

Facility Dynamics

ENGINEERING

Inputs and Outputs – The Field Perspective

Where We Come From

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The Fundamental Goal of the Control System

Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control

The Holistic (Green) Goal of the Control System

*Automatically adjust a piece of machinery to give us what we want by comparing what is going on to what we want to go on and making appropriate adjustments to the process we want to control **as efficiently and sustainably as possible***

The “Three R’s”

Repeatable

To make, do, or perform (an action) again (and again, and again, and again)

Reliable

Giving the same result on successive trials

Robust

Sturdy; capable of performing without failure under a wide range of conditions

A 1912 Vintage Sensor



A 1912 Vintage Sensor



A 1912 Vintage Sensor

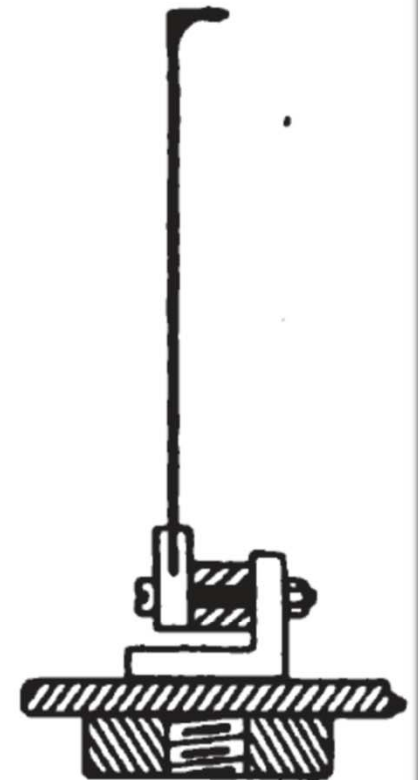
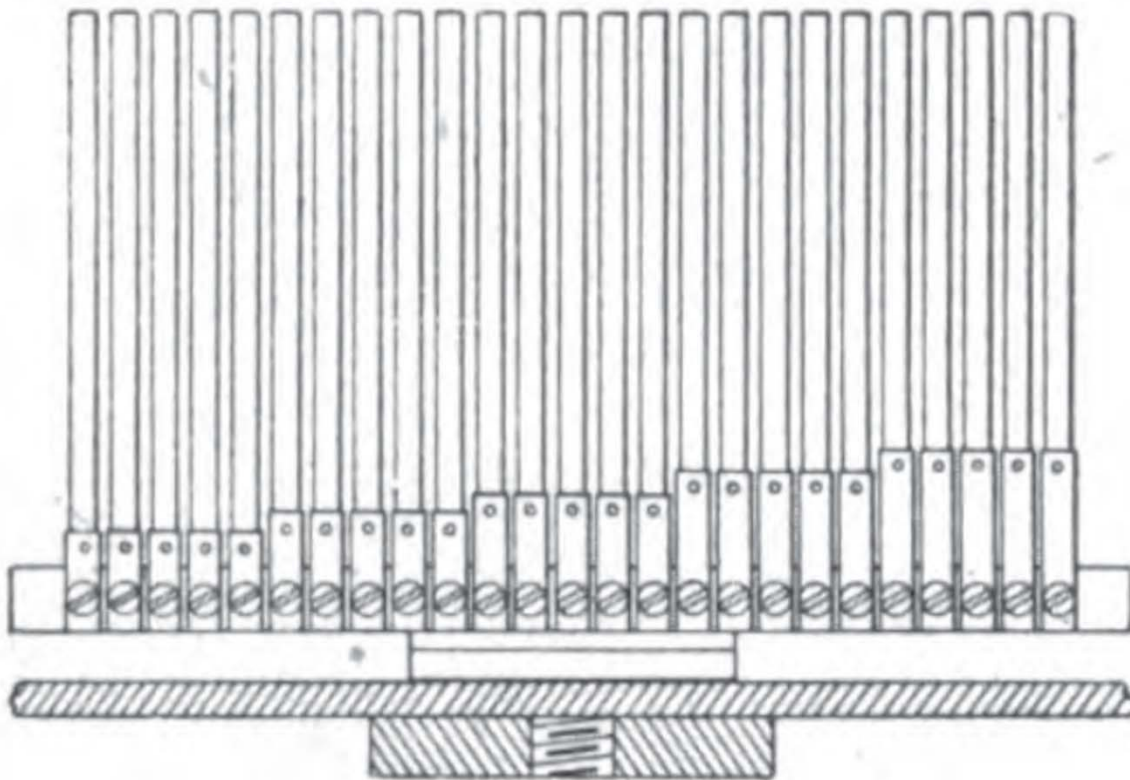
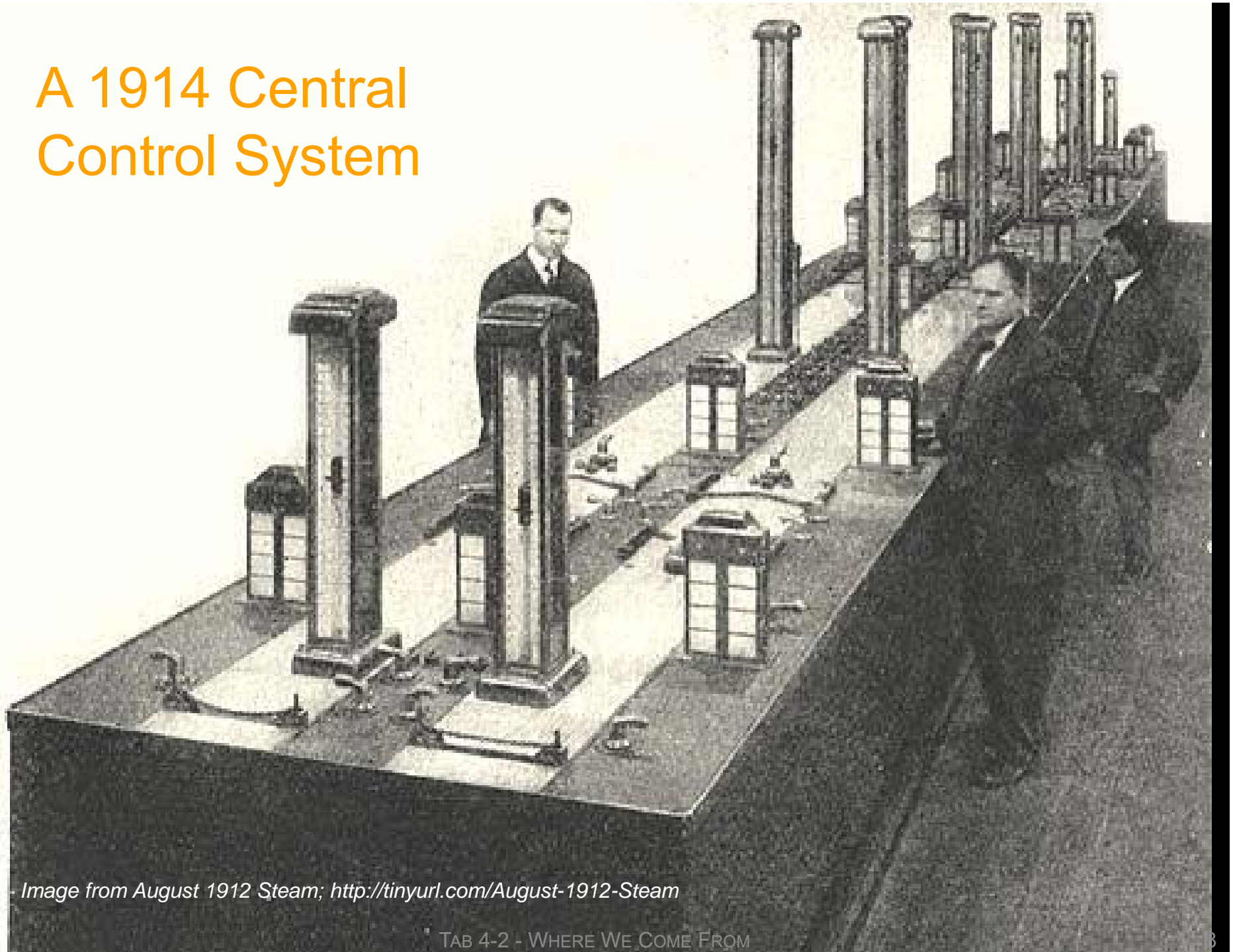


