, we should be very cautious to make any immediate change and analyze this issue deeply in multiple aspects.'"

	Western States Petroleum Association (WSPA) Comments
	Of significant concern to WSPA is the lack of meaningful data that demonstrates that the Safety Case approach produces better process safety performance than the PSM standard. In fact, on page 105 of the CSB draft regulatory report on the Chevron Richmond refinery incident, the CSB acknowledges that "there have been few objective studies conducted on the impact of the Safety Case regulatory approach on safety performance onshore and offshore." That same CSB draft report also recognizes, via many references, that the existing data mainly relates to offshore operations which increase WSPA's concerns about applying Safety Case to refineries. If Safety Case or other regulatory regimes are to be considered, all the relevant United States regulatory bodies should first collect broad and meaningful data that can be used to justify further consideration of regulatory alternatives.
4	WSPA firmly believes the current PSM program is effective and that efforts to enhance PSM should be the focus of the CSB in Washington, California and throughout the United States, not an entire change to a new Safety Case regime. The effectiveness of any safety program is only as good as the commitment made to its preparation, implementation and execution. To the extent the CSB sees other areas for improvement, WSPA welcomes dialogue with the CSB on areas that enhance the current PSM standard and not on alternatives to replace it.

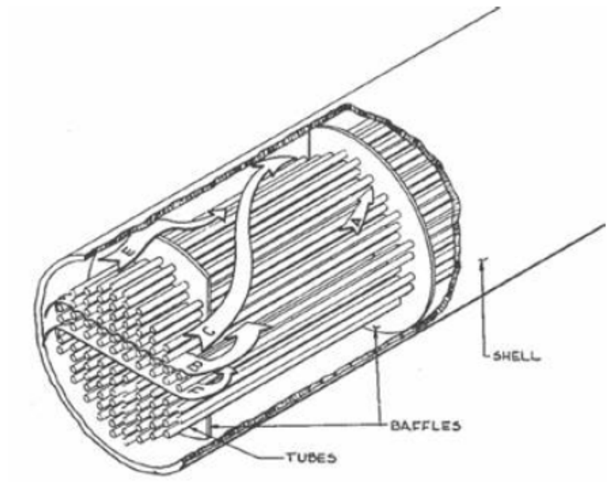
	American Petroleum Institute (API) Comments
1	CSB conclusion that API standards are written permissively: It is API's policy that API standards are written in performance-based language to the maximum extent possible. This allows for a variety of approaches in the application of the standard. API standards use a variety of requirements, with a mixture of "should" and "shall" statements, and this performance-based approach was espoused by a variety of regulators at the 2012 "Expert Forum on the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore". At this event, several of the participating agencies, including OSHA, BSEE, PHMSA, USCG, and EPA, stated that their regulations are a mix of performance-based and more prescriptive-based regulations (i.e. a mixture of "should" and "shall" type language and requirements) which serve to improve safety in the oil and natural gas industry. API standards, while not written as regulations, likewise use this approach, thus this approach should be viewed as a "feature" of the API standards, not a criticism.
2	Nelson Curve Development: While API standards are developed from empirical (experience-based) data, they are also supported by experimental data. In fact, to provide transparency for the development of the Nelson curves presented in Recommended Practice 941, Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants, there are 33 references contained in section 3.4.1, citing a variety of both API committee data references and publically available sources. And to provide further documentation and transparency, API published API Technical Report 941, The Technical Basis Document for API RP 941, a 300-page scientific report. This publication provides a comprehensive and detailed engineering review and analysis of the development of the Nelson curves, including the origin and pedigree of the base data used to develop and refine the curves.

	American Petroleum Institute (API) Comments
3	The members of API are dedicated to continuous efforts to improve safety and the compatibility of their operations with the environment, while economically developing energy resources and supplying high-quality products and services to consumers. Our members recognize their responsibility to work with the public, the government, and others to develop and use natural resources in an environmentally sound manner, while protecting the health and safety of our employees and the public. To meet these responsibilities, API members pledge to manage their businesses according to a series of environmental principles, using sound science to prioritize risks and to implement cost-effective management practices, including the following: "To advise promptly appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures." It is because of API's commitment to safe operations that API took the step to prepare and release an industry alert on high temperature hydrogen attack, HTHA, which was posted on API's website in September 2011, and distributed via API's "SmartBrief" electronic newsletter which has a circulation of 26,000 subscribers.
4	The draft CSB report goes on to cite "at least eight recent refinery incidents where HTHA reportedly occurred below the carbon steel Nelson curve" and that the API industry alert on HTHA in refinery service strongly suggests an industry-wide problem with the carbon steel Nelson curve. In fact, the "eight recent refinery incidents" are under review by API's Subcommittee on Corrosion and Materials, in conjunction with a leading university professor on this topic, who is recognized for his expertise on HTHA and all manners of metallurgical studies related to the properties and degradation mechanisms relevant to these incidents, and at this point it is indeterminate whether they represent actual HTHA incidents or some other damage mechanism. Therefore, we believe it is premature and inaccurate to assert an "industry-wide" problem, but nevertheless, work is progressing on this critical document and proposed revisions will be balloted for consensus approval and made available for public comment later this year.

	American Petroleum Institute (API) Comments
5	As described in the draft CSB report, the Nelson curve has been in use since the first published edition of API Recommended Practice 941, *Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants*, was released in 1970. Since then, the standard has been revised seven times with the Nelson curves adjusted as additional empirical and experimental data has become available. There are currently over 700 individual company electronic subscriptions to this edition of the standard, demonstrating its wide use in the refining and petrochemical industry. The form found in Annex F of API RP 941, "Datasheet for Reporting High Temperature Hydrogen Attack (HTHA) of Carbon and Low-Alloy Steels", provides a recommended format for internal company data collection, which is then reviewed by the RP 941 Committee. Given the relatively few incidents involving carbon steel in the countless hours of operations since the 1st edition of the standard was published in 1970, it is incorrect to state that the curve is inaccurate. In fact, in the "Commonly asked questions" section of API Technical Report 941, *The Technical Basis Document for API RP 941*, the following question is posed and answered: "**2.0 ARE THE API RP 941 CURVES WHERE THEY BELONG?** It depends on the material and how the curves are to be employed. There is scant evidence that the carbon steel line is not conservative. However, the C-0.5% Mo lines used in past years were clearly nonconservative. It should be anticipated that for other materials, the curves will not apply under very adverse or unusual conditions of microstructure, composition, heat treatment or applied stress. The possibility of attack is most significant in applications where the actual operating conditions are close to or at the Nelson curve, and where stress relieving, tempering or PWHT have been minimal and any applied, thermal or residual stresses are high. For example, MPC has reported attack of 2-1/4Cr-1Mo steel weldments in only 2,000 psi hydrogen at 825 ^{o}F when stress was applied and tempering left the material in a high strength (high carbon activity) condition (about 105 ksi U.T.S.)."
6	API's standards procedures call for API standards to be revised, reaffirmed or withdrawn on a regular basis, and in keeping with the policy API has taken the following steps to prepare the next edition of API RP 941, *Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants:* • API reactivated its Recommended Practice 941 Task Group to begin work on the next revision of this document well before the draft CSB report was issued. • API staff and committee members met with members of the Chemical Safety Board staff at API's Spring 2012 Refining and Industry Standards Meeting in Dallas to discuss potential revisions to API Recommended Practice 941. We look forward to working with all materially affected stakeholders on the next revision of this important standard.

	American Petroleum Institute (API) Comments
7	The draft CSB report states that API standards do not require industry to use inherently safer materials. First, the Nelson curve does alert users to utilize more robust carbon steel, different alloys, and in fact, contains a section on "Operating Limits" that provides, amongst other subjects, a basis for setting operating limits and provides guidance on material selection. The standard goes on to cite factors influencing HTHA and provides for a variety of mitigation approaches. In effect, taken in its totality, API Recommended Practice 941, *Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants*, is a treatise on the selection, use, inspection and installation of inherently safer materials.
8	In fact, API's standards facilitate the availability of proven, sound engineering and operating practices throughout the world. API's standards are the most widely cited and used standards on a global basis for the oil and natural gas industry, as cited in the International Oil and Gas Producers Report No. 426, *Regulator's Use of Standards,* March 2010. And, API standards are written in performance-based language to the maximum extent possible, which allows the users to make the best determination in how to apply the standard, given the variety of operating conditions at refineries and petrochemical plants. Mandating a "one-size fits all" approach could actually lead to less safe, rather than more safe operating conditions, as the use of API standards do not obviate the need to apply sound engineering judgment. In addition, under the OSHA Process Safety Management regulation, API's mechanical integrity standards are acknowledged as Recognized and Generally Accepted Good Engineering Practice, or RAGAGEP, and OSHA cites 13 API standards in the U.S. Code of Federal Regulations. For more than 90 years, API has led the development of standards for the petroleum, petrochemical and natural gas industries. These documents, which currently number over 600, are developed under an American National Standards Institute (ANSI) accredited process, following ANSI's essential requirements of openness, balance, consensus, and due process, and are updated on a regular basis. API standards are developed by committees made up of member and nonmember companies of API, including representatives of state and federal agencies. Furthermore, prior to final publication, API standards are available for public comment. It is because of this robust process that over 100 API standards are cited in U.S. Federal Regulations.

