Cost of Propane Fast Cook-Off Testing

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Background

- Fast cookoff (FCO) is an international standard safety test required for all explosive ordnance
- Environmental concerns
  - Tests use large pools of hydrocarbon fuel such as JP5, JP8, kerosene, etc.
  - Emissions from one test: 200 kg CO, 35 kg NOx, 30 kg SOx, 225 kg soot, 125 kg unburned HC, and 20,000 kg CO_2
  - Ground water concerns
  - Public relations
- Propane viable substitute fuel
  - Gas at atmospheric conditions
  - Cleaner burning
  - Readily available
  - Sufficient heat content

Cost Assessment

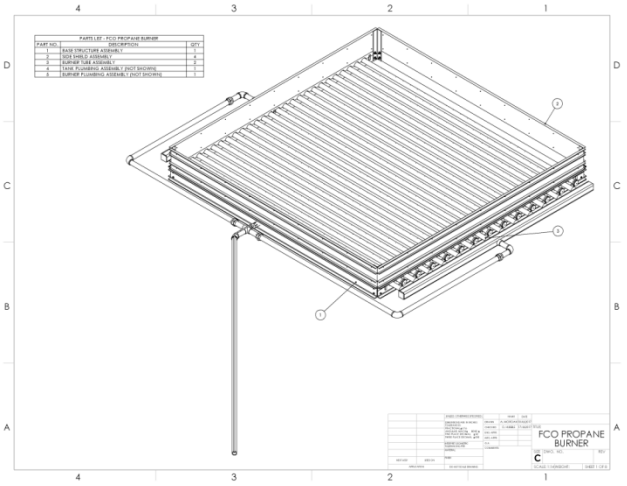
- Compare cost of propane burner FCO test to jet fuel pool fire FCO test
- 3.7 m by 3.7 m propane burner built at Dahlgren, VA used for comparison
- Three categories
  - Non recurring costs
  - Per-test costs
  - Annualized recurring costs

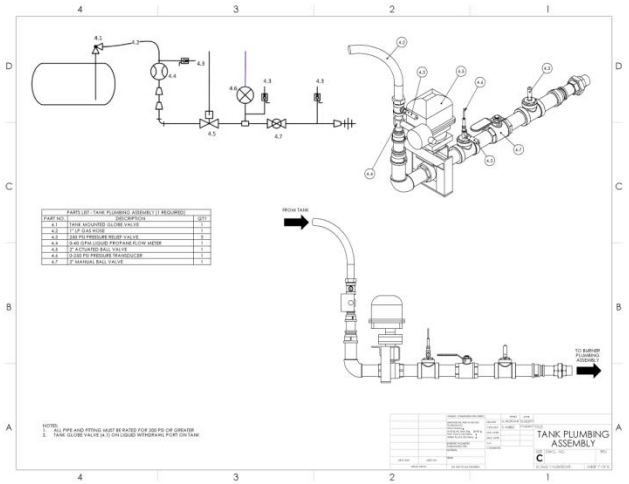
Nonrecurring Costs

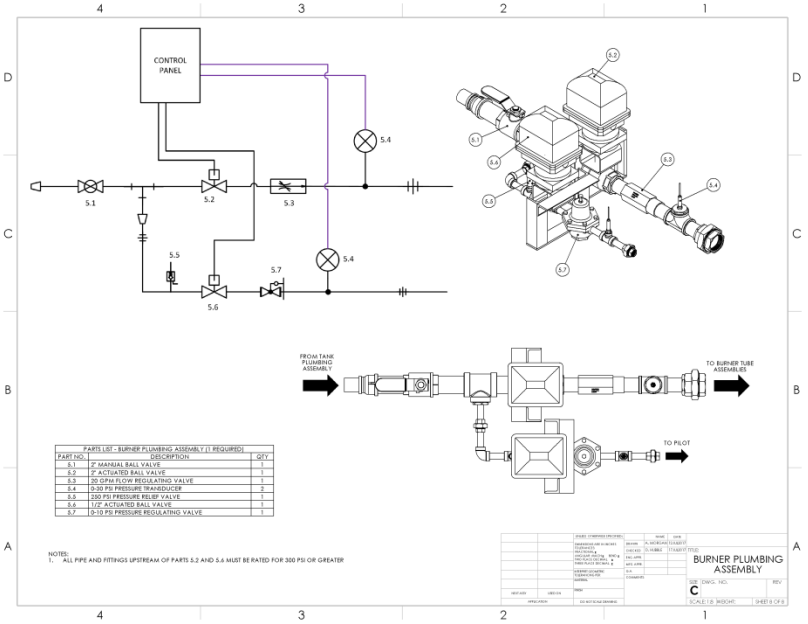
- Engineering design
  - Initial design cost high (>$500K)
    - Tried multiple design iterations
    - Developed and designed to be made from inexpensive readily available supplies
  - Adaption of 3.7 m by 3.7 m propane burner at Dahlgren, VA to 6.1 m by 4.6 m propane burner at China Lake, CA <$100K
  - Considerable work done, future adaptation costs even less

Nonrecurring Costs

- Engineering design
  - 3.7 m by 3.7 m propane burner technical drawing package available upon request







