

## 1. Abstract

A new "Cold Fusion" device was recently demonstrated at the University of Bologna, Italy on Jan 15, 2011. Unlike the Pons and Fleischmann setup, which uses Palladium and Deuterium and can take months to perform an experiment, the Rossi/Focardi **eCAT** uses Hydrogen and Nickel, produces large amounts of power (more than 10kW), and can be turned on and off on demand.

A total of three experiments were performed : One in December 2010 by a panel of independent scientists (led by prof Levi), one in January 2011, attended by the same scientists and invited press, and one in February 2011 attended only by Levi, and for which a formal report has not been issued.

This paper attempts to prove that the Rossi/Focardi device is real, by ruling out all known fakes. For any particular fake the total energy and run-time is computed, assuming that the ENTIRE unknown volume is occupied by the fake material, and that its conversion to heat energy is 100% efficient. If the fake could run LONGER than the experiment, then it is NOT eliminated. If the fake runs out of fuel before the end of the experiment, then the fake is eliminated.

If ALL known fakes are eliminated, then the device must be real.

The December/January experiments were too short to rule out ANY of these theoretical fakes. But if Levi's informal reports on the February trial are accepted, then ALL fakes are eliminated.

## 2. Introduction

A new "[Cold Fusion](#)" or "**LENR**" (**L**ow **E**nergy **N**uclear **R**eactions) device -- the Rossi/Focardi Energy Catalyzer or **eCAT** was recently demonstrated at the University of Bologna, Italy on Jan 15, 2011: [Rossi-Focardi Energy Catalyzer](#)

An additional experiment was performed in February : [Cold Fusion: 18 hour test excludes combustion](#)

A good summary of these is given by Scott Chubb [Infinite Energy • Issue 96 • March/April 2011](#)

Cold fusion was first announced by Pons and Fleischmann in 1989, and was rapidly "debunked". But contrary to popular (and mainstream scientific) opinion, Cold Fusion was never actually disproved (see the history section.) Work has continued in a variety of private, university and government studies, with an annual *ICCF* conference, now in its 17th year. Most of the work has concentrated on the Pons and Fleischmann setup, which uses Palladium and Deuterium. It has been replicated hundreds of times, though experiments can take months to run, and require sophisticated calorimetry.

In contrast, the Rossi/Focardi **eCAT** uses Hydrogen and Nickel, produces large amounts of power (more than 10kW), and can be turned on and off on demand. Rossi plans to install a 1MW water-heating plant, made by connecting 100 10kW devices in series and parallel, in Athens, Greece, in October 2011.

Both of these **eCAT** demonstrations were primarily a "black box" calorimetry experiment. Because his patent application has not yet been approved, Rossi declines to make detailed comments on the process, or to let anyone see inside his "reactor chamber".

Villa notes in his report on the January experiment:

In the present test, as a precautionary attitude, whatever was not known, not disclosed or not understood has been considered as the energy source. This forces to consider relevant only very large energy productions, as those described in [1] where the reactor has been working for weeks and month

....

The duration of the tests would be directly proportional to the mass and volume of unknown origin. For the present set-up a convincing evidence would include a power production of (order of) 10 kW sustained for weeks in a controlled and monitorized environment.

This paper attempts to put numbers to that philosophy, by calculating UPPER BOUNDS on what any known chemical process could produce.

If it's not real, how can the experiment be faked? And if it's faked, how can we detect it, or eliminate it?

As Sherlock Holmes said in *The Adventure of the Beryl Coronet*:

"It is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth.

If all possible fakes are eliminated then the **eCat** must be real -- even though we do not know how it works. If current nuclear physics can't explain it, then the physics is wrong.

### 3. History

Cold fusion was first announced by Pons and Fleischmann in 1989, and was rapidly "debunked".

But contrary to popular (and mainstream scientific) opinion, Cold Fusion was never actually disproved.

Cravens And Letts ([The Enabling Criteria of Electrochemical Heat: Beyond Reasonable Doubt](#)) performed a statistical analysis of 167 papers, and identified 4 criteria which were satisfied in all successful experiments (including Pons and Fleischmann's original paper), and in which one or more were omitted in failed experiments -- including all the original "Debunking" papers. The most important are Lewis (Caltech) -- where NONE of these criteria were met, and Williams (Harwell), in which only ONE was met. These two papers effectively removed Cold Fusion from main stream science (and funding). Cravens And Letts point out that although ignoring these criteria almost guarantees failure, following them improves, but does not ensure success. Alchemists were well advised to include the "eye of newt" in their potions, since they did not understand which of the many steps were critical to success, and which were irrelevant. Perhaps those alchemists used better science than Lewis and Williams.

Also see Krivit: [How Can Cold Fusion Be Real, Considering It Was Disproved By Several Well-Respected Labs In 1989?](#)

Work has continued in a variety of private, university and government studies ([Experiments](#)), with an annual *ICCF* conference, now in its 17th year. Hundreds of papers have been written, some in peer-reviewed mainstream journals. ([Library](#)).

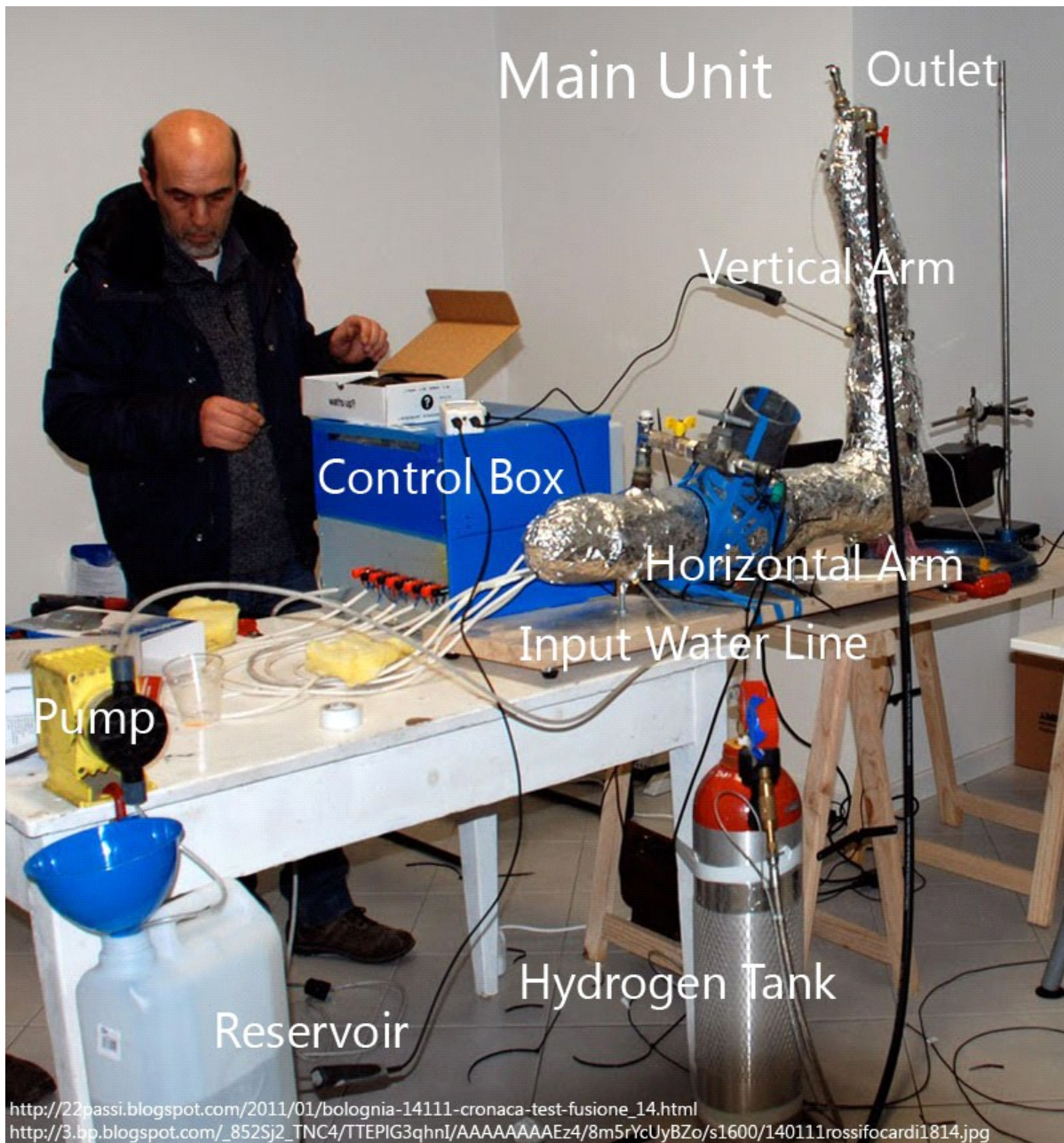
Most of the work has concentrated on the Pons and Fleischmann setup, which uses Palladium and Deuterium. It has been replicated hundreds of times. However, it has not reached 100% reproducibility. Experiments take months to "load" the deuterium into the palladium (though recent experiments with co-depositing deuterium and palladium eliminate this step), and are not guaranteed to work. (Though a set of cathodes which work in one experiment will almost always work in a different set-up). They require very subtle calorimetry over a long period, which introduces doubt into the results.