	American Petroleum Institute (API) Comments
9	We understand that the model employed by the CSB in their analysis is highly sensitive to base-line assumptions and inputs. This sensitivity may therefore inadvertently lead to faulty and overly conservative conclusions and recommendations, especially when coupled with the relatively small sample size. While the report section detailing the modeling is brief and high level, API offers the following comments based on the available information, informed by our February 21, 2014 conference call with CSB's Denver investigation staff. Given the brevity of the modeling content of the draft report, the brief conference call and the short time period API had to review the full report and prepare comments, API's comments are not as comprehensive as they could be and therefore could be enhanced with further study and analysis. API's comments will address Thermal Analysis, Adequacy of Modeling and how the combination of the model's sensitivity and relatively small samples size has led to overly conservative conclusions and recommendations in API's estimation.

	American Petroleum Institute (API) Comments
10	**Baffle-to-Shell Bypassing.** Figure 25 on page 47 of the draft CSB report shows an operating range of the stainless steel clad portion of the carbon steel Naphtha Hydrotreater Unit (NHT) B/E exchangers. According to CSB calculations, the operating temperature range in that region extends well above the Nelson curve for carbon steel materials. All heat exchangers with removable tube bundles, such as those installed in the Anacortes refinery NHT unit, have a clearance of about ¼ inch (could be slightly less or more depending on the shell diameter). This clearance is necessary to accommodate tube bundle removal for cleaning and inspection. As shown in the sketch below, the baffle-to shell by-pass stream E is thermally not active because it is not in contact with the tube bundle containing the cooling fluid (NHT reactor feed).  Consequently, shell temperature in the area of circumferential weld immediately downstream of the stainless steel clad portion of the B and E exchangers will correspond closely to the shell inlet temperature and the maximum operating temperatures for Can 4. For this reason, the operating range for the E exchanger, shown in Figure 26 on page 48, is not correct. Figure 26 should be revised to include the maximum operating temperatures shown in Figure 25, including the temperature range well above the carbon steel Nelson curve.

	American Petroleum Institute (API) Comments
11	The draft CSB report states that fouling in the heat exchangers has significant impact on the shell side temperatures and we strongly agree with this assessment. However, as shown in Figure 44 on page 133 of the draft CSB report, the sensitivity analysis on impact of fouling was one for a very narrow range of fouling conditions. Thermal analysis performed by CSB included fouling resistance in shells A/D (top hottest shells) between 50 and 60% of the total fouling resistance. Thermal conditions in NHT Unit preheat exchangers are such that all liquid feed is vaporized prior to entering the furnace. Full feed vaporization that takes place in the hot (top) shell results in heavy fouling conditions due to deposition of dissolved solids in the feed. The cold and intermediate shells experience very low fouling rates. The pictures below illustrate fouling distribution in one of API member company's NHT Unit preheat exchangers (Note: this NHT preheats feed on the shell side on the feed/effluent exchangers) Example of hot shell (top) fouling in API member company NHT Unit 

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	Example of Medium Exchanger fouling in API member company NHT Unit 

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	Example of Cold (bottom) exchanger fouling in API member company NHT Unit  To determine the impact of fouling distribution on the temperature distribution in the exchanger shells a thermal analysis was performed for an API member company NHT Unit that is similar to the Anacortes NHT Unit. The similarity included feed rates, heat exchanger configuration (a total of six exchangers with two parallel trains of three exchangers), feed inlet temperatures, and reactor effluent temperatures. The analysis assumed the following four fouling scenarios: • Clean conditions, • Uniform fouling, • 60-30-10 fouling distribution (i.e., the same fouling distribution as that assumed in the CSB draft report), • 100% fouling in the top shell The graph below summarizes the results. Observations: • There is little change in the temperature distribution (comparing the overall inlet to the outlet) when all

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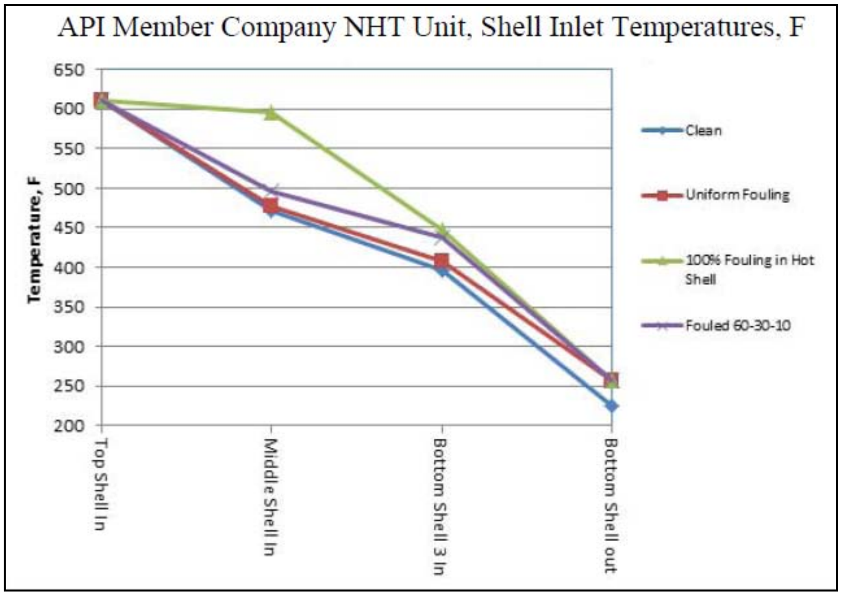
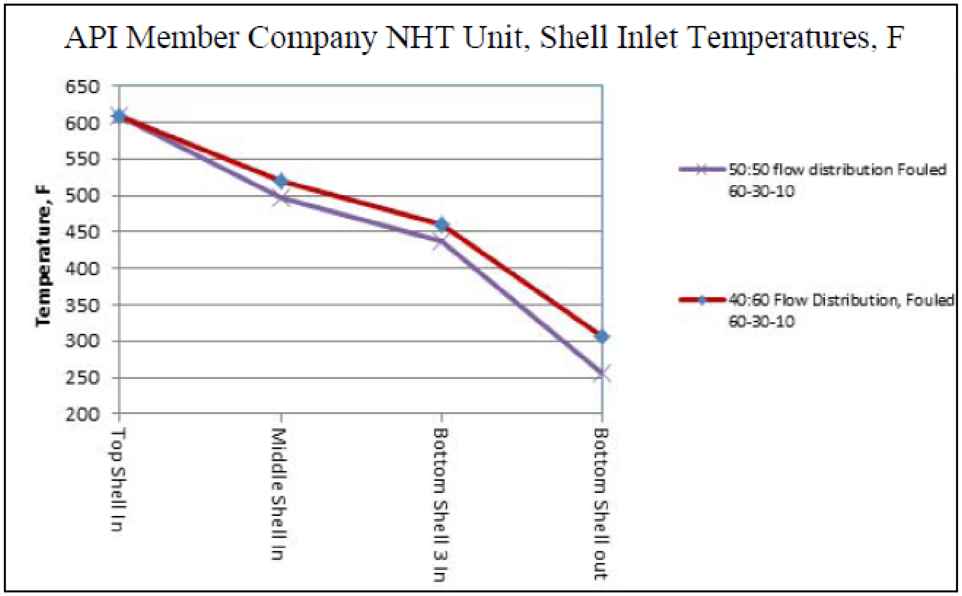
exchangers are simulated as clean, with uniform fouling distribution or with 60-30-10 fouling resistance distribution. For all three cases, the inlet temperature to the middle shell (the shell that failed in Anacortes refinery) varies within 20 ^{o}F.

- Once the analysis assumed that all fouling occurs in the top shell inlet temperature to the middle shell increased by about 80 - 100 ^{o}F. To make the thermal analysis less restrictive, API recommends that CSB expands the sensitivity analysis with respect to fouling distribution. Both this assumption change, and the baffle to shell bypassing noted in Paragraph 1, above, will further broaden the predicted operating temperature range in failed zone of the E exchanger (Figure 26 on page 48) and in the zone identified between Cans 1 and 2 (Figure 27 on page 49).



	American Petroleum Institute (API) Comments
12	Thermal analysis presented in the CSB draft report was done under an assumption of ideal 50% split between two parallel banks of the exchangers A/B/C and D/E/F. In reality, there is a flow maldistribution due to uneven fouling between two parallel sets of the heat exchangers. In order to determine impact of flow maldistribution between two parallel sets of exchangers, an analysis of the same exchangers in the API member company's NHT Unit, as described in Item 11 above, was completed. The graph below indicates that assuming a split of 40% and 60% increases inlet temperature to the idle shell by about 20 ^{o}F. API recommends that to address this issue, modelers should expand the sensitivity analysis in the CSB draft report by including flow maldistribution. This will also increase the range of operating temperatures in the failed zone of the E heat exchanger (Figure 26 on page 48) and in the zone identified between Cans 1 and 2 (Figure 27 on page 49). 