Nonrecurring Costs

- Material and labor for construction of burner

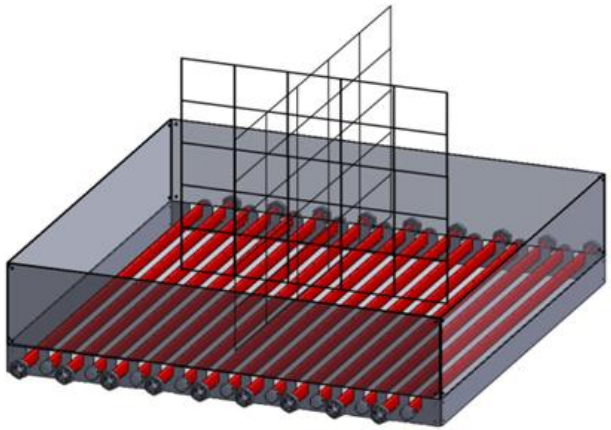
Location	Category	Cost
Electrical Panels	Material	$2633
	Labor	$14900
Burner	Material	$4317
	Labor	$11920
Pipe System from tank to burner	Material	$12882
	Labor	$17880
Total	Material	$19832
	Labor	$44700

Nonrecurring Costs

- Material and labor costs
  - Only $16237 is susceptible to damage
  - Multiple test possible on one burner

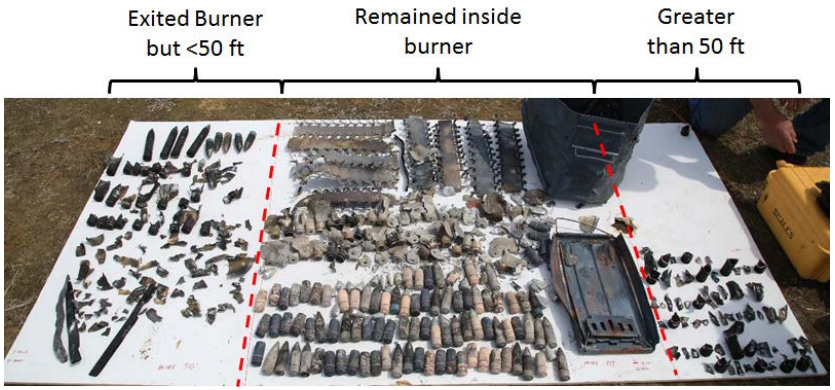
Nonrecurring Costs

- Calibration costs
  - Directed by STANAG 4240
  - Costs dependent on skill of operators
  - NSWCDD Personnel costs for testing
    - Preparation, testing, clean-up, analysis, and reporting - $27000
    - Materials - $1000
  - Calibration setup shown below



Per-Test Costs

- Different types of tests
- Tests to officially “score” item



- Engineering tests

Per-Test Costs

- Comparison of costs of official FCO tests with jet fuel pool fire and propane burner
- Requirements and documentation
  - Meet with customer and determine requirement
  - Safety research and test stand design
  - Same cost for both types, $4321

Per-Test Costs

- Pre-test preparations
  - Fabrication of test fixtures
  - Preparation of area
  - Instrumentation installation
- Savings of $1192 with propane burner
  - No lengthy pit inspection
  - No fuel delivery cost

Per-Test Costs

- Test execution
  - Follow STANAG 4240
  - Savings of $2384 with propane burner
    - Fewer test cancellations from weather
    - No need to wait for fuel pouring
- Post-test activities
  - Fragment and debris mapping
  - Clean up
  - Compiling, editing, and delivering data
  - Little costs difference between tests
  - Big difference in comfort of personnel (no fumes)

Per-Test Costs

- Material and surcharges
  - Biggest cost difference between tests
  - Fuel savings is $6500
- Total costs
  - Jet fuel pool fire FCO test: $36791
  - Propane burner FCO test: $25886
  - Savings of $10905 per test

Annualized recurring costs

- Significant savings compared to the jet fuel fire FCO tests
  - Liquid fuel hauling and maintenance costs
  - Environmental costs
  - Thermite grenade costs

Item	Liquid Fire	Frequency	Cost/year		Propane Fire	
Repair and replace expanded	2 man days	1/per year	$ 2,384		n.a.	
metal grates	materials		$ 500			
Burner tube replacement	n.a.	1/year			2 man days	$ 2,384
Repair wind screens	n.a.	1/year			2 man days	$ 2,384
					materials	$ 176
Propane tank rental	n.a	1/year			2- 500 gallon	$ 100
Liquid waste pump and haul		5 years			n.a.	
Collect samples	4 man days		$ 954			
Labortory analysis	3 man days		$ 715			
Vendor contract	2 man days		$ 477			
Award contact	1 man day		$ 238			
Schedule range	.2 man day		$ 48			
Meet vender, transfer liquid	5 man days		$ 715			
Fuel Truck with Pump						
Parts			$ 1,500			
Maintenace of SOPs-Inert	2 man days	4 years	$ 596		2 man days	$ 596
Maintenace of SOPs-Energetic	3 man days	4 years	$ 894		3 man days	$ 894
Post test clean up w/hazmat	4 man days	1/year	$ 4,768		n.a.	
Environmental reporting	2 man days	1/year	$ 2,384		n.a.	
Thermite grenades					n.a.	
receive shipment	1250	1/yr	$ 1,250			
ammo transfer to EEA	2500	2/year	$ 5,000			
grenade unit cost	34	72/year	$ 2,448			
squib unit cost	29	72/year	$ 2,088			
storage						
requisitions(alocate, expend)	.5 man days	1/year	$ 745			
expenditure forms	.125 man days	1/test	$ 2,682			
		Total	**$ 45,382**		**Total**	**$6,534**

Conclusions

- Compared cost of propane burner FCO test to jet fuel pool fire FCO test
- Non recurring costs are significantly reduced
  - Sharing of past engineering design work
  - Protection of expensive components
- Per-test costs reduced by 30% with propane burner
- Annualized recurring costs reduced by 86% with propane burner

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