FIG. 2. INDICATING REEDS AS MOUNTED IN FRAHM VIBRATION TACHOMETERS

Image from August 1912 Steam; <http://tinyurl.com/August-1912-Steam>

A 1914 Central Control System



- Image from August 1912 Steam; <http://tinyurl.com/August-1912-Steam>

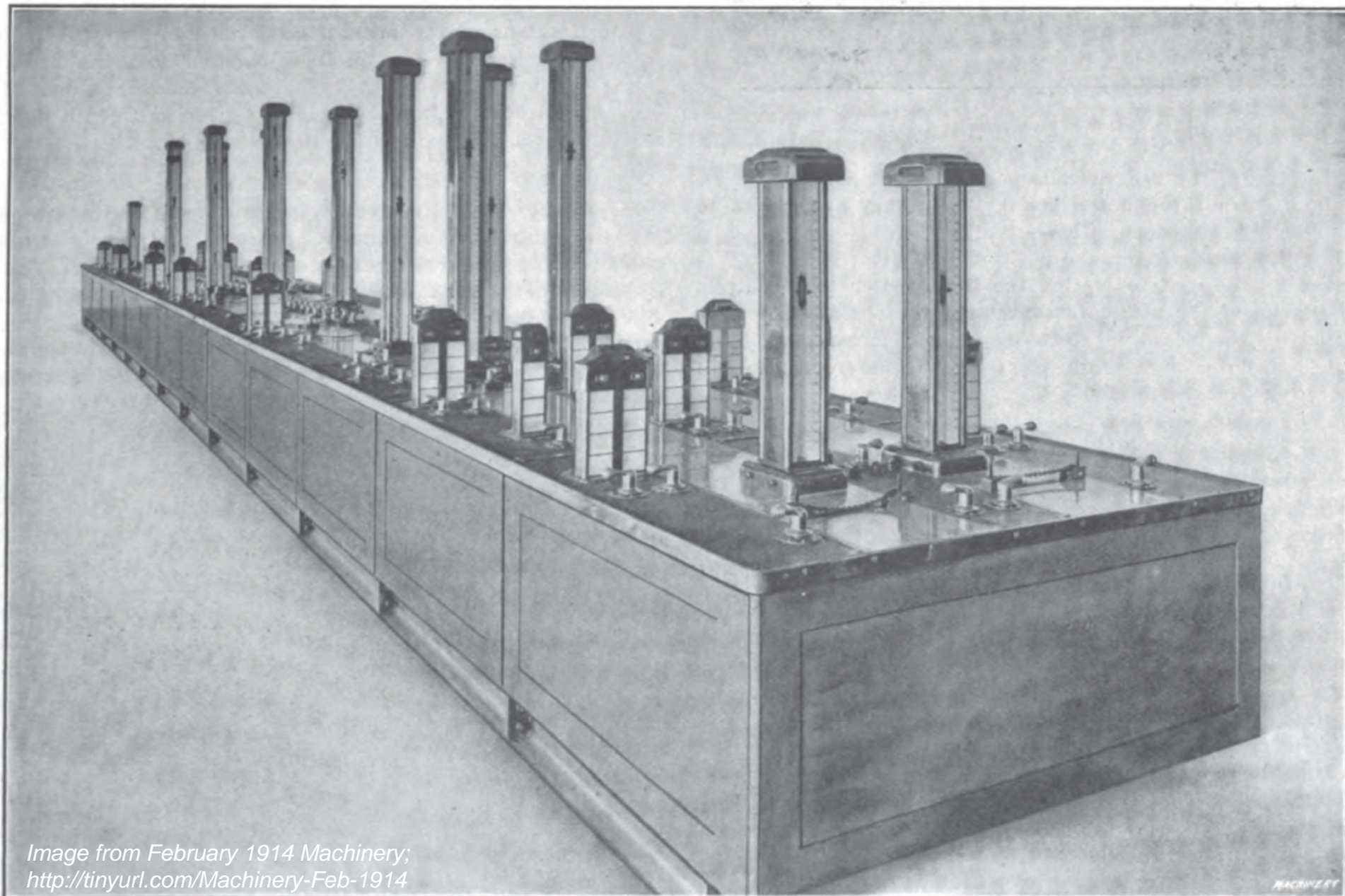


Image from February 1914 Machinery;
<http://tinyurl.com/Machinery-Feb-1914>

Fig. 1. Lock Control-board for Miraflores Locks of Panama Canal—The Water Levels in Different Chambers and Positions of Gates, Valves and Fender Chains are shown by the Indicators seen on Control-board

