INTERNATIONAL CONSTRUCTION CONSULTING, LLC							
JOB No: NA			* PREPRD.BY:	G Lamberson	DATE: 18-Jan-11		
CLIEN I: Sonongas CHECKD.BY: SHEET: PROJECT: 20" Gas Pipeline from Bow Tie to Industrial Park-Sovo. Angola							
SUBJECT: HDD Pipe Stresses & Installation Stress Analysis							
PIPE PARAMETERS:		ameter (in.) =	20.000				
	vvaii Thi	SMYS (nsi) =	65,000				
	avT	e of Service =	Gas				
	Desi	gn Pressure =	4,500				
	S	afety Factor =	0.72				
Installation Temperature (degrees F) =			90.00				
Operating Temperature (degrees F) =			80.00				
CALCULATED VALUES:	Groundwater tab	D/t ratio =	<u> </u>				
		$r_{o}(in.) =$	10				
		$r_i(in.) =$	9.5				
		E (psi) =	2.95E+07	Young's modulus for stee	el		
Coloulated D.O.C.(ft) -	C EEC	l (in⁺) =	1456.863275	Moment of interia, = PI/4	$(r_{o}^{4} - r_{i}^{4})$		
	0,550	M = (in-lb) =	546 324	Radius of curvature M = EI/R			
		$A = (in^{2}) =$	30.631	Cross sect. area = PI*(D	- t)*t		
		$W = (in^3) =$	149.324	(elastic) section modulus	$s = PI/4^*(D - t)^{2*}t$		
LONGITUDINAL STRESSES	(Sigma <sub>x</sub> )						
for positive compressive forces, $N = 0$	, i.e., no push or pull						
	Sigma <sub>x</sub> (psi) =	Sigma <sub>x</sub> <sup>N</sup> + Sigma <sub>x</sub> <sup>M</sup> = N	N/A + M/W	0: N N/A			
	and	Sigma <sub>x</sub> =	3 659	Sigma <sub>x</sub> = N/A Sigma $^{M}$ = M/W			
CRITICAL LONGITUDINAL S	TRESSES (Sigma <sub>xcr</sub> )	olgina <sub>x</sub>	0,000				
when N acts alone, i.e., M = 0 and p =	= 0	Sigma <sub>xcr</sub> <sup>N</sup> (psi) =	63,700.0000	Sigma <sub>x</sub> <sup>N</sup> = Sigma <sup>F</sup> *[10	01*(D/t)-20)]		
N ~ axial				for 20 < D/t < 100			
when M acts alone, i.e., N = 0 and p =	= 0	Sigma <sub>xcr</sub> <sup>M</sup> (psi) =	76,050.0000	Sigma <sub>x</sub> <sup>M</sup> = Sigma <sup>F</sup> *(1.35	5-0.0045*D/t)		
HOOP STRESS (Sigma.)	Given by: Sign	$na = (n_1 - n_2) \times D / (2)$	(t)				
	where	$p_e (psi) =$	26	p <sub>e</sub> = external pressure =	0.052*W <sub>m</sub> *H		
		W <sub>m</sub> (lbs) =	10	W <sub>m</sub> = weight of mud, lbs.	/gal.		
		H (ft.) =	50	H = feet of head (depth of	of burial)		
		p <sub>i</sub> (psi) =	0 520.00	p <sub>i</sub> = internal pressure (as	sumed)		
		Sigma <sub>y</sub> (psi) =	520.00				
				conversion factor, 0.052	converts #/gal to psi/ft.		
CRITICAL HOOP STRESS, (	Sigma <sub>vcr</sub> )						
when p acts alone, i.e., N = 0 and M =	= 0	Sigma <sub>ycr</sub> (psi) =	19,395.13	$Sigma_{ycr} = Sigma_{yE} = E$	*(t / (D-t)) <sup>2</sup>		
		2/3 Sigma (nsi) =	43 333 33	for Sigma <sub>yE</sub> < $2/3$ Sigma	F		
ALPHA DETERMINATION:		270 Olginia <sub>F</sub> (p3i) =	10,000.00	0.11.			
		Alpha =	1.20	Alpha = 1 + 300/(D/t)*Sig	gma <sub>v</sub> /Sigma <sub>vcr</sub>		
PERMISSABLE USAGE FAC	TORS, ( $Nu_{xp}$ and $Nu_{yp}$ )						
$Nu_{xp}$ is the permissable value of Sigma	$a_x$ /Sigma <sub>xcr</sub> , when Sigma <sub>y</sub> = 0						
Nu <sub>yp</sub> is the permissable value of Sigma	$a_y/Sigma_{ycr}$ , when $Sigma_x = 0$						
	BEST CASE			Zone 1, loading			
		Nu <sub>xp</sub> =	1.00				
		Nu <sub>yp</sub> =	0.98				
				Installation in a disc			
	WURSI UASE	Nu –	0 72	installation, loading			
		$Nu_{xp} =$	0.62				
PERMISSABLE COMBINATION OF Sigma <sub>x</sub> and Sigma <sub>y</sub>							
$(Sigma_x/Nu_{xp}*Sigma_{xcr})^{alpha} + (Sigma_y/Nu_{yp}*Sigma_{ycr}) < 1$							
	BEST CASE 0.053494153 о.к.						
9/5/16		HDD Stress Ana	alysis & Results	HDD Full Pipe & Inst	tallation Stress Analysis-20-inch.XLS		

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DIDE DADAMETEDS: Diameter (in ) = 20.000							
Wall Thickness (in.) = SMYS (psi) = Type of Service = Design Pressure = Safety Factor = WORST CASE	20.000 0.500 65,000 Gas 4,500 0.72 0.082022321 <b>о.к</b> .						
* Based on Det Norske Veritas Appendix B Rules for Submarine Pipeline Systems							
INSTALLATION STRESS ANALYSIS							
Longitudinal Stress from Bending = % SMYS =	3,750 psi 5.8%						
Hoop Stross -	80.221 psi	Heen stress limited by design					
% SMVS -	137 3%	factor from 49 CEP Part 192 111					
// 514115 -	137.376	(72% for Class 1, 60% for Class 2)					
Longitudinal Compressive Stress from Hoop Stress = % SMYS =	26,766 psi 41.2%						
Longitudinal Stress from Thermal Expansion = % SMYS =	1,918 psi 3.0%						
Net Longitudinal Compressive Stress = % SMYS =	24,934 psi 38.4%						
Maximum Shear Stress = % SMYS =	32,143 psi 49.5%	Shear stress limited to 45% of SMYS by 402.3.1 of ASME/ANSI B31.4					
Installation Design Results =	ОК						