In addition to the calorimetric results, a 'CR-39' polycarbonate detector (long used by the Russians) placed next to the electrode shows clear evidence of high-energy particles (Mossier-Boss et al : [Use of CR-39 in Pd/D co-deposition experiments](#) and [Reply to a comment ... by Kowalski](#)).

The first reported work using Nickel and Hydrogen was by Francesco Piantelli (See articles by Krivit: [Deuterium and Palladium Not Required](#) and [Piantelli-Focardi Publication and Replication Path](#) ).

The Rossi/Focardi **eCat** uses Hydrogen and Nickel, produces large amounts of energy (more than 10kW), and can be turned on and off on demand.

## 4. eCAT Demonstrator Apparatus



[Image from Passerini Report](#) (January 2011)

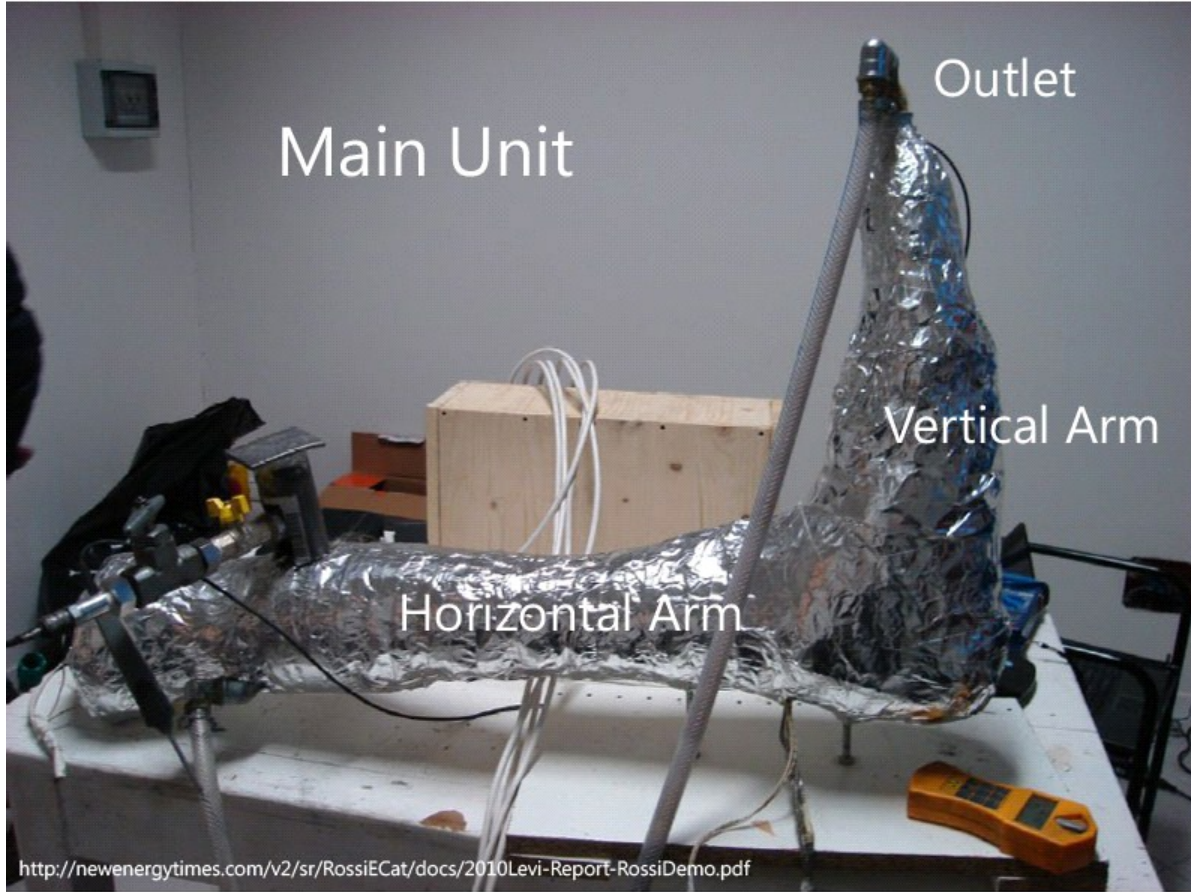


Fig.1

Image from Levi report (December 2010?).



## Operation:

- Load the reactor with hydrogen
- Apply 1 kW through the control panel until the reactor "ignites"
- Reduce the input power to 400 W (Jan) or 80 W (Feb)
- Pump water in at a measured rate and temperature
- Jan: Observe steam output, measure temperature and dryness  
OR  
Feb: Measure the water temperature at the outlet
- Accurately measure the weight of the hydrogen bottle, before and after

## 5. Experiments

### 5.1. January 2011 Experiment

In December 2010 a team of scientists was allowed to examine the device, and performed a number of experiments.

In January 2011 a "press" demonstration was held -- though the reactor developed an internal problem (reportedly on the leads to an internal heating resistor), took a long time to "ignite", and ran at lower efficiency (higher input power).

These two will be referred to as the "January" apparatus and experiment.

The things we know about the January apparatus as a whole are:

- The input power to the controller
- The input water volume and temperature
- The output steam temperature and dryness
- The amount of hydrogen used
- ESTIMATED volumes of the various elements (Villa)  
(These could be confirmed from the photographs).
- A very rough estimate of the weight of the Control Box (Levi)

Villa reported:

The basic observable elements are an horizontal metallic tube (approximate length 70 cm, diameter 20 cm, 22 l volume, 30 kg weight as a guess-estimate) as the reaction chamber, a vertical tube for steam output (50 cm length, 15 cm diameter, 9 l volume), a control system box (approx 40x40x40 cm<sup>3</sup> dimensions, 64 l volume, unknown weight), a water pump and an hydrogen bottle.

Levi reported:

Prudentially I have lifted the control box in search for any other eventually hidden cable and found none. The weight of the control box was of few Kg.

The things we do NOT know about the January apparatus include:

- The contents of the controller
- The power from the controller to the main unit
- The output steam volume
- The weights before and after, other than the hydrogen bottle
- Whether any air was taken in by the device, or combustion products released.



ASSUMING that ALL the water was converted to steam the total OUTPUT energy was computed:

- Heat water to boiling point
- Convert to steam
- Heat the steam

Given the rate of flow, the output power (kW) was calculated, and the INPUT power (kW) to the controller was subtracted.