A 1914 Central Control System

- 2.25 miles of interlocking rod
- 1,100 miles of control wire in the form of 5 to 8 conductor cables
- 732 position indicators and transmitters
- 464 control switches
- 382 indicating lamps
- Accurate to 5/8 inch over a 50 foot span

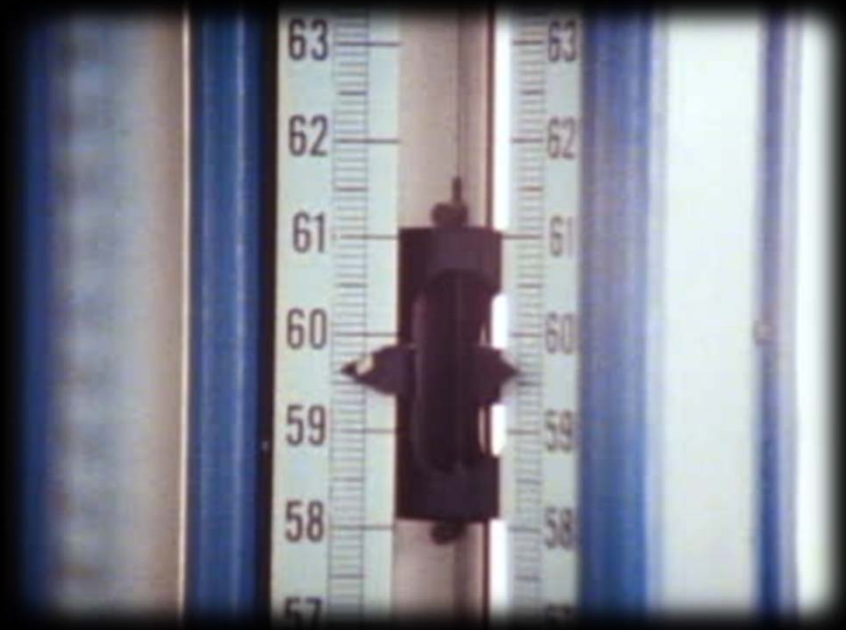


Image courtesy <http://ak5.picdn.net/shutterstock/videos/3832016/preview/stock-footage-panama-canal-lock-control-room-close-up-moving-gauge.jpg>

