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**From:** Evan Vokes  
**Sent:** Wednesday, April 06, 2011 10:54 AM  
**To:** Michael Martens  
**Cc:** Rick Ostrom; James Ferguson  
**Subject:** FW: Counter-bore and taper versus back-bevel

Thanks Mike

I felt very slighted as I had put a lot of work into this and I felt very undermined so thank you for coming by. This is my work, my conception of putting it together and will remain that way.

This has frustrated me from the days of the "one page welding program" and is why I brought my mechanics of material book to work to look at this problem.

The severity of the problem and my understanding of the connection to stress began when Frank Tse sent a picture of an unintended failure of a transition and then I realized how detrimental the bending moment was. I had asked about TES MECH TRAN for this reason as the formula had to have a background

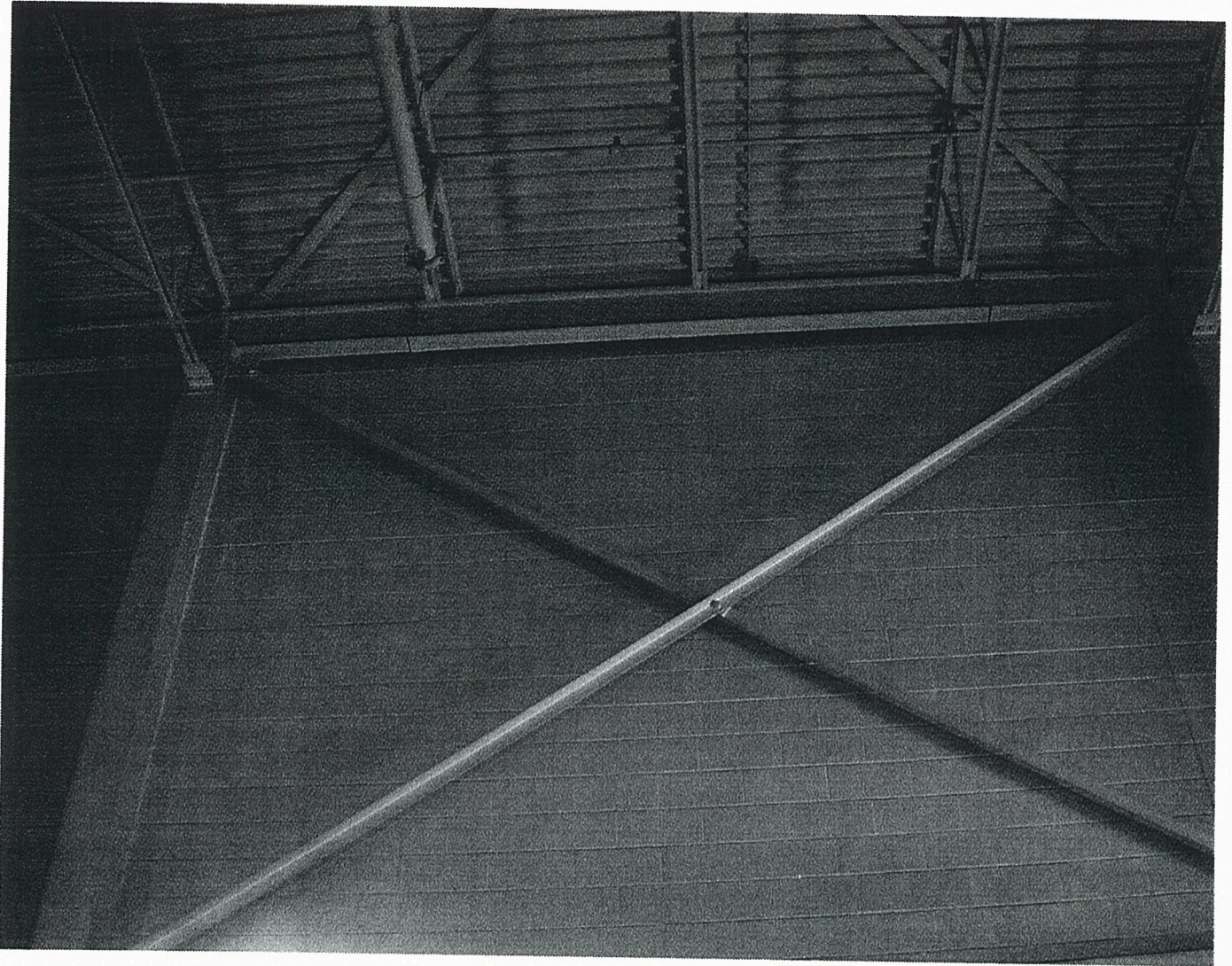
The problem that took the longest to understand was why was there always an undetected LOF in the root on the thin side so some of the evidence from history was put together by listening Dave Hodgkinson's experiences of where to look for the serious defects and reverse engineering to see where the origin of "cant weld the thin side" came from

This is my work no one else's and it gives enough background to start and I have given you the examples of construction failures and in-service failures so we know that the most important parts to support this exist. I have plenty more to add as I have the economics figured out. Adrian Met at UTQ was shocked two weeks ago when I showed his high priced team how the welding NDE and stress all work together.