The volume of the various elements were estimated by [Mauro Villa](#) to be:

- Control Box 60 liters
- Horizontal Arm 22 liters
- Vertical Arm 9 liters

The measured values as summarized in [LENR-CANR News](#) are:

- Duration: 1 hour, of which 30 minutes was steam-producing
- Flow Rate: 17.5 L/Hr (292 ml/min)
- Input Power : 400W
- Excess Power 12.5 kW
- Factor  $12.5/0.4 = 31$
- Excess Energy (Excess Power x Run Time): 6.25 kWh
- Hydrogen: less than 0.1 g of hydrogen was consumed.  
If the hydrogen had been burned it would have produced 0.0143 MJ (0.00397 kWh)

At the press conference Rossi announced that they have a working system providing heating in their own plant (presumably with multiple eCATS), and that he plans to install a 1MW Plant in Athens, Greece in October, 2011.

Reports:

- [Giuseppi Levi](#)
- [Mauro Villa](#)
- [Melich and Macy \(New Energy Times\)](#)    [Melich \(ed by Rothwell\)](#)    [Macy \(N.E.T.\)](#)
- [David Bianchini](#)
- [Francesco Celani](#) and [Celani \(Revised, Gamma burst\)](#)

## 5.2. February 2011 Experiment

The February trial reportedly had the same general structure, except that it was only used to HEAT water, not to convert it to steam.

The primary observer of the February run, Prof Levi, was allowed to examine everything EXCLUDING the reactor chamber, which he estimated to be about 1 liter in volume. He reported that a lot of the volume of the horizontal and vertical arms was insulation, and that lead shielding was visible around the reactor chamber.

Nyteknik.se: [Cold Fusion: 18 hour test excludes combustion](#)

"This time I opened the control unit (and examined the interior), as someone said that it could contain a hidden battery. And I can swear in court that the box was empty, except for the control electronics – five very simple PLCs – and it weighed about seven kilograms," said Levi.

"I have also seen inside the reactor device itself – most of the volume is isolation, and most of the weight of about 30 kg is due to lead."

He confirmed that the reactor chamber, supposedly containing nickel powder, the secret catalysts and hydrogen gas, had a volume of around one liter. The reactor chamber was the only part he could not inspect.

LENR-CANR: [Rossi 18-hour demonstration](#)

On February 10 and 11, 2011, Levi et al. (U. Bologna) performed another test of the Rossi device. Compared to the January 14 test, they used a much higher flow rate, to keep the cooling water from vaporizing. This is partly to recover more heat, and partly because Celani and others criticized phase-change calorimetry as too complicated. There were concerns about the enthalpy of wet steam versus dry steam, and the use of a relative humidity meter to determine how dry the steam was. A source close to the test gave Jed Rothwell the following figures. These are approximations: ....

The things we know about the February apparatus as a whole are:

- The Control Unit and all parts of the Main Unit excluding the reactor were inspected.
- The input power to the controller
- The input water volume and temperature
- The output water temperature
- The amount of hydrogen used
- ESTIMATED volume of the reactor CHAMBER is 1 liter
- ESTIMATED mass of the REACTOR (Levi reports that the mass was 30 kg)

The things we do NOT know about the February apparatus include:

- The power from the controller to the main unit
- The VOLUME of the whole REACTOR.
- The weights before and after, other than the hydrogen bottle
- Whether any air was taken in by the device, or combustion products released.

The values reported by Rothwell are:

- Run Time: 18 hours
- Flow Rate: 3,000 L/h = ~833 ml/s.
- Cooling water input temperature: 15°C
- Cooling water output temperature: ~20°C
- Input power from control electronics: variable, average 80 W, closer to 20 W for 6 hours
- Excess Power 16 kW
- Factor 16/0.08 = 200
- Excess Energy (Excess Power x Run Time): **288 kWh**
- Hydrogen: less than 0.4 g of hydrogen was consumed.  
If the hydrogen had been burned it would have produced **0.0572 MJ (0.0159 kWh)**

However, some of the values reported in Nyteknik are significantly different (and in favor of Rossi's **eCAT**):

"Minimum power was 15 kilowatts, and that's a conservative value. I calculated it several times. At night we did a measurement and the device then worked very stable and produced 20 kilowatts."

Initially, the temperature of the inflowing water was **seven** degrees Celsius and for a while the outlet temperature was **40** degrees Celsius. A flow rate of about one liter per second, equates to a peak power of 130 kilowatts. The power output was later stabilized at 15 to 20 kilowatts.

Note : Levi has not released a report of this experiment, and Rossi has declined to comment on it.

This paper uses Rothwell's numbers.

## 5.3. Recent Events

Rossi continues to provide a trickle of information (some of it conflicting with previous statements) on his blog [JANUARY 15th FOCARDI AND ROSSI PRESS CONFERENCE](#)

For instance, he now [now indicates that](#) it is not the ELECTRICAL power which modulates the output, but the HYDROGEN:

Our plants of 1 MW are made with series and parallels of 10 kW modules. Our 10 kW modules have been tested from 2 years and we have a deep knowledge of them. If the temperature or the pressure inside the apparatus goes critic we cut the hydrogen supply and cool down the E-Cat increasing the flow of water as much as necessary. Consider that we do not use radioactive materials and we do not produce rad waste, that a single module has a volume of about 1 liter and is very easy to cool down with water. Every module is controlled independently from the others and if one module has to be stopped the others can work.

Through a live interview with NyTeknik Rossi answered a number of questions : [E-cat inventor in live chat with the readers \(+ Video Interview\)](#) and [And here are 36 more questions – with Rossi's answers](#) -- though many of these were not technical in nature.

He recently appeared on a US Radio Program : [Andrea Rossi with Sterling Allan on Coast to Coast AM](#)

There is some evidence that the Hydrogen/Nickel reaction can become self-sustaining, so the ratio of output to input electrical power would become infinite.

Since the February experiment was reported, Rossi has reportedly PAID the University of Bologna E500,000 to investigate and develop the eCat device, and presumably under a non-disclosure agreement: [This is how Rossi is financing his E-cat](#) (this Nyteknik article also gives some background on Rossi). Another Nyteknik interview explores the manufacturing : [Cold Fusion: Here's the Greek company building 1 MW](#)

Rossi has stated that NO experimental results will be published for at least a year.

Since many of the original independent observers are now presumed to be under contract to Rossi, some might question their future impartiality. However, as [Levi noted](#):

“If I were an old professor with his career already done, then I would not have anything to risk. But any attempt at fraud on my part would be a terrible personal goal. What could I hope for? To have a title for ten days, and then be thrown from my own department. Because (the matter of) fraud comes up sooner or later. There is no hope for it. So if I ... well, I would be really stupid. Honestly, I would be really stupid!”

## 6. Methodology for FAKE eCATS and their Detection

As Villa reported:

In the present test, as a precautionary attitude, whatever was not known, not disclosed or not understood has been considered as the energy source.

....

The duration of the tests would be directly proportional to the mass and volume of unknown origin.

The general methodology for Batteries and Chemicals is:

- Choose some kind of FAKE (eg batteries)
- Presume that the ENTIRE unknown structure is made up of the Fake material.
- Make NO allowances for implementation efficiency.
- Make NO allowance for practicality (the material or combustion products might be fatally toxic: the required equipment would be impossibly small).
- Use the energy density (by weight or by volume) to determine the MAXIMUM energy content of the fake.
- Using the observed excess POWER (kW) of the system, determine how long you would have to run it to exhaust the energy.
- If that time is LESS than the observed run time, then the FAKE is eliminated.

Some kinds of fake could also be detected by analyzing the output:

- Analyze the chemical composition of the output, to make sure no 'combustion' products are hidden
- Make sure that all the water which goes IN goes OUT
- Weigh the device before and after, to see whether chemicals have been consumed, or combustion products stored

... but see *Rothwell's Razor*, below.

