AFT IMPULSE SAVES CONSTRUCTION COST & TIME BY AVOIDING OVERDESIGN OF SURGE FORCES ON THRUST BLOCK

One of the most important safety design criteria for any Pipeline is 'Failure due to Surge Pressure.' To solve this problem both Process and Mechanical engineer should work together. Unfortunately both do not understand each other's language easily. Process engineer talks in terms of 'Pressure' and Mechanical engineer understands 'Force'. AFT Impulse bridges the gap between both and produces results useful and understood by both. Here is a case study saving construction cost and time by avoiding overdesign using AFT Impulse.

A 12 inch Diesel line connecting Jetty pump and Tank farm located 3 km away were to be analyzed for transient event due to sudden closure of butterfly valve and pump trip case due to power failure. Temperature was 45°C, Flow was 800m^3/hr and Pipe material was carbon steel.

Initially the project was offloaded to Protton engineering for pipeline Stress analysis with consideration of Surge forces according to manual calculations. But Protton Engineering insisted client to use of AFT impulse to find out Surge pressure and forces. The AFT impulse has the following advantages over the conventional manual analysis:

✘ Manual calculation is suitable only for Simple Systems.	✓ AFT Impulse simulates Complex Systems.
✘ With Manual Calculations it is very difficult to calculate the forces formed due to Valve Closure as it is a dynamic phenomenon.	✓ AFT impulse has the provision to consider Valve Cv i.e valve flow coefficient and valve closing profile which makes the calculation more reliable.
✘ Force calculation due to Partial Valve Closure is not reliable.	✓ Force Calculation due to Partial valve closure is reliable due Valve Cv vs Time profile.
✘ With manual calculations the Surge forces formed due to Pump trip is nearly impossible to calculate.	✓ AFT impulse has the provision for pump Curve which is Flow vs Head/Pressure vs Efficiency to calculate exact System flow, along with pump Curve it has a provision to give Rotating inertia of pump, motor & liquid. In absence of Rotating inertia provided by vendor AFT calculates the Rotating Inertia.
✘ Manual Calculation neglects Friction and momentum loads results in non-zero	✓ AFT impulse considers the friction and momentum loads resulting into actual

Steady state loading which results in higher amount of forces.

interpretation of forces.

✘ Manual Calculation uses the speed of sound to calculate the differential pressure.

✓ AFT Uses wave speed i.e. sonic velocity to calculate the differential pressure. Where wave speed is depend upon the Liquid bulk modulus, density and pipe supports. Which gives the more accurate results.