I am pretty advanced from convincing Guadalajara and Bison (below) to adopt good engineering practice but this is what I had sent them. There are a bunch of things missing such as the flange angles that need to get in there.

We need to go through my fabrication presentation again as I keep refining it which is where the attached slide comes from. The stress case is pretty simple in concept but harder to communicate in words. I can draw the stress problem out quick but writing is another story.

It has matured a long ways from the one piece of paper welding plan but I can still draw that one. I wanted to get the diagrams for uniform load and the subsequent bending moment diagram drawn out in my presentation for the below case but I never got around to it. I also need Mohrs circle for the stress state of the bolts so we can show that the bolt loading is not shear



The fracture part needs a lot of work to get it down to show I explain it on the board as it is easier to draw than write about as Mr Anderson proved.

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**From:** Evan Vokes  
**Sent:** Monday, April 26, 2010 4:34 PM  
**To:** Claude Albert  
**Cc:** Ron Curle; Veronique Cantin; Rick Ostrom; Salvatore Delisi  
**Subject:** RE: Counter-bore and taper versus back-bevel

I have seen Kenneth's presentation before and that whole business is avoidable but one of the big problems is TCPL never made counter bore mandatory because there is a real upfront cost. His recommended practice for 3-D bends is on the right path but not entirely there. As you would have seen in my presentation, we do not cellulosic weld X 80 with E9010 because your preheat requirement would have to be too high. Bainitic microstructures don't like this. Keep in mind that we use the same specifications for our AIV lines and do not have problems we see down south.

should have included counter-bores in my presentation to Bison months ago .

The primary importance of the TES MECH TRANS is at the welding side of the contracts but it has a very large implication for probability of detection for NDE.

I consider back beveled transitions with what I call the three strike rule:

- a) Average welder has trouble welding the root and cannot field back-weld (welding ease)
- b) NDE is compromised as we can not get good radiography and we can not use AUT (NDE compromised)
- c) Bending moment applies maximum stress to the weld (mechanical stress)

The welders don't admit it but they like us when we do counter-bore as equal wall thicknesses, the pipes are much easier to weld; this is because the heat sink is different for both sides. I used to have a hard time understanding why the LOF and cracking were predominant on the thin wall side but the welder must concentrate the heat of the root pass on the thick side or there will be a massive root defect. As a consequence we often have IP and other planar defects on the thin wall side. Since we have likely used a cellulosic rod, we now have the conditions to promote cracking; Susceptible material, Stress, and Hydrogen. The reason why it works so well in the shop is that our components can often be back-welded. If you were to have a hydro-test failure in the shop it is not on PHMSA's radar as much as a ROW failure.

Welding contractors should love it as if you make the counter-bore 5 inches deep, the internal clamp can work and you have a regular SMAW poor boy or GMAW mainline weld as compared to a slow SMAW tie-in with external clamps (\$\$\$\$). Louisbourg and Ledcor both do this as it is so fast to do in the field but we can not apply an ECA to the weld unless we specifically quality one for this.

Before we delve into NDE, we need to look at fracture mechanics.  $Kt$  is an indication of geometry on strength to propagate an indication.  $(YS/kt)$  Volumetric indications have a  $kt=3$ , planar indications  $kt=6$  and cracks  $kt=27$ . Planar indications and cracks have a massive effect on strength and radiography is good at finding volumetric indications not planar indications or cracking.

When we use counter-bores I can have a good film with radiography or I can have excellent AUT. One of the big problems we run into with NDE is that if we do not counter-bore we must use Double Wall Single Image (DWSI) radiography, as the weld must be performed with an external clamp with all the attendant engineering concerns that are associated with this condition. The physical requirement for a tie-in weld dictates the DWSI RT and this will give poorer resolution with X ray and worse with gamma. This is related to the fact that radiography is knocking out different wavelength of photons and X-ray has a wider band than gamma. You just have to look at the light spectrum to see the problem. Just because we can see the wires does not mean we have found all the out of plane LOF and cracking. When I have materials over 16mm I really need some concentrated energy to penetrate the material so I have to move to gamma. The different elements for gamma sources; Cs, Co, Se etc all have different ranges which is why the gamma sources give different resolutions. Co is the worst for resolution as it gives a very narrow spectrum but with an extremely strong penetration. The problem with X ray is powerful units are very large where as gamma sources are very small and so strong X-ray sources are hard to make field portable. The next problem is the film. High energy gamma sources suffer from two sources of un-sharpness. The geometric un-sharpness is related to diffraction off sharp features which muddles the film. Film un-sharpness is high energy from gamma radiation inadvertently exposes film next to the areas of proper exposure so now I have two concerns for un-sharpness of the film on a technique that is sensitive to volumetric indications. If I counter-bore, I can use AUT and see everything the first time with no messing about regardless of thickness.