Rothwell [argues](#) that some kinds of fakes would have been NOTICED by the observers (For example, if Diesel fuel were burned, there would be copious, fatally asphyxiating fumes --- though in the January experiment they could theoretically have been piped out of the room in the steam pipe.). However, this paper takes an extremely conservative position, distinguishing between "not NOTICED" and "tested and NOT FOUND":

- Anything which is not TESTED must be ruled in favor of the FAKE.

If both the Volume AND the weight are known, then calculate the maximum run time for both, and use the LOWER number.

These calculations assume that the experiment is run at constant power for the duration of the experiment, although during the February test there were reports that it produced 130 kW for short periods. In this case one would compare the total energy output of the fake and the measured values : it is not as easy to predict the time required to eliminate the fake.

If all fakes are eliminated, then, As Sherlock Holmes said -- again and again -- this time in *The Sign of the Four*:

"You will not apply my precept," he said, shaking his head. "How often have I said to you that when you have eliminated the impossible whatever remains, however improbable, must be the truth?"

## 7. Organization

First, we define the Equipment Sections, giving the weight and volume.

Section	Abrev	Mass	Volume
		kg	L
Section Name 1	SEC-1	11.000	12.000
Section Name 2	SEC-2	21.000	22.000
Section Name 3	SEC-3	31.000	32.000

Then we define various "Fake Materials" which could be used.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Material 1	MAT-1	12.300	3.417	45.600	12.667	

Finally, we construct "Experiments", in which we put various materials in the sections of the unit (presently fixed at three sections), note the *POWER* that the experiment produced, and the *TIME* it ran for.

We calculate and add up the total *ENERGY* that the sections could contain, and calculate how long the *FAKE* could run at the observed *POWER* level.

If the *FAKE* could run *LONGER* than the actual experiment, then it is *NOT* eliminated.

If the *FAKE* only runs *SHORTER* than the actual experiment, then it is *ELIMINATED*.

Experiment 1 : All sections contain MAT-1							
Section	SEC-1	SEC-2	SEC-3	Fake Energy	Expt Power	FAKE?	
Material	MAT-1	MAT-1	MAT-1			Fake	Expt
Energy	152 kWH	279 kWH	405 kWH	836 kWH	10.0 kW	83.6 Hrs	0.500 Hrs
Fake can run longer than the experiment: fake is NOT eliminated							

Experiment 2 : Only SEC-2 contain MAT-1							
Section	SEC-1	SEC-2	SEC-3	Fake Energy	Expt Power	REAL	
Material	-	MAT-1	-			Fake	Expt
Energy		279 kWH		279 kWH	16.0 kW	17.4 Hrs	18.0 Hrs
Fake cannot run as long as the experiment -- Fake is eliminated							

## 8. Equipment Sections

### 8.1. Control Box

Villa reported the volume as 60 liters.

In January Levi reported its weight as "a few kg".

In February Levi looked inside the control box, and reports its weight as 7 kg

Section	Abrev	Mass	Volume
		kg	L
Control Box	Ctrl	7.000	60.000

### 8.2. Horizontal Arm

The weight is unknown -- estimated by Villa as 30 kg

Villa reported the volume as 22 liters.

Levi reported in February that much of the volume is insulation.

Section	Abrev	Mass	Volume
		kg	L
Horizontal Arm	Horz	-	22.000

### 8.3. Vertical Arm

The weight is unknown.

Villa reported the volume as 9 liters.

Levi reported in February that there are no hidden components.

Section	Abrev	Mass	Volume
		kg	L
Vertical Arm	Vert	-	9.000

### 8.4. Reactor

In February Levi reported:

- The mass of the reactor is 30 kg, and that most of that is lead.
- The volume of the Reactor *CHAMBER* is 1 liter, but did not give not the volume of the *REACTOR* as a whole.

Pending further information, this paper *ASSUMES* that the volume of the reactor as a whole is *HALF* the volume of the Horizontal Arm

Section	Abrev	Mass	Volume
		kg	L
Reactor	React	30.000	11.000
Reactor Chamber	Chamber	-	1.000



## 9. Batteries and Chemicals

This section describes various techniques and materials which could be possibly used to construct a fake.

The materials are selected from Wikipedia [Energy Density](#)  
(Unfortunately not all entries give the Energy by volume AND by weight.)

The Wiki table gives the Energy Density for some materials, assuming that oxygen is obtained from an external source. If the oxidant also has to be stored, then the Energy Density is reduced in proportion to the mass or volume of the two components. These calculations are shown in a separate section.

The materials selected represent the highest efficiency for any class.

These all have the characteristic that they contain a fixed amount of energy, and can therefore only run for a limited time. A fake made from batteries or chemicals simply has to be run for long enough to exhaust the material.

Batteries could be contained in the Control Box, and in the Main Unit.

### 9.1. Lithium Ion Batteries

Lithium-Ion batteries are listed as the most efficient by volume.

(Lead-Acid batteries are listed for comparison.)

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Lead-Acid Batteries	Lead B	0.140	0.039	0.360	0.100	
Lithium-Ion Batteries	L-i B	0.720	0.200	3.600	1.000	

Lithium-Sodium batteries are listed as a higher Energy Density by Mass -- but the volume is not given.

## 9.2. Hydrogen Fuel Cell

This method uses a Hydrogen Fuel Cell, which could deliver electric power from the Control Box to the Main Unit.

It could use compressed or liquid Hydrogen, in conjunction with external air, compressed Oxygen or liquid oxygen.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Compressed Hydrogen/External Air Fuel Cell	CH/Air-FC	143.000	39.723	5.600	1.556	
Liquid Hydrogen/External Air Fuel Cell	LH/Air-FC	143.000	39.723	10.100	2.806	
Compressed Hydrogen/Compressed Oxygen Fuel Cell	CH/CO-FC	15.990	4.442	3.734	1.037	
Liquid Hydrogen/Liquid Oxygen Fuel Cell	LH/LO-FC	15.990	4.442	3.748	1.041	

Comments : the by-product is water, which could be vented, or, if burned with oxygen, condensed and stored.

## 9.3. Hydrogen burned with Air or Oxygen

This could be used in the main unit only.

This method burns compressed or liquid Hydrogen with external air, compressed Oxygen or Liquid Oxygen

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Compressed Hydrogen/External Air	CH/Air	143.000	39.723	5.600	1.556	
Liquid Hydrogen/External Air	LH/Air	143.000	39.723	10.100	2.806	
Compressed Hydrogen/Compressed Oxygen	CH/CO	15.990	4.442	3.734	1.037	
Liquid Hydrogen/Liquid Oxygen	LH/LO	15.990	4.442	3.748	1.041	

Comments : the by-product is water, which could be vented into the outlet, or, if burned with oxygen, condensed and stored.

## 9.4. Diesel burned with Air

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Diesel/Air	Dsl/Air	46.200	12.833	37.300	10.361	

The Wiki Energy density table indicates that diesel has a slightly higher energy content than gasoline.

Diesel or Gasoline would produce large quantities of fumes, which would be very hard to hide from observers. It might be possible to vent it into the steam outlet.

## 9.5. Boron burned with Air or Oxygen

This method uses Boron, burned with external air, compressed Oxygen or Liquid Oxygen, forming solid Boron Trioxide, which can remain in the unit.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Boron/External Air	B/Air	58.900	16.361	137.800	38.278	
Boron/Compressed Oxygen	B/CO	18.293	5.081	16.131	4.481	
Boron/Liquid Oxygen	B/LO	18.293	5.081	23.345	6.485	

Boron is hard to ignite in air. Even in Oxygen it has to be raised to a high temperature. It is not clear whether non-toxic, glassy Boron Trioxide is formed by burning, or whether toxic BO and BO<sub>2</sub> compounds are formed.