	American Petroleum Institute (API) Comments
13	As stated in the introduction to this section, API believes that the model's high sensitivity to base-line assumptions and inputs and the relative small sample size have led to overly conservative conclusions and recommendations. The recommendation that API "Prohibit the use of carbon steel above 400 ^{o}F in applications where HTHA could occur" is an example of this conservatism, as follows: In the draft report, the CSB cites two issues which form the basis for their recommendation to limit carbon steel to 400 ^{o}F in hydrogen service: **Issue 1:** Eight other recent refinery incidents due to high temperature hydrogen attack (HTHA) of carbon steel below the Nelson curve **Issue 2:** CSB's conclusion that the Tesoro Anacortes NHT feed effluent heat exchanger failed by HTHA, even though the CSB computer modeling *estimated* it operated at temperatures no higher than the API RP 941 Nelson curve for carbon steel.
14	The draft CSB report cites "at least eight recent refinery incidents where HTHA reportedly occurred below the carbon steel Nelson curve" and that the API industry alert on HTHA in refinery service strongly suggests an industry-wide problem with the carbon steel Nelson curve. All of these incidents occurred in non-post weld heat treated (non-PWHT) carbon steel. One of these incidents is noted as having occurred at "conditions immediately below the Nelson curve". Three more of these incidents occurred just below the existing Nelson curve for carbon steel, and all four of them were within 50 ^{o}F of the Nelson curve. Another 4 potential incident cases are currently under review by API's Subcommittee on Corrosion and Materials, and at this point it is not conclusive whether they represent actual HTHA or some other phenomena. These four potential incidents are associated with one particular licensor's hydrotreating process, and are at temperature and hydrogen partial pressure combinations which are much different (higher temperature, lower pressure) from those in the Tesoro NHT failure. These potential incidents are totally different in microstructural appearance than normal HTHA, and there is still uncertainty as to whether they are due to HTHA or possibly creep relaxation. Some of these samples have been submitted to a leading university professor for further analysis who is recognized for his expertise on HTHA and all manners of metallurgical studies related to the properties and degradation mechanisms relevant to these incidents. Currently, API has characterized these as "HTHA" incidents to be on the cautions side until the investigation is complete. As a result of review of these new data, and the recognition that PWHT improves the resistance of carbon steel to HTHA, the API 941 Task Group has a proposal under consideration for *a new curve for non-PWHT carbon steel*. This proposed

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	curve would be drawn parallel to the existing curve, but 50 ^oF below and 50 psia to the left of the current Nelson curve to account for non-PWHT carbon steel. The current Nelson curve for carbon steel with PWHT would remain the same. Based on evidence from these incidents API feels it is premature to profoundly change the shape and position of the Nelson curve until investigation of all potential incidents is sufficiently conclusive. Drawing the curve as a horizontal line at 400 ^oF would be an unprecedented change, and is not scientifically logical, since the actual HTHA phenomenon is more pronounced at higher temperatures and higher hydrogen pressures, and therefore, should be characterized as a curve rather than a horizontal line at a single temperature of 400 ^oF.
15	The CSB report makes the repeated absolute conclusion that "… the carbon steel Nelson curve methodology is inaccurate, cannot be depended on to prevent HTHA equipment failures, and cannot be reliably used to predict the occurrence of HTHA equipment damage…" This conclusion was reached from examining a single failure (Anacortes) and utilizing a computer software model to reverse calculate operating temperatures with a very limited data set (2007 - 2010) and using visual observations from over 10 years prior to the failure be employees of Shell, the previous owner of the refinery. These observations were strictly visual, with no measurements, no physical data, or analysis as to the nature of the fouling or thermal conductivity of the scales. The CSB draft report even stated (Note 13) that the HYSYS model required "…the use of several assumptions, such as fouling distribution, because of the lack of process and fouling data gathered by Tesoro. As a result, all model results are estimates…" Given the lack of data and multiple assumptions made during modeling it would seem overly conservative to disregard the RP 941 Nelson curves and over 50 years of data and experiences, plus supporting metallurgical research in TR 941, and thousands of successful applications of RP 941 after attempting to model a single failure event.

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16	API believes that based on subject matter expert review, the CSB's conclusion that the Tesoro Anacortes NHT exchanger operated at temperatures below the Nelson curve is not well-proven from a scientific basis. Because of this, API does not agree that the upper limit for the carbon steel Nelson curve should be set at 400 ^{o}F, and presents the following additional comments on this specific topic: Physical Evidence and Exchanger Configuration Does Not Support CSB Temperature Model Referring to Figure 20 from the CSB report, the hottest section (Can 4) of the failed exchanger was clad with stainless steel, which somewhat improves resistance to HTHA. However, the adjoining section (Can 3) was bare carbon steel, and the circumferential weld between Cans 3 and 4 failed by HTHA in a catastrophic manner. This bare carbon steel side of this joint would not have been protected by the stainless, and would have been fully vulnerable to HTHA, as expected. Per their computer modeling, the CSB estimates the stainless-clad Can 4 portion of these two exchangers operated *occasionally* at temperatures above the Nelson curve. However, the un-clad, bare carbon steel Can 3 portion, where the rupture occurred was estimated to have operated below the Nelson curve. Physically, this does not seem logical. The weld joint between Cans 3 and 4, which failed, *is less than 12 inches* from the inlet nozzle where the hottest fluid entering the exchanger. Unless there is an internal detail such as a baffle, it would not be logical to expect the failed weld to operate significantly cooler than the inlet fluid temperature and the rest of the metal of Can 4. Further supporting the contention that the shell actually operated above the Nelson curve are temperature measurements noted on the Tesoro Triangle of Prevention (TOP) Report dated July 21, 2011. These temperature measurements showed that the shell temperature occasionally ran above the Nelson curve temperature. Furthermore, it is well known that surface contact pyrometer measurements typically read somewhat lower than the actual metal temperature.
17	In addition to the aforementioned physical data, API believes there was not enough actual operating data put into the CSB computer model to give a valid answer, as follows: Lack of Data Hinders Validity of Modeling Result

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The CSB computer simulation of the process conditions within the failed exchangers resulted in the conclusion that "The results of the computer reconstruction show that the portion of the carbon steel heat exchanger that ruptured was estimated to have operated below the applicable Nelson curve." In Appendix C, the report states: "The necessary DCS and fluid composition data needed to model the heat exchangers were only available between 2007 and 2010." Later, the report states: "The CSB modeled 10 days of operation during this 2007 to 2010 time period. Two of the periods modeled were characterized by clean heat exchanger conditions; during three of the periods modeled, middle-of-run operation conditions existed; and five of the periods modeled were characterized by fouled heat exchanger conditions near the end of a run." API questions whether or not this small sampling of data is truly representative of temperatures experienced in the failed exchangers during fouling events over the life of these two exchangers. The temperature readings obtained in the relatively brief duration when the DCS was available, led the CSB to believe that only Can 4 of the exchanger was subjected to temperatures just above the Nelson curve for only brief periods during its operational life.

However, without more precise and direct, temperature measurement over the years, it would seem very plausible that higher temperatures were experienced by the units. The refinery could have had much longer episodes of fouling in the years prior to their process readings being tracked online. Personnel may not have recognized the importance of historic temperature excursions on the accumulation of HTHA damage. HTHA damage is a progressive, cumulative damage event from prior operation. Multiple non-continuous periods of operation above the curve during the end of run or during exchanger fouled conditions could have easily accounted for the damage over the life of the exchanger.

Without continuous, online monitoring by DCS tracking software, temperature excursions are generally harder to monitor and track and such episodes could have unknowingly put the exchanger shell over the Nelson curve for significant periods of time.

NHT process experts with 30 years of experience in the industry noted that the NHT operation described in the CSB draft report is very unusual, relative to a typical NHT operation. The typical reactor outlet temperature, according to the aforementioned Tesoro TOP Report, was 670-710° F, with occasional brief spikes to 715° F. One incident reported by the Tesoro TOP resulted in a maximum temperature of 719° F for four days. Operation above 650° F is generally considered detrimental due the start of mercaptan recombination which puts sulfur back into the product. Since the purpose of the NHT is to remove sulfur, running the reactor hotter than 650° F is counterproductive. Operation at a reactor outlet temperature in the 680-690° F range is not commonly practiced. Moreover, operation above 690° F is very unusual. The higher reactor outlet temperatures Tesoro ran suggests periods of high exchanger temperatures.

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18	Additionally, the need to pull and clean NHT exchangers every 6 months is very unusual. More typical industry experience is these exchangers are cleaned during unit outages & turnarounds every two to five years. The rapid fouling suggests these exchangers ran hotter than the CSB model indicates. The degree of fouling used for the CSB model is anecdotal at best. Corrosion product, salting, and olefinic polymerization all increase resistance to heat transfer. The type, thickness, and most importantly, the thermal conductivity of the particular fouling scales and films were not known for the CSB modeling. Thin, tightly-adhered polymer films with low thermal conductivity may look "light" to an operator, yet still greatly reduce heat transfer. Such a scale may have lower heat transfer than a thicker scale with higher thermal conductivity. One would need to analyze the sample to fully quantify the heat transfer coefficient. Different exchanger banks could also have different types of fouling. In addition, a rule-of-thumb is that for every 10° to 20° F increase in temperature doubles polymerization. Therefore, the fouling in the hottest exchanger could have been 20 to 40 times higher than the coldest exchanger. This suggests the second exchanger in each bank was more often hotter than expected. In the CSB draft report the difference between fouling distributions for the exchangers (Figure 44) is small. API believes that it is extremely difficult to assign a fouling factor based on visual inspection and would analyze a significantly greater range than that shown in Figure 44. For instance, the exchangers experiencing full vaporization (A and D) could account for nearly all fouling resistance. Moreover, with regard to fouling based on operator observations, since heat exchangers are usually steamed out and water flushed (to reduce LELs), observations of fouling usually completely ignore salt build up and loose fouling material, which are washed away before pulling the bundle. Another deficiency with the CSB model is the fact that the control of flow and temperature during restart of a clean exchanger train is poor because large gate valves were used for isolation. During the upset the exchanger outlet on the dirty side (the side that failed) was at least 50°F higher than normal and potentially would have gone higher, except for the failure. In addition, when one bank of exchangers is out of service, the single exchangers will operate at higher than normal temperature because half of the surface area is out of service. Because the refinery staggers exchanger bank cleaning, it is likely that the banks have different levels of fouling. This will impact the split further, with more flow forced to the "clean" bank, which increases heat transfer rates as velocity goes up. None of these facts appear to be accounted for in the CSB modeling.