Counter-boring also moves the bending moment from welds that contain defects into the parent metal. IF you look at a weld on flange they have very strict requirements for angle to move the bending moment past the weld so very similar, by counter-boring, we are moving the bending moment. This was proven many years ago and we still get leaks at road-bores with back beveled transitions. If you have access to the S drive there are a couple of delayed failure reports one from Red Deer and another one from Crossfield (right on highway 2) and I am waiting to see the Manitoba failure from last summer. What I often do when I draw the problem out on the whiteboard or paper is to show a roof structure of a large steel framed industrial building such as Costco or any number of others. When we look at the roof we see that the bolted connections are made several feet to the side of the columns. This is to make sure that the bolts are a) in the neutral axis of the bending moment, b) bolts are half as strong in shear in tension so we do not want to apply a shear stress. (I will send a picture later). Becky, we could probably get you to draw this out with a moment diagram to show people. In our case we use counter bore shape to shed the load to apply the bending moment outside the welded area.

There are two problems with this

1) The contractors love to flay the skin from our projects for requesting something so silly when in truth each transition is to their benefit. The counter-bores can be supplied to a project as heavy wall counter-bore transition pups for a small job where they do not want to mobilize a field counter-bore Cat. (in Kenneth's presentation)

Often time's contractors do a horrible job of machining the transitions and the resulting surface causes diffuse reflection rather than the desired specular reflection which is a pain for AUT.

As you probably realize History has shown us that many construction hydro test failures are at back-beveled transitions shot with gamma and Keystone proved it. The laws of gravity have not changed in recent history either. You might get a way with back bevels and using gamma for inspection but you must accept that a hydrotest failure is now an inherent risk.

We have paid for AUT, lets exploit it, buck up for the counterbores and have worry free project.

Hope this helps  
Evan

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**From:** Claude Albert  
**Sent:** Monday, April 26, 2010 2:56 PM  
**To:** Evan Vokes  
**Cc:** Ron Curle; Veronique Cantin  
**Subject:** FW: Counter-bore and taper versus back-bevel  
**Importance:** High

Evans

I forgot to copy you on these e-mails, what is your take on this?

Cheers,

Claude Albert  
Construction Quality Manager  
Bison Pipeline Project  
Tel: 713 354 6292  
Cell: 832 588 0112

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**From:** Ron Curle  
**Sent:** Thursday, April 22, 2010 6:06 PM  
**To:** Claude Albert; Veronique Cantin; Gerard Lalonde; Gary Babich; Joanne Unger  
**Subject:** FW: Counter-bore and taper versus back-bevel  
**Importance:** High

Veronique

What field welds (of different WTs) do we currently allow back-bevel?

Then let's make an estimate of qty, so that we can evaluate Claude's proposal

\$first – decision second – it might be “Chicken S”

Please reply-all

Thanks!

Ron

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**From:** Claude Albert  
**Sent:** Thursday, April 22, 2010 4:34 PM  
**To:** Ron Curle  
**Cc:** Veronique Cantin; Shane Megoran; Gary Babich; Joanne Unger  
**Subject:** FW:  
**Importance:** High

Ron

The attached is the third bulletin received from PHMSA concerning welds of different wall thickness. As you know, today we had the visit from PHMSA at PG yard, to review our Welding Procedure Qualification process, of which they were very happy with, I will submit the meeting note tomorrow.

During the meeting with PHMSA, they express their concern on welds between pipes of different wall thickness, using a back bevel of transition.

**I recommend we ONLY weld pipe of different wall thickness, all welds not only golden welds, using counter bore to ensure the welds will always be done on same wall thickness. It could be a counter bore done in the field using acceptable field equipment or a counter bore pup, which could be done in a shop.**

This would eliminate PHMSA's concern on the subject, and would allow the project to adequately use AUT for the welds,

Cheers,

Claude Albert  
Construction Quality Manager  
Bison Pipeline Project  
Tel: 713 354 6292  
Cell: 832 588 0112

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**From:** kenneth.lee@dot.gov [mailto:kenneth.lee@dot.gov]  
**Sent:** Monday, April 19, 2010 10:00 AM  
**To:** Claude Albert; Shane Megoran  
**Cc:** stephen.bender@dot.gov; chris.hoidal@dot.gov  
**Subject:**

Attached is a presentation I gave last month on PHMSA girth weld construction concerns your review. I welcome any comments or questions you may have. I'll see you Thursday in Houston.

Thanks,  
Ken

**Kenneth Y. Lee**  
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Evan

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**From:** Kevin Lemke  
**Sent:** Thursday, April 21, 2011 1:43 PM  
**To:** Evan Vokes  
**Cc:** Neil Milne; Ken Sortland; Gary Herd  
**Subject:** Bison AUT Scan Analysis

Hi Evan,

We are currently trying to establish the longitudinal weld seam location for 8 joints of pipe. Caliper pig inspection has shown that these joints have dents, and we need to establish whether the dents affect the weld. We're hoping to use the AUT scans and x-rays (only available on the 25<sup>th</sup> floor of Hanover) to establish the longitudinal seam location. I contacted Robert Lazor, and he provided your name as the person to provide this analysis.

I've attached the spreadsheet which summarizes the dents and the AUT scans that apply.

Please provide your input on this.

Thanks,

**Kevin Lemke**  
*EIT - Major Projects*  
TransCanada  
403-827-7307