Tubing Leaks

- Tubing leaks are a problem throughout the industry. The causes include incorrect tubing makeup, thread problems, corrosion and mechanical damage.
- Locating the leak may be as easy as determining fluid level fall in the tubing or annulus, but may also be very difficult in the case of very small or intermittent leaks.
- The following are a variety of leak detection methods and tools.

Locating a Tubing Leak

- High resolution temp tool shows leak by friction heating (high rate leak)
- PLT w/RST waterflow logging tool. Intro trace chemical into the annulus and read with tool.
- Pony tail (frayed nylon rope) on a WL cutter tool (moderate rate leak)
- Run and set a plug going down the well and pressure test above plug until leak is located
- Run downhole camera – inject liquid into annulus & watch for entry into tbg.
- Plug tubing at bottom and fill tbg w/ water. Displace with gas and locate top of liquid. If gas N/A, then use a pump down dart.

Problem or Information Needed	Rec. Logging Tools	Procedure/Level of Detail
Detection of Crossflow or Underground Blow out	Temperature Survey	Difference in slope of temperature gradient – will detect flow rates down to 25 BPD if liquid and temperatures of fluids are different. Figures on temperature vs. flow distance help estimate water flow in the annulus.
	Noise Log	Best performance of noise logs is with gas flow. Gas flow to about 10 actual ft^3/D (Note – not standard ft^3/day). At very low gas flow rates ($q<400$ actual ft^3/D), gas flow can be estimated from millivolts of noise between the 200-Hz and 600-Hz frequencies: $q = 0.35 (N_{200} – N_{600})$. Where q is the actual gas flow in ft3 and N = noise log cut at that frequency.
	Oxygen Activation Survey	Open hole or channels behind single string. Accuracy is sharply reduced for investigating channels behind two strings (use temp or noise tools).

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Location of Cement Top	Temperature Survey	OK if run within 12 to 24 hrs of cement job. Little temperature variation with the formation may make cement top difficult to see.
	CBL (cement bond log)	Best results after 3 days or when cement has developed 70%+ of the compressive strength. These tools may be too large for slim hole wells.
	Gravel-pack logging (GR)	Tool response depends on density difference between cement and annular fluid.

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Evaluation of Cement Placement	Open hole caliper	Accuracy depends on caliper and hole roughness and washouts. Caliper tools with more than 4 arms are needed for hole volume measurement accuracy.
	Sweeps with markers after running casing	Sweeps give decent estimates of hole volume, but sweeps may not reach all of the annular space in uncentralized cased holes. Useful for swept hole % analysis.
	Temperature Survey	OK if run within 12 to 24 hrs of cement job. Little temperature variation with the formation may make cement top difficult to see.
	Gravel Pack Log	Good if fluid density difference greater than 0.3 gm/cc (0.13 lb/bbl). Could run before and after cement for background data.
	CBL – both regular and segmented	Semi-quantitative contact measurement of pipe/cement and cement/formation. Affected by casing pressure and tool calibration.

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Detection of casing wear from drilling	E-line calipers	Multi-arm calipers generally good, but slick line calipers may rotate and “over-report” the bad spots.
	EM – eddy current tool that measures wall thickness	Highly accurate if the hole is filled with a non conductive fluid.
	Acoustic wall thickness tool	Qualitative indicators of wear (thickness numbers are not very accurate)

Problem or Information Needed	Rec. Logging Tools	Level of Detail
Detect casing collapse	EM – eddy current wall thickness survey	Investigation is to 8 to 10” radius. Investigation ability falls off after the first string encountered. Qualitative investigation. Splits are more difficult to see.
	Gravel-pack (GR – density)	Depth of investigation depends on source strength – may range from 4” to 16”. Splits are more difficult to see.

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Annular Flow	Temperature Survey	Useful where the well has active annular flow. Can spot flows on the order of 1 bpd (after 24 hrs) if temperature of formation at measurement and source of water is sufficiently different. Two surveys, 12 hrs apart is usually adequate to spot presence of a channel.
	OA - oxygen activation	Accurate, but don't swap out muds. Migration of fluids in pipe may be seen as "channel".
	Noise logging	Accuracy depends on channel variations to accelerate flow and change sound.