	American Petroleum Institute (API) Comments
19	In summary, API strongly believes the Tesoro exchangers likely ran significantly hotter during their history than the CSB models concluded, and that the carbon steel Nelson curve is more accurate for predicting HTHA than the CSB draft report states.
20	*2010-08-I-WA-R10* *Revise American Petroleum Institute API RP 941: Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants to:* *a. Clearly establish the minimum necessary "shall" requirements to prevent HTHA equipment failures using a format such as that used in ANSI/AIHA Z10-2012, Occupational Health and Safety Management Systems;* API has a document entitled "Format and Style Manual" which is used to provide consistent format for all API standards. This format allows for the ease of access of the information contained in the standards by world-wide users. And, as stated in the "API Standards" section of this report, API standards are written in performance based language to the maximum extent possible. Having said that, API RP 941: Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants is under revision and the next edition will be produced with both "change" designations as well as a "red-line" edition, both of which will serve to highlight the changes to the standard.
21	*2010-08-I-WA-R10* *Revise American Petroleum Institute API RP 941: Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants to:* *b. Require the use of inherently safer materials to the greatest extent feasible;* Throughout the draft report the terms "inherently safer design", "inherently safer systems" and "inherently safer materials" are used to suggest that the use of carbon steel at temperatures above 400°F is unsafe and does not reduce the risk of the applicable damage mechanism hazards, i.e. high temperature hydrogen attack. The draft report recommends the use of 5Cr, 9Cr, 12Cr and 300 series stainless steel alloys as being the inherently safer materials.

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When designing new process units, materials selection is an engineering activity that must consider all potential degradation mechanisms applicable to the service conditions, and should never focus on just one degradation mechanism. For processes containing hydrogen, high temperature hydrogen attack is only one of many degradation mechanisms that must be considered. In the case of a hydrotreating unit like the Tesoro Naphtha Hydrotreater, the use of API RP 941 is only one criterion for selecting a fit for purpose material. The engineer/designer must also consider corrosion, embrittlement, and stress corrosion cracking mechanisms, as discussed in API RP 571, Damage Mechanisms Affecting Fixed Equipment in the Refining Industry, as well as ease of fabrication and the introduction of fabrication related defects.

At temperatures in excess of 400°F, but less than the Nelson curve minus a 50°F design margin, killed carbon steel is generally considered to be a fit for purpose material. Upgrading the metallurgy to resist high temperature hydrogen attack may introduce different damage mechanisms (as discussed in RP 571) and their related risks. The use of austenitic stainless steels, for example, introduces the potential for stress corrosion cracking mechanisms due to the presence of chlorides or polythionic acid that can be present either in the process or the external environment.

Materials selection for hydroprocessing units must consider all the potential forms of degradation that may be present. All engineering materials used in the refining industry are susceptible to some form of degradation in hydrotreating units, so one material should not be considered inherently safer than another. Without the use of proper engineering design, hazard analysis, safe operating practices and engineering safeguards, material degradation will occur regardless of the metallurgy. Installing an upgraded material does not fundamentally reduce the overall hazard or risk of the process, and therefore, the use of an upgraded material should not be considered to be inherently safer.

And, as stated earlier in the “API Standards” section, the Nelson curve does alert users to utilize more robust carbon steel, different alloys, and in fact, contains a section on “Operating Limits” that provides, amongst other subjects, a basis for setting operating limits and provides guidance on material selection based on the particular unique operating conditions of a particular process unit. The standard goes on to cite factors influencing HTHA and provides for a variety of mitigation approaches. In effect, taken in its totality, API Recommended Practice 941, Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants, is a treatise on the selection, use, inspection and installation of inherently safer materials.

	American Petroleum Institute (API) Comments
22	*2010-08-I-WA-R10* *Revise American Petroleum Institute API RP 941: Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants to:* *c. Require verification of actual operating conditions to confirm that material of construction selection prevents HTHA equipment failure;* API RP 941 and its Technical Basis Document, TR 941 provides guidance for use of materials when the operating/exposure conditions are known and validated. The API subject matter expert committees have a culture of continuous review, and, as such, are always monitoring industry inspection criteria; incidents/near misses and performance results to ensure materials guidelines are as accurate and up to date as possible. These groups also conduct research as needed to improve the scientific basis as shown, for example, in RP 941 and TR 941 (as well as other standards). The history of the API standards development has shown that these standards continue to improve with regards to their accuracy and technical quality.
23	*2010-08-I-WA-R10* *Revise American Petroleum Institute API RP 941: Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants to:* *d. Prohibit the use of carbon steel above 400 ºF in applications where HTHA could occur.* API has made extensive technical comments on this subject in the “Modeling Comments” section of this document. Additionally, a review of metallurgical fundamentals shows it is scientifically intuitive that the onset of HTHA with regard to hydrogen partial pressure versus temperature should be a curve, as currently shown in API RP 941, not a flat line as suggested by CSB. The greater the hydrogen activity (as measured by partial pressure), the lower the temperature needed for reaction with the iron carbides in the steel to produce methane. Conversely, the lower the hydrogen activity (pressure), the lower the driving force for methane production in the steel, and therefore, the higher the temperature required to drive the reaction. Therefore, we believe that the CSB recommendation to limit carbon steel to 400°F in hydrogen service, regardless of hydrogen pressure, is based on erroneous modeling, is not supported by actual data and is not technically accurate.

	American Petroleum Institute (API) Comments
24	*2010-08-I-WA-R11* *Revise American Petroleum Institute API RP 581: Risk-Based Inspection Technology to:* *a. Clearly establish the minimum necessary "shall" requirements to prevent HTHA equipment failures using a format such as that used in ANSI/AIHA Z10-2012, Occupational Health and Safety Management Systems;* API has a document entitled "Format and Style Manual" which is used to provide consistent format for all API standards. This format allows for the ease of access of the information contained in the standards by world-wide users. And, as stated in the "API Standards" section of this report, API standards are written in performance based language to the maximum extent possible. Having said that, API RP 581, Risk-Based Inspection Technology is under revision and the next edition will be produced with both "change" designations as well as a "red-line" edition both of which will serve to highlight the changes to the standard.
25	*2010-08-I-WA-R11* *Revise American Petroleum Institute API RP 581: Risk-Based Inspection Technology to:* *b. Prohibit the use of carbon steel above 400 ºF in applications where HTHA could occur.* API has made extensive technical comments on this subject in the "Modeling Comments" section of this document. Additionally, a review of metallurgical fundamentals shows it is scientifically intuitive that the onset of HTHA with regard to hydrogen partial pressure versus temperature should be a curve, as currently shown in API RP 941, not a flat line as suggested by CSB. The greater the hydrogen activity (as measured by partial pressure), the lower the temperature needed for reaction with the iron carbides in the steel to produce methane. Conversely, the lower the hydrogen activity (pressure), the lower the driving force for methane production in the steel, and therefore the higher the temperature required to drive the reaction. Therefore, we believe that the CSB recommendation to limit carbon steel to 400°F in hydrogen service, regardless of hydrogen pressure, is based on erroneous modeling, is not supported by actual data and is not technically accurate.

	American Petroleum Institute (API) Comments
26	*2010-08-I-WA-R11* *Revise American Petroleum Institute API RP 581: Risk-Based Inspection Technology* *to:* *c. Require verification of actual operating conditions to determine potential equipment damage mechanisms.* API RP 581 provides guidelines for inspection on a risk-based approach. The API subject matter expert committees have a culture of continuous review, and as such are always monitoring industry inspection criteria, incidents/near misses and performance results to ensure materials inspection guidelines are as accurate and up to date as possible. The history of the API standards development has shown that these standards continue to improve with regards to their accuracy and technical quality.
27	*2010-08-I-WA-R4* *Washington State Legislature, Governor of Washington* *"Develop and implement a step-by-step plan to supplement the existing process safety management regulatory framework for petroleum refineries in the state of Washington with a more rigorous safety management regulatory framework based on the principles of the "safety case" type regulatory regime in use in countries such as the United Kingdom, Australia, and Norway, and as described in this report…"* API believes the current OSHA Process Safety Management (PSM) regulatory approach is effective and that additional regulations beyond the PSM regulations based on "Safety Case" for the State of Washington is unwarranted. The PSM standard represents a consistent and well-understood framework that has been used by manufacturing facilities throughout Washington and the rest of the United States for over two decades. Changing and/or adding to the current PSM regulatory approach with a Safety Case regime will add complexity and uncertainty with no demonstrated benefit. This added complexity may even increase risk due to conflicting priorities created by the potential overlay of new Safety Case regulations. Even now, federal OSHA is working to enhance and improve the existing PSM standard. On December 9, 2013, OSHA issued a Request for Information (RFI) requesting information from stakeholders regarding potential revisions to the PSM standard. This RFI is usually the first step in what may be rulemaking to amend the PSM standard. Efforts by federal OSHA to improve the existing PSM regulatory program should be explored before CSB, Washington State or any other state aggressively pursue the introduction of an