It might only be feasible to burn powdered Boron : we assume that solid Boron is used.

## 9.6. Aluminum burned with Air or Oxygen

This method uses Aluminum, burned with external air, compressed Oxygen or Liquid Oxygen, forming oxides, which can remain in the unit.

Aluminum is easier to ignite than Boron.

Its energy density is less than Boron, so it would be easier to detect. As with Boron, it might only burn in powdered form.

## 9.7. Beryllium burned with Air or Oxygen

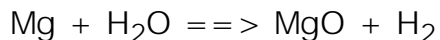
This method uses Beryllium, burned with external air, compressed Oxygen or Liquid Oxygen, forming oxides, which can remain in the unit.

Beryllium is easier to ignite than Boron, but both Beryllium and its combustion products are extremely toxic.

## 9.8. Magnesium and Steam

### [Reactions of Metals and Water](#)

Magnesium combines with STEAM to produce Magnesium Oxide and Hydrogen.



The hydrogen can then be burned with Air or Oxygen to produce water.

An initial amount of water can be boiled using the internal resistors, and then the resultant steam can be recycled.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Magnesium/Steam	Mg/Steam	24.884	6.912	43.248	12.013	

## 9.9. Explosives

One might expect that Explosives would contain a lot of energy. In fact, most of them do not. For instance, Nitroglycerine only contains 10 MJ/L, compared to Boron/External Air, which has 138 MJ/L. They just release their energy very quickly.

## 9.10. Compressed or Liquid Hydrogen and Oxygen

These ABSORB energy when decompressed or evaporated. It is presumed that this is obtained from the ambient air.

## 9.11. Previously Unknown Chemical Reactions

Rossi has indicated that the reactor chamber has to be re-charged every six months.

A chemical reaction which can produce 10kW for 18 hours (let alone 6 months) would be as big a break-through in Chemistry as a LENR device would be in Physics.

## 9.12. Other suggested fakes (Pending analysis)

This section lists fakes which have been suggested by readers, but which have not yet been evaluated.

- Krzysztof Dydak : The reactor could contain Raney Nickel/air fuel cell fed with hydrazine dissolved in water with caustic.

# 10. Other Fixed-Energy Methods

## 10.1. Pre-loaded Heat Sink

Proposed By : Rothwell ([Rossi credibility](#))

The entire volume is composed of a material with high specific heat.

See [Heat capacity](#), which has an entry for Volumetric Heat Capacity  $J \cdot cm^{-3} \cdot K^{-1}$

Material	Specific Heat	Maximum Temperature	Minimum Temperature	MJ/Liter	Comments
Water	4.21	100	14	0.36206	Boils
Be	3.38	1287	14	4.30274	Melts. Poisonous
Iron	3.53	1538	14	5.37972	Melts
Lead	1.44	327.46	14	0.4513824	Melts

Beryllium and Iron are selected for their high specific heat values. Water and lead are included because they are known to be constituents of the main unit.

These values are loaded into a material table:

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
SPH Water	SPH Water	-	-	0.362	0.101	
SPH Be	SPH Be	-	-	4.303	1.195	
SPH Iron	SPH Iron	-	-	5.380	1.494	
SPH Lead	SPH Lead	-	-	0.451	0.125	

Note that the heat capacity might also explain "heat after death", when the output power continues after the inputs are turned off.

This fake must be entirely contained in the main body of the apparatus.

The upper temperatures are set to the boiling point of water, or for other materials, their melting point.

## 10.2. Input Water Diversion

Proposed by : Rothwell

The water which is pumped INTO the system is NOT all sent into the heat exchanger, but some is diverted into storage.

For example, if the observed output power is 10 times the input power, and only 1/10 the water is converted to steam then the apparent output will be FAKE. It can run until the diverted 9/10 of the water fills the reservoir.

As an UPPER limit, presume that the ENTIRE flow is diverted.

Maximum run time = volume / flow\_rate

	Sections	Volume (liters)	Flow (liters/hr)	Time to Fill (Hrs)
Jan	Horz and Vert	31.00	17.50	1.77
Feb	Horz	22.00	3000.00	0.01

# 11. Unlimited-Energy Methods

These have the characteristic that they can run for an unlimited time.

Instead of calculating how long they could run, one has to calculate what is needed to produce the observed power.

## 11.1. Hidden Wires or Tubes

It has been suggested that hidden wires could have provided the observed power (Rothwell: [Hidden wire hypothesis redux](#)). This can only be eliminated by inspecting the apparatus.

Similarly, a small tube could supply gas to the unit (Rothwell: [Vortex List](#)) --- although other methods might detect this (change of weight, imbalance between input and output volumes).

The January experiment was fully open to inspection. There were clearly no hidden wires capable of carrying 10kW or any tubes.

## 11.2. Heat Pump

*KitemanSA* [on the polywell forum](#). suggested that a [heat pump](#) could have provided the observed power.

If these numbers are true, then even with a perfect **heat pump**, the output power (given max Coefficient of Performance and 80W input) could only be ~4.6kW.

$$\text{CoP} \sim T/\Delta T \sim 300/5 = 60$$
$$60 * 80 = 4800 = 4.6\text{kW}$$

So unless there is significant measurement error or fraud, this isn't a **heat pump** device either.

Actually...

if the room was at typical room temperature, which is ~21 °C, the theoretical CoP would be infinite, so it COULD be a fancy heat pump.

The Wiki article indicates that the maximum CoP in a Carnot Cycle might be as low as 12.5

The January experiment would have needed a CoP of 31, and the February experiment would need 200.

A theoretical, infinite-CoP heat pump could probably only be ruled out by enclosing the entire Main Unit in a calorimeter. If this were filled with Nitrogen, it would also rule out any method using Air as a fuel.



### 11.3. Nuclear : Plutonium 238

One gram of [Plutonium 238](#) generates approximately 0.5 watts of power.

Material	Abrev	Power by Mass kW/kg	Power by Volume kW/L	Specific gravity
Plutonium 238	Pu238	0.500	0.000	0.000

To produce 10 kW of power one would need 5.00 kg of Pu 238.

Since 1993, all of the plutonium-238 the U.S. has used in space probes has been purchased from Russia. 16.5 kilograms in total have been purchased.

For the proposed 1 MW unit, one needs 500.00 kg -- more than was acquired by NASA.

Note : the Wiki Energy Density value is very high : it is probably the total energy emitted until the Plutonium is effectively depleted.

## 12. Experiments -- FAKES by VOLUME

For each type of fake, various "experiments" are defined, with individual sections loaded with fake materials.

For each combination of materials, five experiments are evaluated:

- The January Power and Duration, with ALL sections, including the Control Box, filled with fake material
- The January Power and Duration, with the Main Unit filled with fake material. Levi's statement that the control box "weighed a few kg" and therefore cannot contain fake material, is accepted.
- The February Power and Duration, with the Horizontal Arm filled with fake material. Levi's statements about the control box and the vertical arm are accepted.
- The February Power and Duration, with an ESTIMATE of the volume of the whole reactor.
- The February Power and Duration, with Levi's description of the volume of the reactor CHAMBER..

# 12.1. Lithium Ion Batteries

Control Box: Lithium-Ion Batteries Main Unit: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	L-i B	L-i B	L-i B			Fake	Expt
Energy	60.0 kWH	22.0 kWH	9.00 kWH	91.0 kWH	10.0 kW	9.10 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	L-i B	L-i B			Fake	Expt
Energy		22.0 kWH	9.00 kWH	31.0 kWH	10.0 kW	3.10 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		22.0 kWH		22.0 kWH	16.0 kW	1.38 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Lithium-Ion Batteries							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		11.0 kWH		11.0 kWH	16.0 kW	0.688 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Lithium-Ion Batteries							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		1.00 kWH		1.00 kWH	16.0 kW	0.0625 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.2. Hydrogen

Controller contains a Hydrogen Fuel Cell, Main unit burns Hydrogen.