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Determine annular flow in injector	RA Tracer Survey - inject slug of I-131 in brine.	Track from surface to annulus until slug is completely pumped away. Track any flow that goes behind pipe and moves up.
	OA- oxygen activation survey	Not as reliable as the chemical tracer, due to fluctuations in the injection rate.
	Temperature survey	Three temperature surveys are needed: one before annular injection (base line), one during and one 4 to 6 hours after injection (decay).
	Borax Log	Pumping borax/water solution down tbg into the liner, allowing mix to invade perfs & any channels in casing/formation annuli. Initial pass, before borate injection, is w/ Pulsed Neutron log (no Borax), followed by passes at 20bbls, 40bbls, and 60bbls as borax mix pumped. Borax affects neutron capture, leaving a characteristic signature. Overlays of the Sigma/CNL counts reveal the zones of borax penetration, and identifies channels taking fluid.

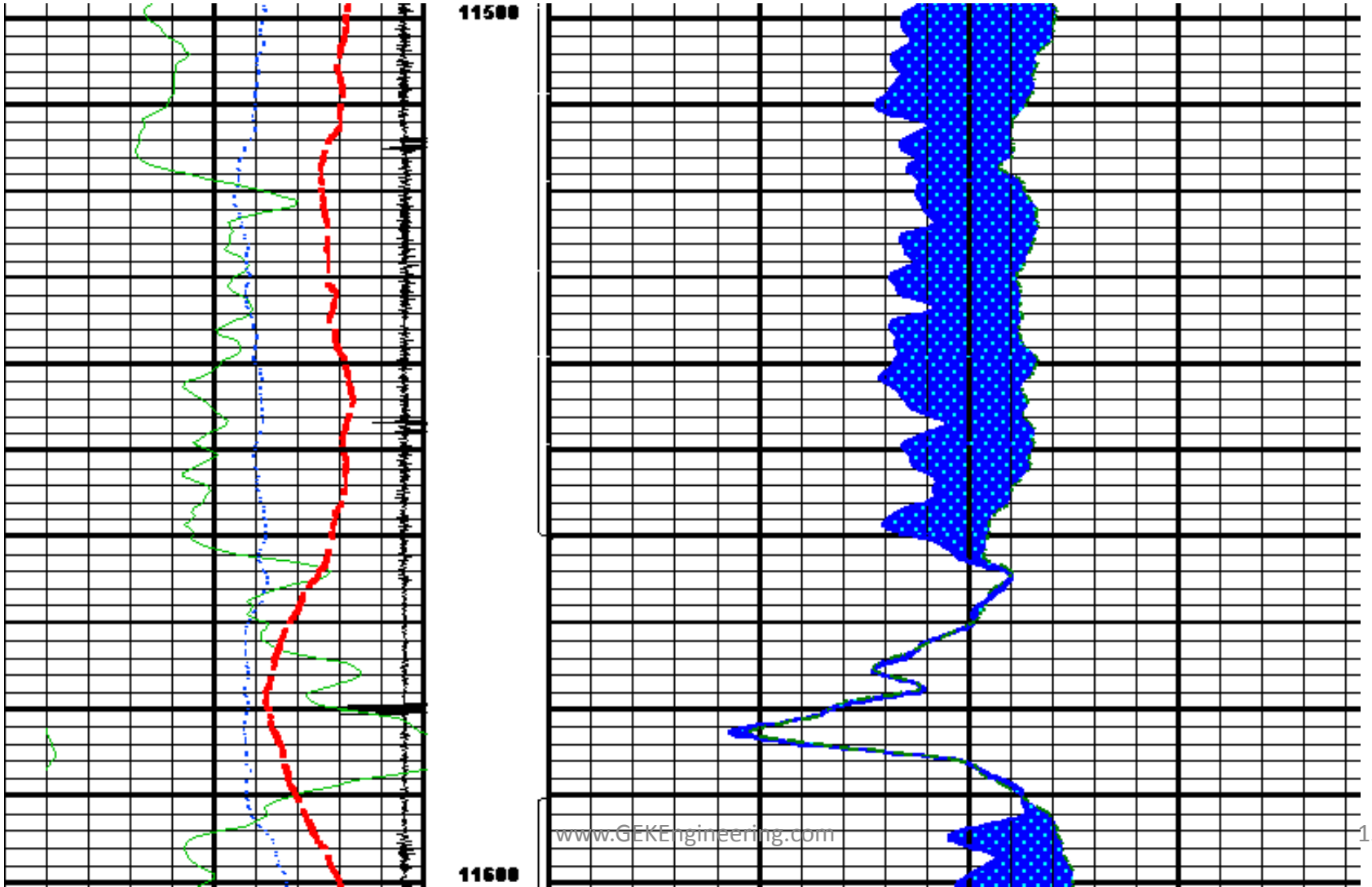
Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Certification for annular disposal	Radioactive Tracer Survey with RA isotope in brine, pumped into annulus while logging with a GR tool in tubing.	Can distinguish entry points and limited detail on up or down movement of the inject slug.
	Oxygen activation survey	Not as accurate as RA logging. Fluctuations in rate create problems.
	Temperature survey	Can determine channels and entry points. Needs 3 runs – before, during and after.
	Borax Log	Pumping borax/water solution down tbg into the liner, allowing mix to invade perfs & any channels in casing/formation annuli. Initial pass, before borate injection, is w/ Pulsed Neutron log (no Borax), followed by passes at 20bbls, 40bbls, and 60bbls as borax mix pumped. Borax affects neutron capture, leaving a characteristic signature. Overlays of the Sigma/CNL counts reveal the zones of borax penetration, and identifies channels taking fluid.