	American Petroleum Institute (API) Comments
	entirely new, additional and/or different regulatory approach. Of significant concern to API is the lack of meaningful data that demonstrates that the Safety Case approach produces better process safety performance than the PSM standard. In fact, on page 105 of the CSB draft regulatory report on the Chevron Richmond refinery incident, the CSB acknowledges that "there have been few objective studies conducted on the impact of the Safety Case regulatory approach on safety performance onshore and offshore." That same CSB draft report also recognizes, via many references, that the existing data mainly relates to offshore operations which increase API's concerns about applying Safety Case to refineries. If Safety Case or other regulatory regimes are to be considered, all the relevant U.S. regulatory bodies should first collect broad and meaningful data that can be used to justify further consideration of regulatory alternatives. As noted above, API believes the current PSM program is effective and that the OSHA RFI needs to be carried out and the results analyzed which may lead to potential improvements in the PSM standard. Additionally, API believes there are insufficient factual bases and data to support the adoption of the Safety Case at this time. The effectiveness of any safety program is only as good as the commitment made to its preparation, implementation and execution and the site operator is ultimately responsible to ensure safe operations. The development of a Safety Case, does not, in and of itself, improve safety. To the extent the CSB sees areas for improvements, API encourages the CSB to continue its focus on enhancements to the current PSM standard and not on alternatives to replace or add to it. (Further comments from API on the Safety Case topic are shown in the API & WSPA Comments American Petroleum Institute and Western States Petroleum Association Comments on U.S. Chemical Safety and Hazard Investigation Board's Regulatory Report on Chevron Richmond Refinery Pipe Rupture and Fire, and for additional information in support of API's position please see J. Bresland comments on same.)
28	*2010-08-I-WA-R1* *2010-08-I-WA-R2* *2010-08-I-WA-R3* API believes opportunities exist to further improve safety and security and will continue to offer our expertise to assist the CSB, but we strongly oppose any proposal that will create a federal requirement to assess or implement so-called Inherently Safer Technologies (IST). IST decisions are extremely complex and cannot be and should not be determined by a governmental agency. The potential for creating unintended consequences is high, and the Environmental Protection

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	Agency (EPA) has long held that IST requirements would not produce additional benefits beyond those that already exist in the current Risk Management Plan (RMP) program structure, see Federal Register Volume 61, Number 120, FR Doc o: 96-14957 (Thursday, June 20, 1996): Pages 31668-31730, http://www.gpo.gov/fdsys/pkg/FR-1996-06-20/html/96-14597.htm. Inherently safer approaches to manufacturing processes have been, and will continue to be, considered by facilities as a matter of course and the facility operators—not the government—are in the best position to understand the full ramifications of implementing IST. No one regulatory program or government agency can properly address the broad range of factors, such as risk shifting, technical efficacy, cost, and product quality that a facility must consider and address when choosing appropriate safety and security measures, much less all of the different site-specific scenarios for the approximately 12,000 facilities that could be impacted by an IST requirement. In addition, decisions by government officials to require alternatives could impose new risks, such as more hazardous materials in transportation, if facilities must reduce inventories of certain substances. Operators need to take an all-inclusive approach when looking at the safety profile of a facility, and they must factor in the requirements of the numerous overlapping regulatory programs that help shape this approach. EPA, the Occupational Safety and Health Administration, the U.S. Department of Transportation, the U.S. Department of Homeland Security (DHS), and the Bureau of Alcohol, Tobacco, Firearms and Explosives all have existing regulatory programs that require operators to examine their operations and make them as safe and secure as possible. To attempt to overlay an IST requirement would negatively impact all of these safety and security programs and create an impossible bureaucratic burden. The current performance-based regulations in place today and in the marketplace itself already provide strong incentives for companies to consider and adopt “safer alternatives” such as IST. These programs allow facility operators to use all of the risk management tools and options at their disposal, while considering the complexities of their unique operating environment. Adding a new regulatory requirement focused on IST is not only unwarranted, but potentially detrimental. At a minimum, it would divert scarce federal agency resources. At worst, IST could overwhelm federal agencies with thousands of complex evaluations, without requisite staff expertise to properly review the submissions. Pursuing recommendations related specifically to IST could threaten to create unnecessary and duplicative regulatory requirements that would not contribute to enhancing safety.

	United Steelworkers Comments
1	The USW has long supported inherently safer technology. But IST is more easily accomplished in the initial design phase. Even with IST, other measures in the hierarchy of controls may be important. The draft report does not place sufficient emphasis on a control that is especially essential in older facilities – inspection and maintenance.
2	In addition, we do not believe that the report adequately defines the root cause of this event, which we believe is the tube fouling in the NHT exchangers. This was the cause of the six month bundle/shell cleaning operation that most likely contributed to integrity issues in the shell, through the fluctuations in temperatures by being taken off line and returned to service so often. The draft report devotes only a couple of paragraphs to the fouling of the tubes and only in order to explain the reason for the six month cleaning. You did not explore the reason for the fouling. Had it been addressed by Tesoro, it might have allowed the exchangers to operate up to three years between cleanings. Whatever was caused the fouling was created the situation requiring the short duration between cleanings.
3	The manual block valves did not allow operators to efficiently start feed into the exchangers to control the temperature of the shells. This caused a higher than normal number of operators to be present during a hazardous period – start-up. This hazard was identified in several reports of refinery incidents prior to your BP Texas City refinery fire report. At the time that report was released, much attention was paid to its findings. However, Tesoro apparently failed to learn the lesson.
4	The draft report identifies and only comments or makes inspection recommendations (shortfalls) on high temperature hydrogen attack (HTHA). In reality, based on the service and operational conditions of the E-6600 exchangers at Tesoro and the NIHS review (Appendix I), the fatigued metal also showed signs of other contributing factors. There is very little mention of the benefits of post-weld heat treating (PWHT) and the role it could have played in lengthening the service of this vessel as the failure mode was indicated along weld seams, identified as the heat affected zone (HAZ). This is a well-known hazard with a well-known remedy, yet this was down played as being effective because it relied on someone making a decision.
5	The fact that there was no identifiable damage (degradation) of the shell outside of the HAZ would support the fact that PWHT may have prolonged the life of the exchangers. This is also missing from the report.

	United Steelworkers Comments
6	As difficult as HTHA may be for some inspectors to identify, had Tesoro done any of the recommended testing for HTHA on this vessel (or even performed inspections for cracking such as wet fluorescent magnetic particle inspection) they would have discovered this cracking long before the vessel failed. Had adequate inspections been done and cracks identified, then an inherently safer material of construction could have been used to replace the defective exchangers. But that could only have been done if the equipment had been identified as needing replacement. Had proper inspections been performed, the need for replacement would have been recognized.
7	The failure of Tesoro to do a root cause investigation on the tube fouling when it first started was what set the scenario in motion for this disaster to take place. The draft report should place much greater emphasis on that fact.
8	The tube fouling investigation, coupled with a management of change (MOC) study with enough rigor in it to adequately review the effects that a change in crude slates, changing the feed sources to the NHT exchangers or elevating levels of hydrogen or increasing temperatures should have identified potential problems that would have led to more in depth inspections when the exchangers were down for service. The inability to control heat in an acceptable range (had Tesoro done an investigation) should have led them to install automated control valves. All these events say something about the complacency of the safety management system Tesoro had fostered over the years.
9	Tesoro keeps putting the triangle of prevention (TOP) report out as a means to prove they were engaged with their employees in the employee involvement element of the PSM standard. But the fact that Tesoro mandated locally that TOP would not investigate all fires in process areas again belies the claimed engagement. All fires in an oil refinery should be investigated. However, TOP was not allowed to do an investigation of the NHT exchanger incidents until 14 events had taken place. The last two events were fires about a month apart. This does not reflect good safety management.
10	Another sign of dangerous complacency was the fact that, when unit orders called for maximum feed rates on the unit, no one knew what the maximum safe rates were, since there were none identified in the safe operating limits for the unit.

	United Steelworkers Comments
11	Turning to the recommendations, the desire to focus on a safety case system as the fix for all hazardous chemical operations appears to be a significant driver and a potential source of bias. The safety case system as used in the United Kingdom (UK) is actually two different cases; one for offshore facilities, and an onshore program, the safety report. The draft Tesoro report fails to mention any of the drawbacks or shortcomings with the UK‟s current onshore safety report program. As we pointed out in our comments on the recent staff report on the Chevron Richmond fire, the USW believes that a safety case system could offer significant improvements, but its disadvantages need to be analyzed even more thoroughly than its advantages, in order that those disadvantages might be overcome.
12	In addition, the report's recommendations need to include a focus on improving the current OSHA Process Safety Management (PSM) rules. A safety case system may someday modify our basic approach to the regulation of high-hazard facilities, but unless and until that happens, the worker and community safety will continue to depend on the OSHA PSM standard and the corresponding EPA Risk Management rules. We would appreciate the opportunity to discuss with CSB staff what we think are areas of the PSM standard that should be strengthened and clarified. We also suggest review some of the written comments received on your Chevron Richmond report, particularly those of Steve Gill who brings the perspective of having worked with the safety case system in the UK. Ultimately, any effective regulation will require a written program; whether it is a safety case, the Process Hazards Analysis and other documents required by the PSM standard, or a UK-style Safety Report. There is no more inherent enforcement in one than the other. A decision to not follow the written program should be a violation in any regulatory system. As in the Chevron Richmond refinery, Tesoro Anacortes management was well aware of the hazardous conditions that caused the tragedy. They chose to accept the risk. A catastrophe was the result. This is a common theme in the scores of refinery accidents investigated by the USW and its predecessor unions since the early days of the PSM standard.