Liquid Hydrogen and external Air are the most favorable for a fake.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	LH/Air	LH/Air			Fake	Expt
Energy	168 kWh	61.7 kWh	25.3 kWh	255 kWh	10.0 kW	25.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	LH/Air	LH/Air			Fake	Expt
Energy		61.7 kWh	25.3 kWh	87.0 kWh	10.0 kW	8.70 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		61.7 kWh		61.7 kWh	16.0 kW	3.86 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Liquid Hydrogen/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		30.9 kWh		30.9 kWh	16.0 kW	1.93 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Liquid Hydrogen/External Air							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		2.81 kWh		2.81 kWh	16.0 kW	0.175 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Control Box: Compressed Hydrogen/External Air Fuel Cell Main Unit: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	CH/Air-FC	CH/Air	CH/Air			Fake	Expt
Energy	93.3 kWh	34.2 kWh	14.0 kWh	142 kWh	10.0 kW	14.2 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	CH/Air	CH/Air			Fake	Expt
Energy		34.2 kWh	14.0 kWh	48.2 kWh	10.0 kW	4.82 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		34.2 kWh		34.2 kWh	16.0 kW	2.14 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Compressed Hydrogen/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		17.1 kWh		17.1 kWh	16.0 kW	1.07 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Compressed Hydrogen/External Air							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		1.56 kWh		1.56 kWh	16.0 kW	0.0972 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Control Box: Compressed Hydrogen/Compressed Oxygen Fuel Cell Main Unit: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	CH/CO-FC	CH/CO	CH/CO			Fake	Expt
Energy	62.2 kWh	22.8 kWh	9.34 kWh	94.4 kWh	10.0 kW	9.44 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	CH/CO	CH/CO			Fake	Expt
Energy		22.8 kWh	9.34 kWh	32.2 kWh	10.0 kW	3.22 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		22.8 kWh		22.8 kWh	16.0 kW	1.43 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		11.4 kWh		11.4 kWh	16.0 kW	0.713 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		1.04 kWh		1.04 kWh	16.0 kW	0.0648 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## Liquid Hydrogen, Liquid Oxygen

### Control Box: Liquid Hydrogen/Liquid Oxygen Fuel Cell Main Unit: Liquid Hydrogen/Liquid Oxygen

<b>Section</b>	Ctrl	Horz	Vert	<b>Fake Energy</b>	<b>Expt Power</b>	FAKE?	
<b>Material</b>	LH/LO-FC	LH/LO	LH/LO			<b>Fake</b>	<b>Expt</b>
<b>Energy</b>	62.5 kWh	22.9 kWh	9.37 kWh	94.7 kWh	10.0 kW	9.47 Hrs	0.500 Hrs

January with ALL sections

### Main Unit: Liquid Hydrogen/Liquid Oxygen

<b>Section</b>	Ctrl	Horz	Vert	<b>Fake Energy</b>	<b>Expt Power</b>	FAKE?	
<b>Material</b>	-	LH/LO	LH/LO			<b>Fake</b>	<b>Expt</b>
<b>Energy</b>		22.9 kWh	9.37 kWh	32.3 kWh	10.0 kW	3.23 Hrs	0.500 Hrs

January with MAIN unit - - excluding Control Box

### Horizontal Arm: Liquid Hydrogen/Liquid Oxygen

<b>Section</b>	Ctrl	Horz	Vert	<b>Fake Energy</b>	<b>Expt Power</b>	REAL	
<b>Material</b>	-	LH/LO	-			<b>Fake</b>	<b>Expt</b>
<b>Energy</b>		22.9 kWh		22.9 kWh	16.0 kW	1.43 Hrs	18.0 Hrs

February with HORIZONTAL unit

### Reactor: Liquid Hydrogen/Liquid Oxygen

<b>Section</b>	Ctrl	React	Vert	<b>Fake Energy</b>	<b>Expt Power</b>	REAL	
<b>Material</b>	-	LH/LO	-			<b>Fake</b>	<b>Expt</b>
<b>Energy</b>		11.5 kWh		11.5 kWh	16.0 kW	0.716 Hrs	18.0 Hrs

February with ESTIMATED reactor volume

### Reactor chamber: Liquid Hydrogen/Liquid Oxygen

<b>Section</b>	Ctrl	Chamber	Vert	<b>Fake Energy</b>	<b>Expt Power</b>	REAL	
<b>Material</b>	-	LH/LO	-			<b>Fake</b>	<b>Expt</b>
<b>Energy</b>		1.04 kWh		1.04 kWh	16.0 kW	0.0651 Hrs	18.0 Hrs

February with reactor CHAMBER volume

**FAKE?** means that the fake could run longer than the experiment, and is NOT eliminated  
**REAL** means that the fake is ELIMINATED by an experiment, so the device could be REAL

## 12.3. Diesel Fuel

Controller contains a Hydrogen Fuel Cell, Main unit burns Diesel.

For both, external Air is the most favorable for a fake.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	Dsl/Air	Dsl/Air			Fake	Expt
Energy	168 kWh	228 kWh	93.3 kWh	490 kWh	10.0 kW	49.0 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	Dsl/Air	Dsl/Air			Fake	Expt
Energy		228 kWh	93.3 kWh	321 kWh	10.0 kW	32.1 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		228 kWh		228 kWh	16.0 kW	14.2 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Diesel/Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		114 kWh		114 kWh	16.0 kW	7.12 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Diesel/Air							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		10.4 kWh		10.4 kWh	16.0 kW	0.648 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							



## 12.4. Boron and Air or Oxygen

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Air.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/Air	B/Air			Fake	Expt
Energy	168 kWh	842 kWh	345 kWh	1355 kWh	10.0 kW	135 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	B/Air			Fake	Expt
Energy		842 kWh	345 kWh	1187 kWh	10.0 kW	119 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	-			Fake	Expt
Energy		842 kWh		842 kWh	16.0 kW	52.6 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	-			Fake	Expt
Energy		421 kWh		421 kWh	16.0 kW	26.3 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Boron/External Air							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/Air	-			Fake	Expt
Energy		38.3 kWh		38.3 kWh	16.0 kW	2.39 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Compressed Oxygen.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/CO	B/CO			Fake	Expt
Energy	168 kWh	98.6 kWh	40.3 kWh	307 kWh	10.0 kW	30.7 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/CO	B/CO			Fake	Expt
Energy		98.6 kWh	40.3 kWh	139 kWh	10.0 kW	13.9 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		98.6 kWh		98.6 kWh	16.0 kW	6.16 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/Compressed Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		49.3 kWh		49.3 kWh	16.0 kW	3.08 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Boron/Compressed Oxygen							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		4.48 kWh		4.48 kWh	16.0 kW	0.280 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Liquid Oxygen.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/LO	B/LO			Fake	Expt
Energy	168 kWh	143 kWh	58.4 kWh	369 kWh	10.0 kW	36.9 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/LO	B/LO			Fake	Expt
Energy		143 kWh	58.4 kWh	201 kWh	10.0 kW	20.1 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		143 kWh		143 kWh	16.0 kW	8.92 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/Liquid Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		71.3 kWh		71.3 kWh	16.0 kW	4.46 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Boron/Liquid Oxygen							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		6.48 kWh		6.48 kWh	16.0 kW	0.405 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.5. Magnesium and Steam

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Magnesium in Steam, producing Hydrogen, which is burned with external Air.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	Mg/Steam	Mg/Steam			Fake	Expt
Energy	168 kWh	264 kWh	108 kWh	541 kWh	10.0 kW	54.1 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	Mg/Steam	Mg/Steam			Fake	Expt
Energy		264 kWh	108 kWh	372 kWh	10.0 kW	37.2 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		264 kWh		264 kWh	16.0 kW	16.5 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Magnesium/Steam							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		132 kWh		132 kWh	16.0 kW	8.26 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: Magnesium/Steam							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		12.0 kWh		12.0 kWh	16.0 kW	0.751 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.6. Water Heat Sink