Still Doing Its
Thing



Image courtesy www.ttnews.com/galleries/panama2014/images05-IMG_3730_lg.jpg

The Other End of the Spectrum



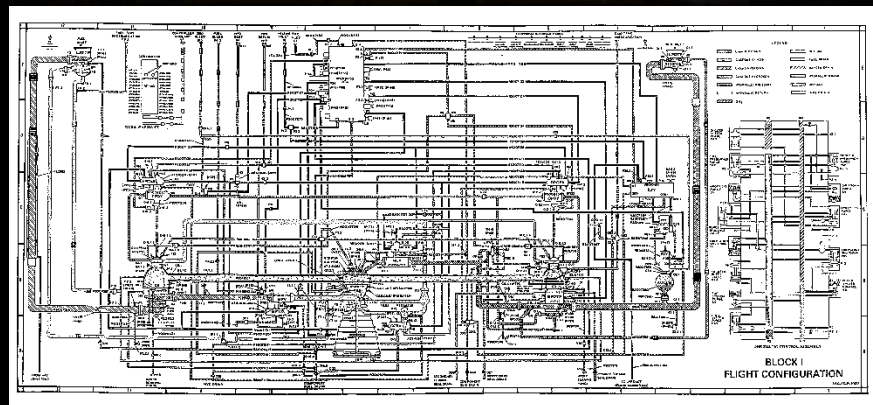
Image courtesy

http://image.dieselpowermag.com/f/news/9104552+w799+h499+cr1+ar0/0705dp_04_z%2Bnasa_diesel_shuttle_crawler%2Bshuttle.jpg

The Other End of the Spectrum

Aerojet Rocketdyne RS-25 Space Shuttle Main Engine and Controller

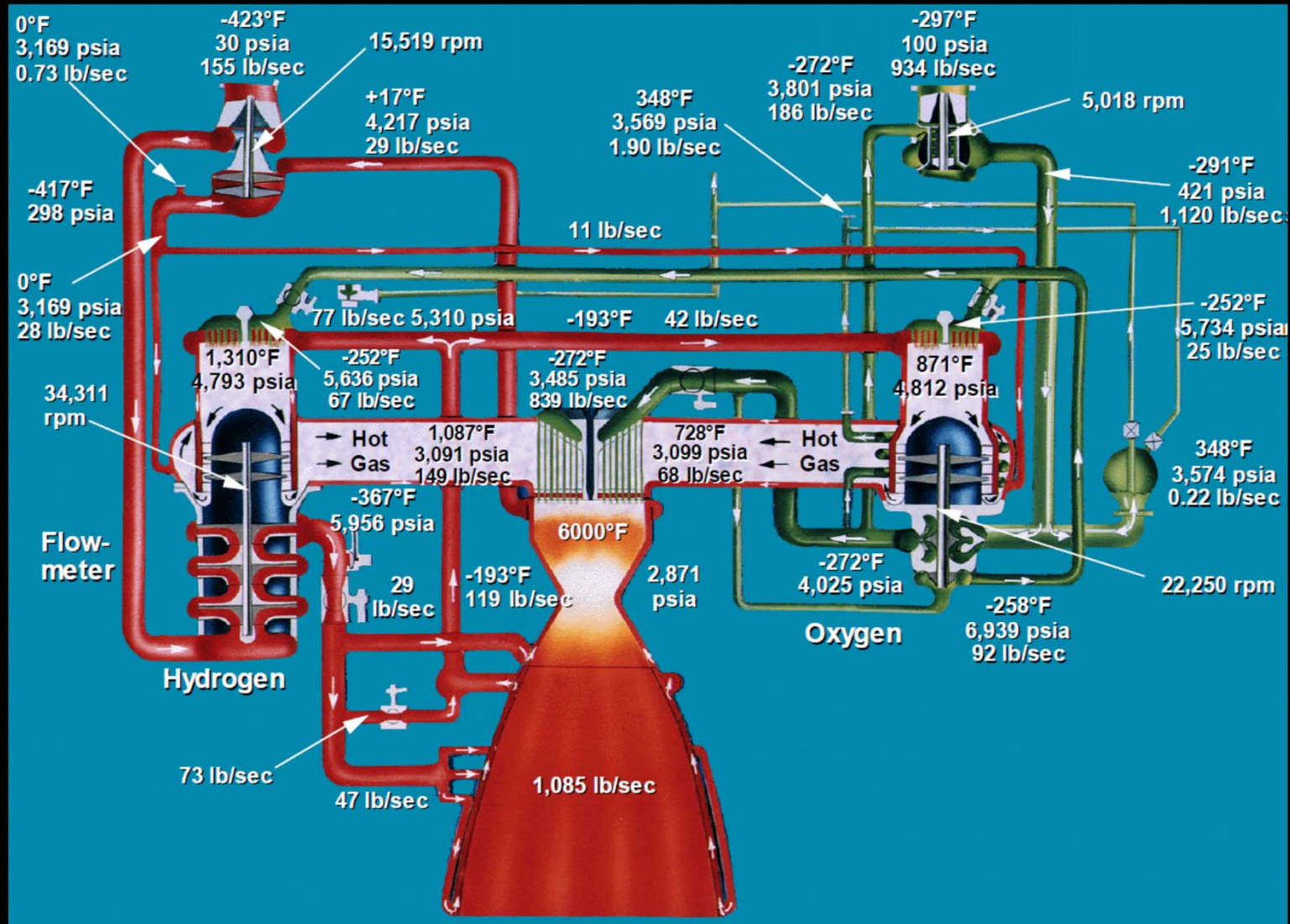
- About 50,000 parts
- Rated for multiple flights
- 135 flights with no failures