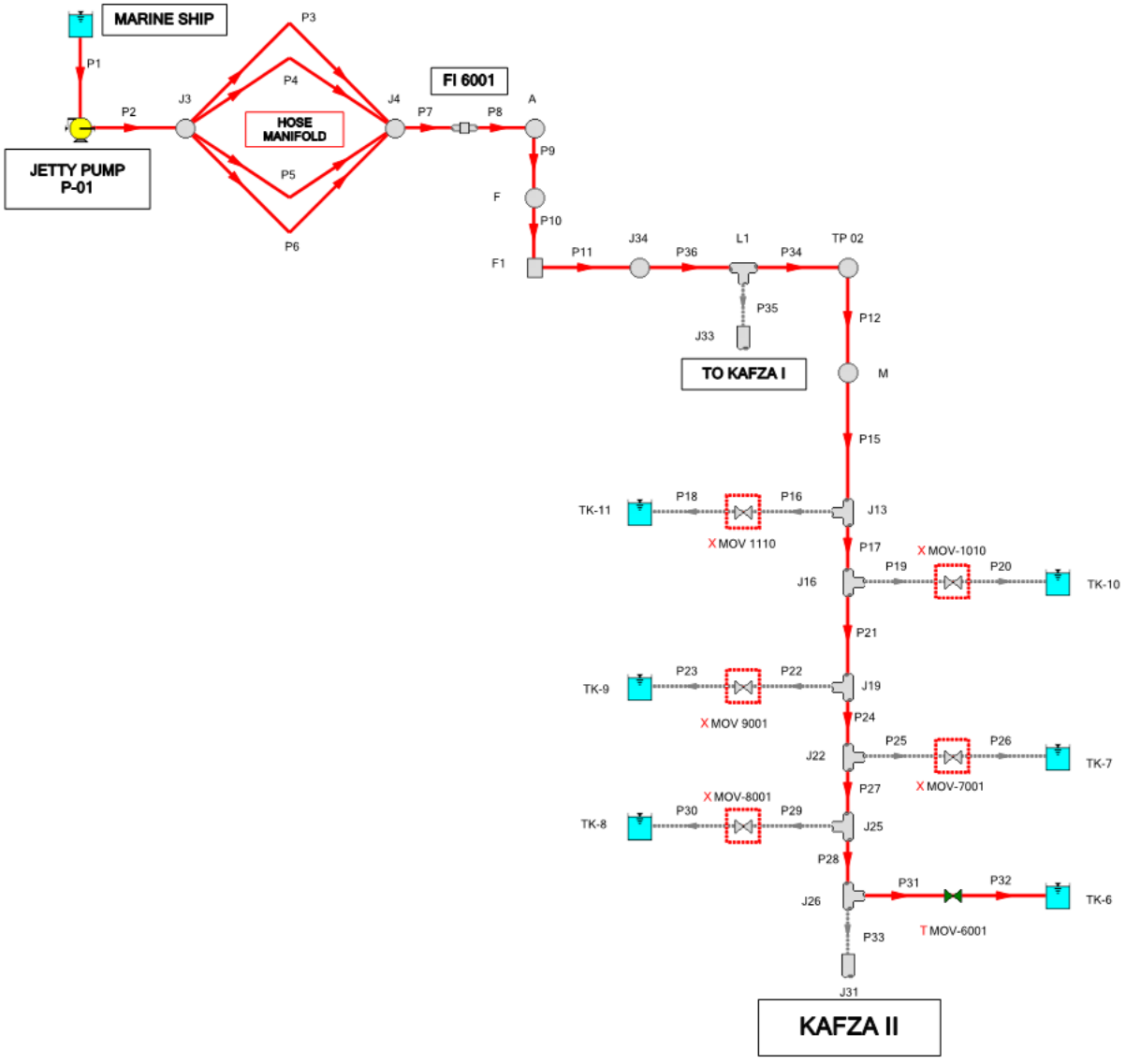

Fig 1: AFT Impulse model for 12” Diesel pipe line.

Following is a typical comparison between Force calculation through Manual Calculation and AFT Impulse Simulation.

Mean Pipe diameter	d		12.14	inch	
Speed of Sound in Fluid	C	$\{[g_c * E_f/\rho]/[1 + (d/t)(E_f/E)]\}^{1/2}$	4818.52	ft/sec	Piping Handbook: Nayyar
Pressure Fluctuation due to the instantaneous stoppage of flow through the pump / valve	dp	$\rho * c * dv / g_c$	448.93	PSI	
Duration of Load	t	L / c	7598.635	milisec	
Magnitude of Unbalanced Force	F	dp * A	46849.79	lbf	High force
Magnitude of Unbalanced Force	F	dp * A	208398.63	N	