The entire volume of the main unit is a water heat sink. Note that this cannot BOIL the water for the January experiment.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Water	SPH Water			Fake	Expt
Energy	168 kWh	2.21 kWh	0.905 kWh	171 kWh	10.0 kW	17.1 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	SPH Water			Fake	Expt
Energy		2.21 kWh	0.905 kWh	3.12 kWh	10.0 kW	0.312 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		2.21 kWh		2.21 kWh	16.0 kW	0.138 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Water							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		1.11 kWh		1.11 kWh	16.0 kW	0.0691 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: SPH Water							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		0.101 kWh		0.101 kWh	16.0 kW	0.00629 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.7. Beryllium Heat Sink

The entire volume of the main unit is a Beryllium Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Be	SPH Be			Fake	Expt
Energy	168 kWh	26.3 kWh	10.8 kWh	205 kWh	10.0 kW	20.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	SPH Be	SPH Be			Fake	Expt
Energy		26.3 kWh	10.8 kWh	37.1 kWh	10.0 kW	3.71 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		26.3 kWh		26.3 kWh	16.0 kW	1.64 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Be							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		13.1 kWh		13.1 kWh	16.0 kW	0.822 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: SPH Be							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		1.20 kWh		1.20 kWh	16.0 kW	0.0747 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.8. Iron Heat Sink

The entire volume of the main unit is an Iron Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Iron	SPH Iron			Fake	Expt
Energy	168 kWh	32.9 kWh	13.4 kWh	215 kWh	10.0 kW	21.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	SPH Iron	SPH Iron			Fake	Expt
Energy		32.9 kWh	13.4 kWh	46.3 kWh	10.0 kW	4.63 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		32.9 kWh		32.9 kWh	16.0 kW	2.05 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Iron							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		16.4 kWh		16.4 kWh	16.0 kW	1.03 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: SPH Iron							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		1.49 kWh		1.49 kWh	16.0 kW	0.0934 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 12.9. Lead Heat Sink

The entire volume of the main unit is an Lead Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Lead	SPH Lead			Fake	Expt
Energy	168 kWh	2.76 kWh	1.13 kWh	172 kWh	10.0 kW	17.2 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	SPH Lead			Fake	Expt
Energy		2.76 kWh	1.13 kWh	3.89 kWh	10.0 kW	0.389 Hrs	0.500 Hrs
January with MAIN unit - - excluding Control Box							
Horizontal Arm: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		2.76 kWh		2.76 kWh	16.0 kW	0.172 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Lead							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		1.38 kWh		1.38 kWh	16.0 kW	0.0862 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Reactor chamber: SPH Lead							
Section	Ctrl	Chamber	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		0.125 kWh		0.125 kWh	16.0 kW	0.00784 Hrs	18.0 Hrs
February with reactor CHAMBER volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							



### 13. Experiments -- FAKES by WEIGHT

At present we have no independent measurements of the weight of the various parts of the *eCat*.

### 14. Rothwell's Razor

This is a variation of (the usually misquoted) [Occam's razor - Wikipedia, the free encyclopedia](#)

... the razor is a principle that suggests we should tend towards simpler theories ... until we can trade some simplicity for increased explanatory power. Contrary to the popular summary, the simplest available theory is sometimes a less accurate explanation.

It is very tempting to propose elaborate schemes by which a fake *eCat* could be detected. For instance, in the author's physorg.com posts he suggested feeding it a brew of various isotopes of water to make sure that the SAME water goes in and comes out.

However, in the [Vortex](#) mailing list [Re: \[Vo\]:Hidden wire hypothesis redux](#)

Jed Rothwell suggests in response to another comment:

This is my point, there may be a million things you haven't thought of.

Nope. That does not work. A good experiment cannot have a million possible problems. If we had to think up a million ways that an experiment might be wrong (or fake -- pretty much the same thing) then no experiment would ever prove anything, and there would be no progress.

A bad experiment can have a large number of possible errors (or ways to make it fake).

....

Flow calorimetry experiments similar to this, with boiling water or flowing water, have been done many times. The potential errors are well understood and their number is strictly limited -- unless you are aiming for the kind of precision SRI achieved.

In an experiment with only 4 main parameters -- input power, inlet temperature, outlet temperature and flow rate -- the number of potential significant errors will [be] small, and so will the number of ways deliberately fake data can be surreptitiously introduced. When the method is complicated, and the results close to the margin, with many parameters with, for example, the possibility of recombination producing a significant error, then there are many ways an error can creep in, and many ways to deliberately introduce fake data.

Complexity and a low s/n ratio invite error, misinterpretation or fraud.

## 15. Conclusion

Since the December/January experiments only recorded the inputs and outputs for a short time (30 minutes), almost ANY of the fakes could have produced the result.

For the February experiment Levi was allowed to inspect everything, EXCLUDING only the 1-liter reactor chamber.

Neither the January or February experiments can rule out a Heat Pump which exceeds known efficiencies by a factor of 100 (or even higher, if the 130kW peak output could be sustained). An **eCat** doing this would be as important an engineering breakthrough as an **LENR** device. Similarly, a previously-unknown chemical reaction which can produce 10kW for 6 months from a 1 liter source would be an equally important discovery in chemistry. As Sherlock Holmes said in *Silver Blaze*:

... and improbable as it is, all other explanations are more improbable still.

The "Proof" that the device is real currently rests on Levi's informal description: if you accept all of Levi's February report, then all fakes are conclusively ruled out. Or as Sherlock Holmes repeatedly said (in *The Adventure of the Bruce-Partington Plans*):

"We must fall back upon the old axiom that when all other contingencies fail, whatever remains, however improbable, must be the truth. Here all other contingencies have failed.

## 16. Discussion

This paper considers **UPPER BOUNDS** for what a Fake could achieve.

Any actual fake would run into engineering difficulties long before those limits were reached.

When designing a machine for propulsion or for electricity, thermodynamics is your enemy. The heat of friction, for instance, robs your output. But if your machine is simply heating water, then thermodynamics is your friend, or at least neutral.

But the limits of thermal efficiency are not THAT far off 100% : for instance, modern gas furnaces have an efficiency of over 95% ([Furnaces and Boilers](#)). Nor is the assumption that 100% of the weight or volume is fuel : advanced rockets such as the [Proton UR-500](#) have a 95.6% fuel-to-dry-weight factor.

So any discussion of "implementation" is quibbling over less than 5%!

Because of the difficulty of measuring the results with steam (volume and content), future experiments should be used to heat the water (as in the February experiment). For this we need:

- Input electrical power (BETWEEN the control panel and the reactor)
- Input hydrogen (by weight)
- Inlet temperature
- Outlet temperature
- Water volume
- Total weight before
- Total weight after
- Heat pump requires an air calorimeter round the main unit
- Sealed unit, to prevent drawing air as a fuel (calorimeter filled with Nitrogen)  
OR  
Thorough inspection to check for leaks

As much as possible of the unit should be open to inspection to reduce the volumes (or weights) in which fake material could be hidden, and thus shorten the time needed to eliminate fakes.

# 17. Calculations

## 17.1. Wiki Energy Densities

The Wiki of Energy Densities doesn't have entries for all cases where (for instance) Hydrogen is used with Compressed or Liquid Oxygen.

This section calculates how much the "wiki" Energy Densities by Mass and by Volume are reduced if the available space has to be shared between the Hydrogen and Oxygen.