Images courtesy

http://image.dieselpowermag.com/f/news/9104552+w799+h499+cr1+ar0/0705dp_04_z%2Bnasa_diesel_shuttle_crawler%2Bshuttle.jpg

They Are Doing Rocket Science



We Are Not Doing Rocket Science

Seems like:

- We should be able to maintain a 57°F discharge temperature by sequencing preheat with the economizer and the chilled water coil
- We should be able to start around 6:00 am and shut down around 7:00 pm



Comprehending the Situation

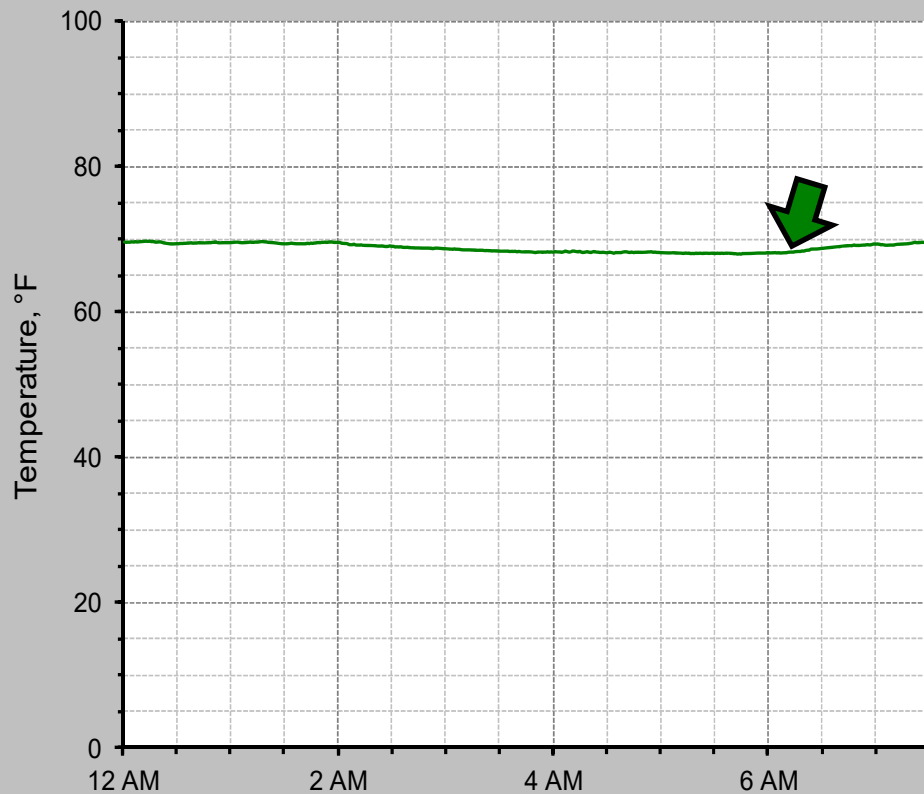


“Madame, if you are piloting an untested vehicle on its first test flight and that vehicle contains more propellant than was ever placed on a launch pad before and the vehicle was assembled by the low bidder and you aren’t a little nervous, then you don’t fully comprehend the situation”