Fig 2 : Force Calculation Through Manual Calculations for Pipe P-11

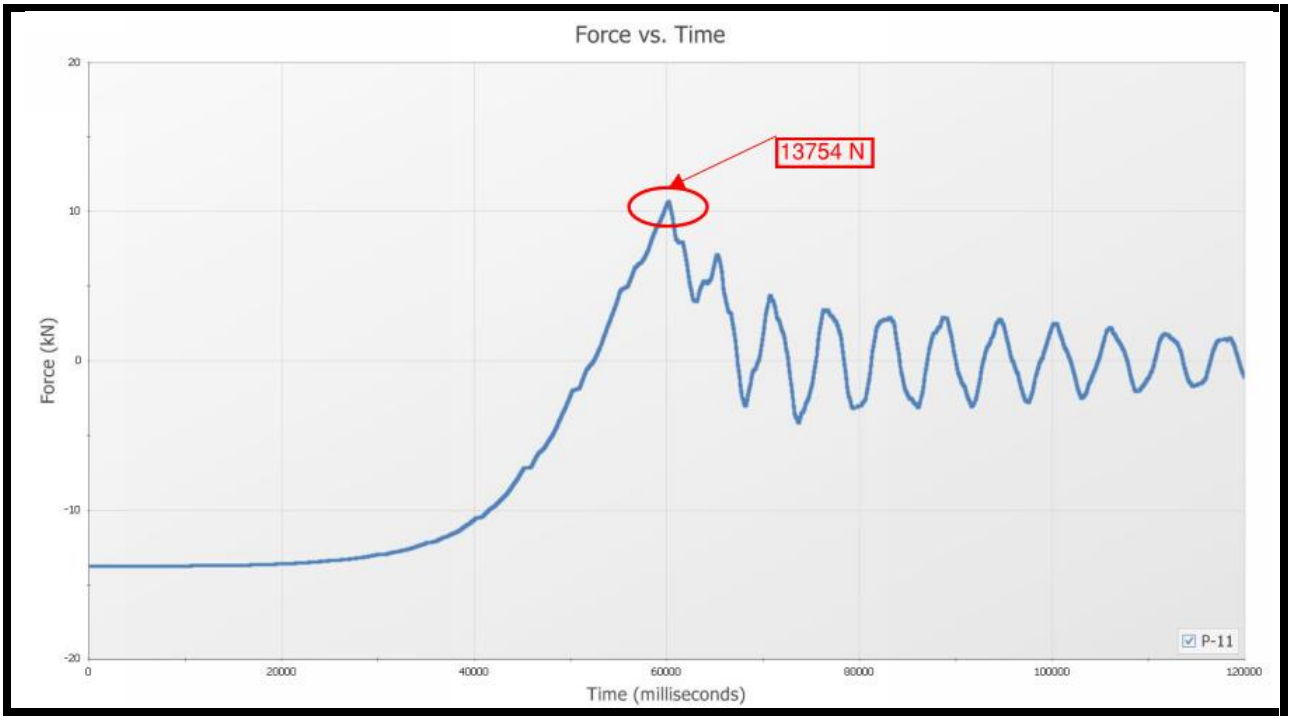

Fig 3: Force Calculation Through AFT IMPULSE for Pipe P-11

The Above model needs to be run for 2 Cases. First case is for Valve Closure (MOV 6001) and the Second Case for the Jetty Pump (P-01) tripping.

The “Scenario manager” Feature of AFT Impulse is very useful for Surge analyst. Analyst has to create Base Scenario followed with its Children. The Children unable to check the system under different scenarios viz. different valve closure timing. In case of pump tripping, system can be analyzed for different Pump Impeller sizes. The pump curve is vital parameter in surge analysis.

Sometimes just by selecting proper pump curve, surge or surge mitigating devises can be avoided.

The Batch Run option makes the AFT impulse software to run Multiple number of systems to one after another which can be started at the COB of the day which utilizes non-working office hours and eventually saves the working time and ultimately reduces the cost of project.

Earlier the surge analysis was considered as the process engineer's baby. Once the calculation performed by the process engineer, the force data used to be transferred to Piping stress engineer (Mechanical engineer). But due to AFT Impulse's user friendly interface, now it is easily possible to analyze surge problem by a piping stress engineer with minimum data requirement. It gives practical advantage that one engineer does both process and mechanical calculations, The decision regarding location of the Surge Suppression devices like Liquid Surge Tanks, Gas accumulators etc. can be taken easily due as piping engineer has better understanding of layout.

Feather in cap is AFT Impulse has capability to generate interface '.frc' file which provides Force vs Time, which can be directly exported to CAESAR II model to perform Dynamic analysis. The loads on the Anchor block can be evaluated easily. From fig 2 and 3 clearly indicates that forces from manual calculation are quite high due to its over conservative approach where as in case of AFT impulse based calculation it is Very low and realistic.

The surge force will largely impacts the Thrust block Size which indeed a very costly affair. AFT impulse helped us reducing the thrust block size and save considerable construction cost.