## 17.2. Reference Documents

[Wiki : Hydrogen](#) \*\*\*

[Wiki: Oxygen](#) \*\*\*

[Amount of Substance](#)

[Molar Volume](#)

[Molar Mass](#) g/mol

[Periodic Table with Properties](#)

[Liquid Hydrogen](#)

[Hydrogen](#)

[Oxygen Storage](#)

[Hydrogen/LOX storage](#)

## 17.3. Atoms and Molecules

H	mass	1.0071		
H2	mass	2.0142		
	Gas		Density :	8.988E-5 kg/L
	Compressed		Density :	0.046647636700649 kg/L (700 Bar)
	Liquid		Density :	0.07099 kg/L
O	mass	15.999		
O2	mass	31.998		
	Gas		Density :	0.001429 kg/L
	Compressed		Density :	0.74164967562558 kg/L (700 Bar)
	Liquid		Density :	1.141 kg/L
B	mass	10.811		
	Solid		Density :	2.52 kg/L

## 17.4. Compressed hydrogen + Compressed Oxygen

Formula:  $2 \text{H}_2 + \text{O}_2 \implies 2 \text{H}_2\text{O}$   
H<sub>2</sub> (Compressed H2)  
O<sub>2</sub> (Compressed O2)  
H<sub>2</sub> mass :  $2 * 2.0142 = 4.0284$   
O<sub>2</sub> mass :  $1 * 31.998 = 31.998$   
Total mass :  $36.0264$   
H<sub>2</sub> mass fac :  $4.0284 / 36.0264 = 0.11181800013324$   
O<sub>2</sub> mass fac :  $31.998 / 36.0264 = 0.88818199986676$   
Volume : mass / density  
H<sub>2</sub> volume :  $4.0284 / 0.046647636700649 = 86.35807266832$   
O<sub>2</sub> volume :  $31.998 / 0.74164967562558 = 43.144359192242$   
Total vol :  $129.50243186056$   
H<sub>2</sub> vol fac :  $86.35807266832/129.50243186056 = 0.66684518141948$   
O<sub>2</sub> vol fac :  $43.144359192242/129.50243186056 = 0.33315481858052$

## 17.5. Liquid hydrogen + Liquid Oxygen

Formula:  $2 \text{H}_2 + \text{O}_2 \implies 2 \text{H}_2\text{O}$   
H<sub>2</sub> (Liquid H2)  
O<sub>2</sub> (Liquid O2)  
H<sub>2</sub> mass :  $2 * 2.0142 = 4.0284$   
O<sub>2</sub> mass :  $1 * 31.998 = 31.998$   
Total mass :  $36.0264$   
H<sub>2</sub> mass fac :  $4.0284 / 36.0264 = 0.11181800013324$   
O<sub>2</sub> mass fac :  $31.998 / 36.0264 = 0.88818199986676$   
Volume : mass / density  
H<sub>2</sub> volume :  $4.0284 / 0.07099 = 56.746020566277$   
O<sub>2</sub> volume :  $31.998 / 1.141 = 28.043821209465$   
Total vol :  $84.789841775742$   
H<sub>2</sub> vol fac :  $56.746020566277/84.789841775742 = 0.66925494113272$   
O<sub>2</sub> vol fac :  $28.043821209465/84.789841775742 = 0.33074505886728$

## 17.6. Boron + Compressed Oxygen

Formula:  $4 \text{ B} + 3 \text{ O}_2 \implies 2 \text{ B}_2\text{O}_3$   
B (Solid B)  
 $\text{O}_2$  (Compressed  $\text{O}_2$ )  
B mass :  $4 * 10.811 = 43.244$   
 $\text{O}_2$  mass :  $3 * 31.998 = 95.994$   
Total mass : 139.238  
B mass fac :  $43.244 / 139.238 = 0.31057613582499$   
 $\text{O}_2$  mass fac :  $95.994 / 139.238 = 0.68942386417501$   
Volume : mass / density  
B volume :  $43.244 / 2.52 = 17.160317460317$   
 $\text{O}_2$  volume :  $95.994 / 0.74164967562558 = 129.43307757673$   
Total vol : 146.59339503704  
B vol fac :  $17.160317460317/146.59339503704 = 0.11706064557671$   
 $\text{O}_2$  vol fac :  $129.43307757673/146.59339503704 = 0.88293935442329$

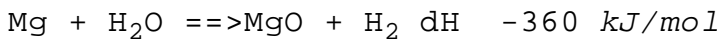
## 17.7. Boron + Liquid Oxygen

Formula:  $4 \text{ B} + 3 \text{ O}_2 \implies 2 \text{ B}_2\text{O}_3$   
B (Solid B)  
 $\text{O}_2$  (Liquid  $\text{O}_2$ )  
B mass :  $4 * 10.811 = 43.244$   
 $\text{O}_2$  mass :  $3 * 31.998 = 95.994$   
Total mass : 139.238  
B mass fac :  $43.244 / 139.238 = 0.31057613582499$   
 $\text{O}_2$  mass fac :  $95.994 / 139.238 = 0.68942386417501$   
Volume : mass / density  
B volume :  $43.244 / 2.52 = 17.160317460317$   
 $\text{O}_2$  volume :  $95.994 / 1.141 = 84.131463628396$   
Total vol : 101.29178108871  
B vol fac :  $17.160317460317/101.29178108871 = 0.16941470745083$   
 $\text{O}_2$  vol fac :  $84.131463628396/101.29178108871 = 0.83058529254917$

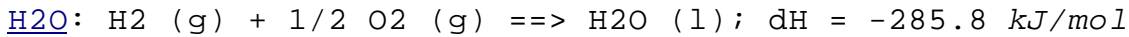
## 17.8. Magnesium and Steam

### [Reactions of Metals and Water](#)

Magnesium combines with STEAM to produce Magnesium Oxide and Hydrogen.



The hydrogen can then be burned with Air or Oxygen to produce water.



(Remove [Latent Heat](#)  $41 \text{ kJ/mol} = -285.8 + 41 \text{ kJ/mol}$  )

Check math by comparing liquid H /External O2

Total (from H2) is  $-286 \text{ kJ/mol}$ .

Atomic weight:  $2.01 \text{ g/mol}$ .

Density (L):  $0.0710 \text{ g/cm}^3$

Energy by mass :  $( 286 \text{ kJ/mol}) / (2.01 \text{ g/mol} )$   
 $= 142 \text{ kJ/g} = 142 \text{ MJ/kg}$

Energy by volume:  $10.1 \text{ MJ/L}$

Comparison to Wiki values

	Energy by Mass	Energy by Volume
Wiki	143.000	10.100
Calculation	141.893	10.100

Total (from Mg/Steam + H/O) is  $-604.8 \text{ kJ/mol}$ .

Atomic weight :  $24.305 \text{ g/mol}$

Density :  $1.738 \text{ g/cm}^3$

Energy by mass :  $( 605 \text{ kJ/mol} ) / (24.305 \text{ g/mol} ) = 24.9 \text{ kJ/g}$   
 $= 24.9 \text{ MJ/kg}$

Energy by volume :  $43.2 \text{ MJ/L}$

## 17.9. Embedded Calculations

All calculations in this document are performed with the PHP programming language which generates the document.

[Partial PHP Source Code](#)

## 18. Physorg Posts

These ideas were first noted in [PhysOrg](#) (posting as **alanf777**)

The 1,000-character posting limit made my comments rather hard to read), so I have extracted and clarified them in [Physorg v1](#)

## 19. Acknowledgements

Thanks to Jed Rothwell, Jeff Driscoll and Jones Beene on the "[Vortex](#)" mailing list for information, corrections and comments.

Oh, and thanks to Sir Arthur Conan Doyle, who really, really liked the phrase which Sherlock Holmes used more times than this paper has space for (in *The Sign of the Four*):

Eliminate all other factors, and the one which remains must be the truth."

Version 3.11, April 1, 2011 [AlanFletcher@FarCad.com](mailto:AlanFletcher@FarCad.com) [Home](#)