Paraphrased; John Young to Barbara Walters when asked if he would be nervous as the test pilot on the first manned shuttle flight

To the Casual Observer, We're Doing O.K.

RTU2 Temperatures - 1 Minute Sample Rate - December 7, 2001

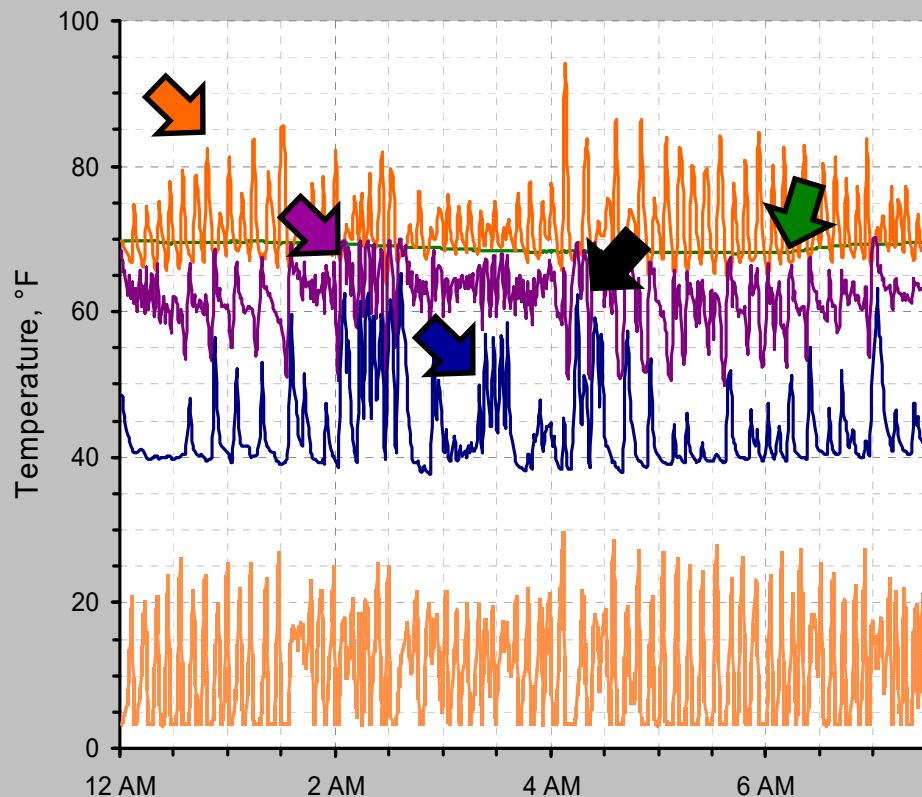


- Control point stable at set point; Everything's just fine!

— Zone Average Temperature

But Maybe Not if You Take a Closer Look

RTU2 Temperatures - 1 Minute Sample Rate - December 7, 2001



- Control point stable at set point; Everything's just fine!
- Preheat coil discharge temperature becomes unstable
- Mixed air temperature becomes unstable
- Outdoor air temperature becomes unstable?
- Chiller plant starts are triggered!