	Walter Cleve Comments
1	The report highlights the National Institute of Standards and Technology (NIST) conclusion that failure of the exchangers was unlikely in the absence of HTHA damage. The NIST also identified damage from possible contributing co-mechanisms, such as hydrogen-induced cold cracking, yet the report devotes very few words to these other co-mechanisms. Stress within the walls of the exchanger shell, caused by different rates of expansion within the bonded, dissimilar materials of exchanger construction, was also mentioned by the NIST experts. Again, the concept was not covered in depth by the report.
2	Possible causes of these co-mechanisms, such as the 6-month frequency of the online cleaning cycles and/or the procedure by which the work was accomplished, were not explored within the report. No recommendation directly related to a possible co-mechanism was made, nor was the refinery challenged to reduce the number of online cleaning cycles between unit shutdowns for maintenance on similar equipment.
3	In a broader sense, the potential causes of the exchanger fouling were not covered in the report. The need for cleaning the E-6600s on a six-month cycle should be listed as a contributing factor to the incident, as it was this relatively-frequent cleaning work between whole-unit maintenance shutdowns that caused the exchangers to be cooled to ambient temperatures and reheated, as well as caused the presence of seven workers on that terrible night.
4	The general issue of damage mechanism awareness does not appear to be addressed in the narrative sections of the report, although it is addressed in the recommendations. Revision and improvements to the Integrity Operating Window (IOW) program are recommended to Tesoro Refining & Marketing Company (on a corporate level versus refinery level), but the role inadequate IOWs played in the catastrophe is not explained.
5	The importance of a thorough mechanical integrity program, including effective equipment inspections, cannot be over-emphasized. While HTHA damage may be difficult to detect in its initial stages, it becomes easier to detect as the degradation continues. Certainly, a crack 0.3 inch deep should have been readily identified, had an appropriate inspection technique been applied.

	Walter Cleve Comments
6	The report cites an inaccurate Nelson Curve as a contributing factor to the failure and makes a strong case for improved science behind API RP 941. It is significant that the Nelson Curves are not intended to be used as a “bright line” or a clear delineation between damage-guaranteed and damage-impossible operating conditions. As is mentioned in the investigation report, API TR/RP 941 plainly state HTHA is not expected in equipment operating below the Nelson Curve, but make no guarantees. Further to the inherent imprecision, API RP 941 advises inspection of equipment operating below, but in the vicinity of a Curve, and advises determination of actual operating conditions where they are unknown.
7	Also noted in the report is guidance related to PWHT (Post Weld Heat Treated) equipment. PWHT metal is more resistant to damage, but improper PWHT procedures can result in metal that is out of specification for the service. According to the report, HTHA damage was found only in the Heat Affected Zones of the exchangers- areas more vulnerable to damage than the base metal itself. Despite the fact the E-6600s were not PWHT, appropriate inspections for HTHA were not completed.
8	Much is made in the report of “shall” vs. “should” in API documents, but it may not be realistic to expect anything more prescriptive than advice from a non-regulatory, industry association. Ultimately, the onus lies with the equipment owner/operator.

	Walter Cleve Comments
9	Process safety culture plays an important part in several aspects of the seven fatalities, yet the culture-related recommendations to Tesoro are relatively few. The report recommends the refinery focus, at a minimum, on willingness to report incidents, normalization of hazardous conditions and a burden of proof of safety in plant safety programs and practices. The report itself highlights a number of cultural issues: 1. A lack of hazard recognition related to non-routine work 2. Prevalence and limitations of assumptions used in PHA processes 3. Acceptance of leaks and fires from process units 4. Use/staging of emergency equipment, such as steam lances, without appropriate PPE and other considerations 5. Willingness to continue operating, instead of moving equipment to a "safe/off" state 6. Acceptance of increased risk without safeguards verified to be effective 7. Lack of corrective action implementation and tracking from near misses and incidents 8. Willingness to allow people in hazardous areas without clearly-defined, necessary roles 9. Failure to apply safety review policies that are not strictly required by the PSM standard, such as MOOC reviews 10. Failure to address hazard concerns raised by employees Given the sheer magnitude of process safety culture deficiencies discussed in the report, associated recommendations to Tesoro should be more specific.
10	In addition, further contributing factor discussion should be dedicated to the fact five Operators not trained in the specific hazards of NHT operation were present when the exchanger ruptured. Although possible, the question is not whether additional training would have saved lives, but whether all five would have been in the affected area at the time of exchanger failure. Had the equipment operation activities been limited to only those trained on the specific hazards of the NHT, some of the Operators would not have been immediately present that night.
11	As in the Tesoro Anacortes draft Investigation Report, the Chevron Richmond draft Investigation Report, released on December 16, 2013, makes an argument for adoption of the "safety case" regulatory regime. Several members of the public, with professional experience directly related to process safety and the safety case, have expressed concerns with the CSB's advocacy of the safety case; rather than attempt to reprint or summarize here, I will defer to the Chevron Richmond Report-related comments of Stephen Gill, John Bresland, Najmedin Meshkati, Alvin Chin, Dr. Sam Mannan, Michael Wright and Kim Nibarger.

	Refinery Action Collaborative Comments
1	The Refinery Action Collaborative, a labor-community-environmental-academic coalition, supports the CSB's Draft Investigation Report on Tesoro Anacortes call for inherently safer systems and technology throughout U.S. refineries. While the specific details of the CSB report have not been reviewed and approved by all Collaborative partners we offer these general comments to provide an explanation for our endorsement of the CSB's recommendation for inherently safer systems at Tesoro Anacortes.
2	The Refinery Action Collaborative views the implementation of inherently safer systems throughout refineries as a necessity for ensuring the safety and health of workers, community members and the surrounding environment. Neglecting to adopt and implement inherently safer systems and technology continues to put all three groups at unnecessary risk. Industry groups and refinery managements who oppose implementing IST are knowingly and willingly subjecting their workers to dangerous and sometimes fatal conditions.
3	Time and time again the failure to implement IST has led to ruptures, explosions and fires at refineries that have killed workers, sickened residents and destroyed local environments. The heat exchanger rupture at Tesoro Anacortes clearly represents the consequences of failing to adopt inherently safer systems and technology. As the CSB report illustrates:
4	1) The neglect of the refinery management to install piping that was constructed out of an inherently safer material (such as high-chromium steel) led to the high rate of pipe corrosion and the high temperature hydrogen attack (HTHA) that caused the rupture and explosion of the exchanger. If IST was implemented through this use of material substitution, "the incident would not have occurred" states the Draft CSB report. Even the refining industry's American Petroleum Institute has stated that high-chromium steels would prevent HTHA. API has acknowledged this fact and yet they have not led any significant effort to implement safer piping throughout the industry; this is truly appalling.

	Refinery Action Collaborative Comments
5	2) The labor-intensive process of heat exchanger start-up operations did the opposite of minimizing risk – it maximized risk by requiring more workers to be present in a high-hazard setting. Failure to implement IST can further be seen here in the geared ("long-winded") mechanisms of the heat exchanger start-up process, which necessitated over a hundred turns by hand of large wheels to open the valves, requiring more workers to be present in order to help turn the wheels as well as mitigate a potential leak or fire that may have been caused by this antiquated technology. As the Draft CSB Report states, automating the heat exchangers would have prevented the need for additional workers to be present to assist in the aforementioned tasks. This automation technology, if it had been implemented, might have saved the lives of several workers.
6	It should also be noted that the Refinery Action Collaborative acknowledges the many other factors that led to the abysmal health and safety conditions at the Tesoro Anacortes refinery. These include a poor safety culture, dangerously incomplete PHAs and damage hazard mechanism reviews and the lack of any significant effort to reduce risks to as low as reasonably practical. The overall neglect of hazard control processes and/or risk reduction processes is evident and well-documented in the Draft CSB Report.
7	Refinery Action Collaborative Recommends Requiring the Implementation of Inherently Safer Systems and Technology: The Refinery Action Collaborative joins with the CSB in calling on the EPA to require inherently safer technology through the General Duty Clause and/or its Risk Management Program. Seconding the CSB's perspective, the Collaborative sees the adoption of IST in the three following ways as critical: 1) chemical substitutions; 2) lowering temperatures and pressures; and 3) installing the most reliable equipment

	Brian Ricks Comments
1	I agree with the report in Section 4 where it states Inspection is lower on the hierarchy of controls than Inherently Safety Design of the equipment, but I disagree with the reports lack of emphasis put on Inspection in Section 4. With the aging equipment in our refineries it is not likely old equipment will be replaced to come into current standards. Having a robust Inspection/Testing process can prevent the catastrophic failure of operating equipment. Your recommendations need to strengthen the Inspection/Testing processes even more than it does.
2	Post Weld Heat Treating (PWHT) does not replace the control of Inherently Safer Design but still provides another barrier to catastrophic failure of equipment. The requirement to utilize the industry practice and standard for PWHT for equipment in service where PWHT will improve the mechanical integrity of a piece of equipment needs to be followed and needs to be required. The report highlights the area of damage is in the weld heat affected zone and not in the other areas of the base metal. Recommendations to improve the complete Mechanical Integrity process in Refining are needed.
3	The report highlights a number of Organizational Deficiencies at the Tesoro Refinery, with the multitude of deficiencies highlight from Investigations, MOC's, PHA's, Non Routine Hazardous Work, more detailed recommendations should be made to give clearer guidance on improving these deficiencies. The issue the report missed is the lack of training required by the PSM standard for operators prior to operating a covered process. A recommendation addressing this deficiency is needed.
4	The report highlights the reason for the frequency of cleaning the E6600's was due to fouling. If the fouling wasn't as severe in the first 20 years or so of the E6600's service what changed in the operation to increase the rate of fouling? The stress to the metal of heating up and cooling down so frequently wasn't addressed in the report. The accelerated cleaning cycle should have been listed as a contributing factor in this tragedy.
5	The recommendation to implement a Safety Case type of regulation will take focus from the PSM requirements at a time the PSM Regulation needs to be strengthened and more rigorously enforced. With some strengthening of the PSM standard and rigorous enforcement we would get a bigger improvement in Process Safety quicker than trying to implement a complete new safety regulation.