Location of Source of Annular Leak

Problem or Information Needed	Rec. Logging Tools	Procedure / Level of Detail
Location of leak to annulus or crossflow behind pipe	Temperature survey	Relatively accurate at rates of at 1 bpd or more. Need minimum of 2 runs, before and during injection. A third run may help define a qualitative level of leak rate. Run at 1°F/in sensitivity. Will not see small gas leak rates through liquid.
	Noise log	Best for gas leak detection. Run static log and then again during flow or negative test. Upward gas movement (percolation) at actual 10 ft3/D or more should be detectable.
	Oxygen activation log	Can detect flows of 20 to 40 bpd in the annulus of a single string well if the leak is directly opposite the tool. Resolution drops to >200 bpd when two strings are present
	Borax Log	Pumping borax/water solution down tbg into the liner, allowing mix to invade perfs & any channels in casing/formation annuli. Initial pass, before borate injection, is w/ Pulsed Neutron log (no Borax), followed by passes at 20bbls, 40bbls, and 60bbls as borax mix pumped. Borax affects neutron capture, leaving a characteristic signature. Overlays of the Sigma/CNL counts reveal the zones of borax penetration, and identifies channels taking fluid.

Channel Detection Behind Pipe

- Channel logging, with borax solution injection, is accomplished by pumping the solution down the tubing into the liner, allowing the mix to infiltrate the perforations and any channels in the casing formation annuli.
- The initial pass, before borate injection, is made with a thru-tubing Pulsed Neutron logging (or memory neutron) base pass (no Borax), followed by subsequent passes at 20bbls, 40bbls, and 60bbls as the borax solution is pumped away.
- The borax affects neutron capture, leaving a characteristic signature. Overlays of the Sigma/CNL counts reveal the zones of borax penetration, and identify the channels taking fluid.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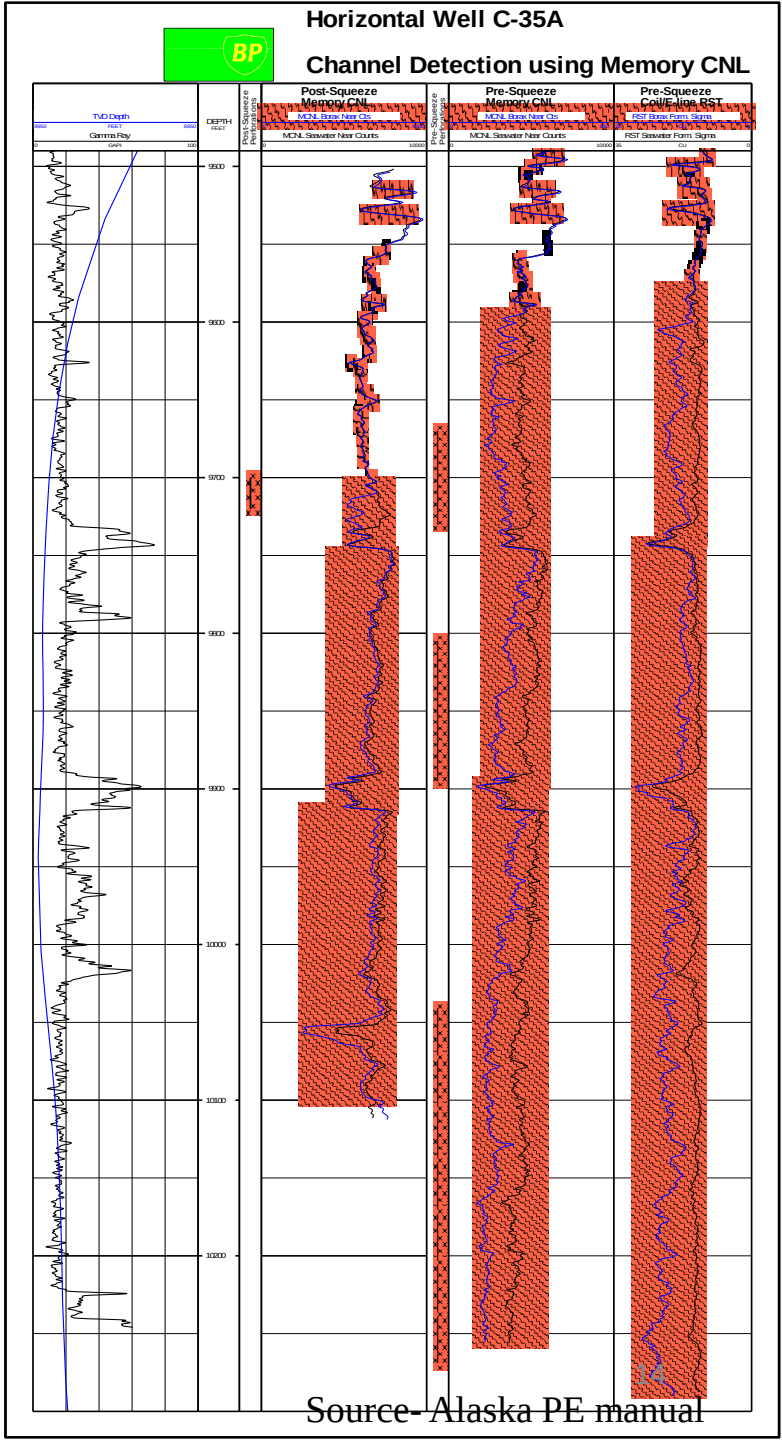
In some cases, the borax logging technique is sufficiently robust to complement or replace temperature logging when looking for behind the pipe channels. (SPE 25383 for Borax logging)

The technique has not been used widely outside Alaska, due to the problems in making the “Borax Brew” and keeping it hot to avoid precipitation of the Borax at colder temperatures (<100degf).

The Borax needs to be mixed at a near critical saturation in order to give the best result. Typically this is 7lb/bbl Borax Pent hydrate and 7lb/bbl NaCl.



Source- Alaska PE manual