	Organizations Supporting Inherent Safety Comments
1	The undersigned organizations commend the **U.S. Chemical Safety Board (CSB)** for recommending that the U.S. Environmental Protection Agency (EPA) issue new rules requiring the use of inherently safer technology (IST) in their January 29, 2014 draft report on the fatal Tesoro refinery disaster which claimed the lives of seven workers: Steve Taylor **Coming Clean** Ted Schettler **Science and Environmental Health Network** Michele Roberts **Environmental Justice Health Alliance** Richard Moore **Los Jardines Institute (The Gardens Institue)** C. Edward Brittingham, President **NAACP WILMINGTON, DE Branch** Beverley Thorpe **Clean Production Action** Lin Kaatz Chary **Great Lakes Green Chemistry Network** Barbara Warren **Citizens' Environmental Coalition** Jeannie Economos **Farmworker Association of Florida**

Organizations Supporting Inherent Safety Comments

Rick Hind
Greenpeace

Sara E. Smith, J.D.
Texas Public Interest Research Group

Pamela Miller
Alaska Community Action on Toxics

Maya Nye and Stephanie Tyree
People Concerned About Chemical Safety

Juan Parras
Texas Environmental Justice Advisory Services (TEJAS)

Lisa Larkin
Beyond Toxics

Robin Schneider
Texas Campaign for the Environment
Lynn Thorp
Clean Water Action

Kathleen A. Curtis
Clean and Healthy New York

Ronald White
Center for Effective Government

	Organizations Supporting Inherent Safety Comments
	Monique Harden **Advocates for Environmental Human Rights** Ken Dryden **Minority Workforce Development Coalition** Jose T. Bravo **Just Transition Alliance** David LeGrande **Communications Workers of America** Michael Wright **United Steelworkers** John Pajak **New Jersey Work Environment Council** Renee C. Sharp **Environmental Working Group** Niaz Dorry **Northwest Atlantic Marine Alliance** Catherine Thomasson **Physicians for Social Responsibility** Bill Walsh **Healthy Building Network** Marcie Keever **Friends of the Earth**

	Organizations Supporting Inherent Safety Comments
	Sofia Martinez **Concerned Citizens of Wagon Mound and Mora County, NM** Sara Chieffo **League of Conservation Voters** Lynn Carroll, Ph.D. **TEDX, The Endocrine Disruption Exchange** Denny Larson **Global Community Monitor** Tom Goldtooth **Indigenous Environmental Network**
2	**We strongly urge the CSB to retain these recommendations in its final report and incorporate similar recommendations in future reports.** The only foolproof way to prevent tragic consequences is through the use of safer chemicals and processes. When safer alternatives are available, effective, and affordable, they should be required. The EPA now has an additional incentive to act thanks to the President's August 1, 2013 Executive Order (EO) 13650, Improving Chemical Facility Safety and Security. The intention of this EO is "to improve and modernize key policies, regulations, and standards to enhance the safety and security of chemical facilities" to be included in a report to the White House due approximately May 1, 2014. **Section 112(r)(7)(A) of the Clean Air Act provides the EPA broad authority to regulate chemical facilities in order to prevent "accidental" discharges:** In order to prevent accidental releases of regulated substances, the Administrator is authorized to promulgate release prevention, detection, and correction requirements which may include monitoring, record-keeping, reporting, training, vapor recovery, secondary containment, and other design, equipment, work practice, and operational requirements. Regulations promulgated under this paragraph may make distinctions between various types, classes, and kinds of

	Organizations Supporting Inherent Safety Comments
	facilities, devices and systems taking into consideration factors including, but not limited to, the size, location, process, process controls, quantity of substances handled, potency of substances, and response capabilities present at any stationary source. **Regulations promulgated pursuant to this subparagraph shall have an effective date, as determined by the Administrator, assuring compliance as expeditiously as practicable.** 42 U.S.C. § 7412(r)(7)(A). This authority clearly encompasses the power to require the use of safer technology to reduce or eliminate quantities of extremely hazardous substances. The provision specifically authorizes the imposition of "design" and "operational" requirements, and further authorizes EPA to make distinctions among facilities based on "process controls, quantity of substances handled, [and] potency of substances." This authority is ideally suited to serve as the basis for regulations that require that facilities be designed and operated in such a manner as to minimize quantities of highly potent hazardous substances. And it permits regulation of any stationary source, thus permitting the agency to regulate without regard to whether "threshold" quantities of substances are present (as under regulations pursuant to § 112(r)(7)(B)) and without restrictions on the types of facilities subject to regulation (such as the limits imposed on DHS in establishing the CFATS regulations). The EPA's authority is also consistent with the intent of Congress. As the Senate Report on the 1990 legislation that added § 112(r) to the Clean Air Act explains, such measures were viewed by Congress as the best way to achieve the statutory goal of preventing accidental releases: The objectives of the proposed section … include both the prevention of accidental releases and the minimization of the consequences which may result. Systems and measures which are effective in preventing accidents are preferable to those which are intended to minimize the consequences of a release. ***Measures which entirely eliminate the presence of potential hazards (through substitution of less harmful substances or by minimizing the quantity of an extremely hazardous substance present at any one time), as opposed to those which merely provide additional containment, are the most preferred.***

	Tesoro Council of the United Steelworkers Comments
1	The Tesoro Council of the United Steelworkers, which represents workers at Tesoro refineries and facilities all across the United States including the Anacortes Washington refinery, supports the investigative findings of the Chemical Safety Board (CSB) of the April 2, 2010 incident at the Anacortes refinery, which resulted in the deaths of seven workers.
2	The CSB found that the cause of the explosion and fire was a heat exchanger which catastrophically ruptured because it had been weakened over time as it was exposed to hydrogen at high temperatures and pressure. This exposure caused fissures and cracks in the carbon steel heat exchanger and damaged the mechanical properties of the steel. Routine inspections of the exchanger potentially could have identified such damage. However, this is unlikely because the damage potentially may be contained in one area or may be microscopic in scope. Finding such damage, before it causes an incident, is incumbent upon sufficient procedures, personnel and resources to conduct inspections.
3	The CSB recommends, and the Tesoro Council supports, the use of inherently safer technology (IST). In this case, appropriate IST would involve replacing the carbon steel heat exchangers with ones made of chromium steel, which can better withstand the temperatures and pressures involved in refining operations. IST goes to the root cause of the problem and is superior to potentially unreliable inspection procedures. In fact, the CSB report states that the "Tesoro incident could have been prevented if inherently safer equipment construction materials had been used." As workers who are exposed to potential hazards on a daily basis, we support the use of IST as it will significantly improve safety within the refineries in which we work and is a preventive measure that can save lives and property and protect neighboring communities.
4	A second finding by the CSB notes the inadequate process safety culture within the Tesoro Anacortes refinery. Specifically, the CSB reported that management had become complacent about leaks and seemingly normalized occurrences of hazardous conditions. In addition, the company commonly used additional operators beyond the staffing level that is specified in their procedures, in part to assist with potential leaks and fires. This practice of using more operators directly contributed to the large loss of life on the day of the incident. The Tesoro Council supports the CSB's recommendation that Tesoro improve its process safety culture. Our members have years of experience working in refineries and for Tesoro and believe that Tesoro's safety culture is severely lacking and in dire need of strengthening.

	American Fuel and Petrochemical Manufacturers Comments
1	*A. Inherently Safer Technologies* 2010-08-I-WA-R1 2010-08-I-WA-R2 2010-08-I-WA-R3 AFPM members recognize that there is a broad responsibility for managing the hazards within facilities such that the safety of employees, contractors and the neighboring community is protected. These hazards are addressed through the implementation of industry standards, regulatory requirements and other risk management programs that focus on personnel safety, process safety and engineering solutions. Significant progress has been made in developing risk management tools to prevent incidents from occurring in the petroleum refining and petrochemical manufacturing industries and our members take every opportunity to work with stakeholders to make further improvements. However, we strongly oppose any recommendation that will require EPA or any other federal agency to require "Inherently Safer Technologies (IST)." A federal IST regulation may actually increase risk and create unsafe environments due to the high potential for shifting risks when implementing a one size fits all approach to IST. Inherently Safer Technologies is a philosophy applied to design and operation from initial conception through its entire life cycle. There is no one-size- fits -all method to ensure one process or material is safer than another without considering the site specific characteristics of that facility. Current practice by industry is to use a multitude of risk management tools at their disposal when considering the complexities of their unique operating environment. This practice is also consistent with numerous existing performance based regulations. These regulations are performance- based because the government acknowledges the owner operator has the best expertise in managing risk at their facility. Pursuing an IST regulation will take existing resources away from where they are most needed, is duplicative of current regulations and would do nothing to improve the safety and reduce the risk at facilities.
2	*B. The Safety Case Regime* 2010-08-I-WA-R4 AFPM is very concerned by the lack of factual basis and data supporting the CSB's claims regarding the benefits of the Safety Case. AFPM expressed this concern in its comments on the CSB's Chevron Regulatory Report and we reiterate that concern and others in these comments. The Chevron Regulatory Report noted that there is no evidence that the Safety Case approach to process safety reduces risk and increases safety, as "there have been few objective studies conducted on the impact of the safety case regulatory approach on safety performance." (See Regulatory Report, p. 108.)

American Fuel and Petrochemical Manufacturers Comments

Advocating sweeping regulatory change based only on conjecture is inconsistent with the objective, fact-based approach required of the CSB in conducting its investigations and making recommendations. The CSB instead is using separate process safety incidents, each having their own independent causal factors, to arbitrarily suggest a pattern invalidating an entire regulatory regime. Such an approach is not a scientific or technical inquiry, and sidesteps the harder analysis required to improve existing aspects of management system performance and technical process safety.

The federal OSHA Process Safety Management of Highly Hazardous Chemicals (PSM) standard represents a consistent and well-understood and established framework that has been incorporated into thousands of PSM regulated manufacturing facilities throughout California and the rest of the United States for over two decades. Changing the approach to the Safety Case will add complexity and uncertainty with no demonstrated benefit. This added complexity may even increase risk due to conflicting priorities created by the potential overlay of new regulations.

A better approach to improving process safety performance would be to leverage the industry's substantial investment and commitment to the existing regulatory regime. Federal OSHA has already begun their process to enhance and improve the PSM standard. On December 9, 2013, OSHA's Request for Information regarding potential revisions to the PSM standard was published in the Federal Register (PSM RFI) 78 Fed. Reg. 73756. This initiative is the first step in what likely will be notice and public comment rulemaking to amend and enhance the PSM standard. Efforts by OSHA to improve the existing regulatory program should be pursued before advocating for the wholesale introduction of an entirely new and different regulatory approach.

While the PSM RFI and other efforts are underway, the CSB should continue to study and analyze the different regulatory regimes and develop meaningful data on which it can then base a recommendation or provide other input to OSHA as part of the PSM RFI. This approach is expressly contemplated by the agency's enabling statute, the federal Clean Air Act:

The [CSB] is authorized to conduct research and studies with respect to the potential for accidental releases, whether or not an accidental release has occurred, where there is evidence which indicates the presence of a potential hazard or hazards. To the extent practicable, the [CSB] shall conduct such studies in cooperation with other Federal agencies having emergency response authorities, State and local governmental agencies and associations and organizations from the industrial, commercial, and nonprofit sectors.
42 U.S.C. § 7412(r)(6) (F).

	American Fuel and Petrochemical Manufacturers Comments
3	***The Importance of Effectively Managing Organizational Change*** The addition of the Safety Case approach to existing requirements would be a massive organizational change for regulators and for industry. The CSB recognizes that it is good practice to apply change management procedures to organizational changes which requires "the right people and resources to review the situation . . . [and] identify potential hazards, develop protective measures, and propose a course of action." *See* CSB Safety Bulletin No. 2001-04-SB, "Management of Change," August 2001, at pp. 1, 2. The CSB has also cited guidelines issued by the U.K. Health and Safety Executive (HSE) on this subject. The HSE's admonitions about effectively managing organizational change are relevant to the proposed change that the CSB appears determined to recommend. *Id.* The HSE warns that "[o]rganisational change should be planned in a thorough, systematic, and realistic way." *See* HSE Information Sheet, "Organisational change and major accident hazards," Chemical Information Sheet No. CHIS7, p. 2 A central consideration of management of change is ensuring that, following the change, "the organisation will have the resources (human, time, information etc.), competence and motivation to ensure safety without making unrealistic expectations of people." *Id*. Further, "[t]he process of organisational change should involve all those concerned from an early stage . . . [t]hose making decisions should be careful to analyze all information and views carefully, and be made aware of their own potential lack of objectivity . . . . " *Id.* at 3. Crucially, "[i]nvolvement in this context means active participation in decisions, not just passive consultation." Id. The CSB should not recommend such a sweeping regulatory change until it has considered the requirements of organizational change such as resource availability and participation by stakeholders. AFPM believes engagement of key stakeholders on issues such as these would be appropriate, relevant, and beneficial. Such engagement, coupled with appropriate objective data on the efficacy of the Safety Case, would allow meaningful consideration of the benefits of this new approach.

	Shell Oil Company Comments
1	Please note that the absence of a comment or request for correction on the draft Report or any particular part of the draft Report, does not mean, and should not be interpreted to mean, that Shell Oil Company (SOC) agrees with or endorses the draft Report, in whole or in part.
2	Although SOC understands and appreciates the difficulties involved in repairing a technical Report, SOC respectfully takes exception to the draft Report, in which there are various factual and technical errors and omissions related to various Shell companies and documents, including, without limitation, the former operation of the Anacortes Refinery by Shell Anacortes Refining Company ("SARC"), which is referenced as "Shell Oil" in the draft Report, as well as the third-party specialist work provided by the Shell Westhollow Technology Center following Tesoro's purchase of the refinery in 1998.
3	SOC also takes exception to the draft Report's conclusions related to certain SARC documents that were prepared fourteen to twenty years prior to the Tesoro April 2, 2010 incident and prior to Tesoro's post-1998 operation of and changes to the Naphtha Hydrotreater Unit (NHT).

	American Chemistry Council Comments
1	The American Chemistry Council1 (ACC) is pleased to provide a written response to the U.S. Chemical Safety and Hazard Investigation Board's (CSB) January 2014 Draft Investigation Report of the Tesoro Anacortes Refinery Incident. Safety has always been a primary concern of ACC members; both ACC and its member companies have been recipients of and benefitted from CSB safety recommendations. We value CSB's independent and technical insight and utilize the lessons learned from incidents to improve performance as well as standards and practices. The CSB investigation of the Tesoro Anacortes refinery accident and subsequent recommendations will be important to help determine what actions might be warranted based on the root causes of this incident and could ultimately influence the direction of the regulated community.
2	Although CSB's investigation uncovered deficiencies in Tesoro's practices, ACC believes the agency was incorrect on several of its recommendations. Specifically, the recommendations pertaining to the implementation of inherently safer systems, ascribing the use of the "Safety Case" approach, and general reference to the incorporation of industry best practices were inappropriate given the findings enumerated in the interim report.
3	ACC and our member companies proactively work to continuously improve process safety standards and practices with comprehensive management systems that include consideration of inherently safer technologies. The suggestion that legislation is needed to require the use of the most corrosion resistant materials on the authority of inherently safety technology (IST) irrespective of the cost, risks or an engineering analysis raises concerns. IST decisions must be process- and/or site-specific, feasible and avoid shifting risk. In many cases, mandatory IST policies are not feasible because they do not consider the numerous factors related to processes, facilities and society at large. As such, many proposed regulatory approaches have failed to address the potential for trading one risk for another. A regulatory program focused exclusively on eliminating a safety hazard would overlook other important considerations for a process change. While IST is a widely recognized chemical engineering philosophy, no methodology or relative comparisons are available to apply IST to a regulatory framework.

	American Chemistry Council Comments
4	ACC's members are committed to chemical safety and recognize IST as a potential tool to achieve this goal. CSB's recommendation to require the documented use of inherently safer systems analysis is inappropriate and founded upon erroneous suppositions. IST is a complex concept that requires a holistic risk assessment approach. Current regulatory programs as well as corporate practices already encourage facilities to incorporate IST. Creating IST regulations would be a complex undertaking at best, provide little benefit, and could hinder the federal government's ability to implement existing safety and security programs by emphasizing IST over other potentially more appropriate process safety and security techniques.
5	It is also important to highlight that the main issue leading to the heat exchanger failure was a lack of a robust mechanical integrity program, including routine inspection and testing. Had Tesoro conducted scheduled non-destructive testing on the heat exchangers, which were known to be in hydrogen service, the deficiencies would have been appropriately addressed. To conclude that IST would have prevented this incident on a piece of equipment that has been in service for 40 years is speculative. As was the case in the Chevron Richmond Refinery incident, the actual failure was a gap (or breakdown) in the site's mechanical integrity program.
6	While ACC shares the CSB's goals of ensuring that process safety is handled and implemented as safely as possible, ACC has a number of concerns about the recommendations in the January 2014 Draft Investigation Report for Public Comment regarding the establishment of a safety management regulatory framework based on "safety case" principles. 2 In particular, ACC believes that its members, through OSHA's current PSM standard and voluntary programs such as Responsible Care®, already address the continuous improvement goals detailed in the CSB report. ACC further believes that the recommended safety case regulatory regime is not justified by the reasons articulated in the report, nor would the safety case framework actually achieve the desired results and benefits for covered workplaces. ACC also is concerned that the drastic changes contemplated by the recommended safety case framework would result in a wide variety of practical problems if implemented.

	American Chemistry Council Comments
7	The general reference embedded into the recommendations of PHA and IST requiring the analysis and incorporation of “industry best practices” is concerning. “Industry best practices” could involve a multitude of procedures that are not considered Recognized And Generally Accepted Good Engineering Practice (RAGAGEP), resulting in inconsistencies and misinterpretations should a regulatory agency adopt or enforce this generic concept. RAGAGEP, language that is already codified into the framework of OSHA’s PSM and EPA’s RMP, requires the regulated community to define and document what guidelines, standards and principals are used to design, operate and maintain covered processes to sustain and continually improve process safety. The nonspecific inclusion of “industry best practices” undermines the significance of RAGAGEP and is inconsistent with verbiage cited in existing regulations. ACC member companies have standards and work practices in place to manage the integrity of our facilities to reduce the risk to personnel using RAGAGEP. These standards and practices are reviewed and, where warranted, updated as new data becomes available as part of our commitment to safety and continuous improvement.
8	In conclusion, the CSB’s recommendations pertaining to the implementation of inherently safer systems, ascribing the use of the “Safety Case” approach, and general reference to the incorporation of industry best practices are unwarranted. These actions are inadequately justified and, more importantly, would fail to directly address CSB’s findings. ACC recommends that CSB revise the report to eliminate the references to IST and “industry best practices” and focus recommendations to specifically address the agency’s findings.