References

No	Title	Summary	Prepared By	Prepared For
1	Development for Ctrl Sys. For Preventing Food Ignition on Gas Ranges	A TC based cooking fire solution developed for gas ranges using 1 off-centered semi-shielded.	Energy International Inc.	CPSC
2	Study of Tech .for Detecting Pre-ignition Conditions of Cooking Related Fires Assoc. w/ Elec. Ranges Phase I Report	CPSC work to determine pre-ignition condition for food related cooking firescusing multiple sensors such as: smoke, temperatures, cooking alcohols and hydrocarbons.	Erik L. Johnsson NIST	CPSC
3	Study of Tech .for Detecting Pre-ignition Conditions of Cooking Related Fires Assoc. w/ Elec. Ranges Phase IV Report	Review on the CPSC three unshielded TC cooking fire solution for electric coil cooking element. Describe designs and coking tests results	Han Lim CPSC	CPSC
4	Study of Tech .for Detecting Pre-ignition Conditions of Cooking Related Fires Assoc. w/ Elec. Ranges Final Report	Summary of NIST/CPSC work on technical solutions for food-related cooking fires: Determination of pre-ignition conditions, development & test of prototype TC based solution -- conclusion pre-fire detection system is physically feasible and merits further exploration	Erik L. Johnsson NIST	CPSC
5	Practical Work w/ an electric-coil range equipped w/ an experimental TC-based preignition control system	Result review of the GHI cooking tests on the EI/CPSC TC based cooking fire prevention solution for electric coil heating element	Sharon Franke Good Housekeeping Institute	CPSC
6	Range Fires Characteristic Reported in National Fire Data and a CPSC Special Study	Report on statistical data obtained from NFPA/NFRIS on home fires especially cooking fires w/ breakdown of specific causes and types of cooking equipments involved	Linda Smith CPSC	CPSC
7	Response to Peer Reviewers Comments on Range Fires Project Technical Reports	Editorial comments of the first draft for the final report on the Study of Tech. for Detecting Pre-ignition Conditions of Cooking Related Fires Assoc. w/ Elec. Ranges	Andrew Trotta CPSC	CPSC

No	Title	Summary	Prepared By	Prepared For
1	Nov 1998 Working Group Meeting (Minutes)	Defining sources of cooking fire, Define potential solutions, review previous TC devices	Wayne Morris	Cooking Fires Issues Task Group
2	Feb 1999 Task Group #4 on Non-Technological Options	Task group reviewed AHAM's "Recipe for Safer Cooking Campaign." Discuss other non-technical solution for cooking fire prevention: how to increase public awareness on cooking fire, and how can building codes be improved to address cooking fire incidents (sprinkler systems)	Wayne Morris	Working Group on Careless Cooking Fire
3	March 1999 Working Group Meeting (Minutes)	Range manufacturers agree TC pan feedback mech. Shows greatest promise for solution. Discuss cooking test result on CPSC elec. prototype. Discuss predicted system cost. Discuss other solutions from industry (Cherry + TRC)	Wayne Morris	Cooking Fires Issues Task Group
4	Aug 2000 Work Assignments for Task Group	Cooking fires joint task group are determining the types of testing that a cooktop that has cooking fire systems has to pass in order for it to be a viable technological option	Wayne Morris	Cooking Fires Joint Task Group
5	Aug 1999 Report of Cooking Fires Working Group	Review of residential fire data from NFPA, CPSC phone survey, and NASFM/AHAM 1997 report. Review on CPSC TC system on coil element cooktop and subsequent cooking tests by GHI. Discuss Additional cost of safety system to cooktop	AHAM	
6	Ten Community Study of the Behaviors & Profiles of People Involved in Residential Cooking Fires (July 1998)	A detailed research to learn the sources of cooking fire based on equipment and user's behavior. Used a survey form distributed to fire dept. of 10 community over 6 months period.	NASFM/AHAM	
7	US Home Cooking Fire Patterns and Trends through 1996	Report of statistical home fire data gathered from NFPA. Study is conducted for fire data from 1980 to 1996. Has some data on sources of fire -- kitchen being the leading area of origin.	Nat'l Fire Protection Assoc.	AHAM
8	US Home Cooking Fire Patterns and Trends (April 00)	Report of statistical home fire data gathered from NFPA. Similar information as previous entry with the addition of a more detailed data eceived from 1993 to 1997	Nat'l Fire Protection Assoc.	AHAM
9	Bailey's Industrial Oil & Fat Products	Information on cooking oils properties: smoke, flash and fire point	Y.H. Hui	
10	Table of Fats & Oils used in food	Information on cooking oils properties: smoke, flash and fire point	Economic Res. Serv. Of the US Dept of agriculture	
11	Food, Fats & Oils	Information on cooking oils properties: smoke, flash and fire point	Inst. Of Shortening & Edible Oils	
12	Cost Analysis of CPSC Range Control Prototype	Cost analysis of CPSC three TC solution for electric coil heating element	AHAM	CPSC
13	Kitchen range -- Fire safety device/system for surface elements/burners: list for design criterias	List of acceptance criteria of fire safety device/system and list of several fire systems developed or in development	AHAM (member?)	
14	NFPA-NFIRS Fire Data	Review on how NFPA & NFIRS collect their fire data	UL	STP members
15	Test Results of 1986 Food Fires Test Program	Test reports on food fire tests conducted by mulliple appliance manufacturers as part of AHAM food fires test	AHAM	CPSC

No.	Company	Product/Title	Comments	Type
1	Cherry Sensors and Control.	Standard Comfort Module	Controllers for ceramic top electric cooktop.	Paper brochure
2	Cherry Sensors and Control	Design Freedom (We make cooktops smarter)	Controllers for ceramic top electric cooktop. Describe various sensors that can be included with the controllers including a temperature sensor for cooking vessel	Paper brochure
3	Siemens	Cooking Sensors (Pan temp - IR)	Ceramic elec. Hob w/ IR pop-up cooking vessel T sensor	Web printout
4	Rinnai	Smart Hob RB-3EMB	Gas cooktop w/ contact T sensor for pan bottom	Web printout
5	Fire Line	Ansul Fire Suppression System	Hood installed extinguisher	Web printout
6	Firemelt	DoubleFire Hood System	Hood installed extinguisher	Web printout
7	PEM ALL Fire exting. Corp.	Fire Suppression System (Detect/Suppress/Alarm)	Hood installed extinguisher	Web printout
8	Miele	Miele cooktop	Auto switch-off/heat-up/spill-detect	Web printout
9	Gaggenau	Gaggenau cooktop	Cook-settings and Auto quick-boil	Web printout
10	Twenty First Century	The Guardian System	Hood installed extinguisher	Web printout
11	Cabinova AB Swesen	Stove Alarm for Electrical Stoves	Wall mounted alarm	Web printout
12	Cabinova AB Swesen	Stove Alarm and Stove Cutout for Electrical Stoves	Wall mounted alarm + Stove power cutout device	Web printout
13	Figaro	Gas sensors General Information	Thin film metal oxide semiconductor gas sensors	Paper brochure
14	GRI	Simmer Sentry	Tsensor + acoustic sensor directly in contact w/ food	Paper brochure
15	Robertshaw	Gas Thermal Eye with Flame Set	Tsensor for bottom of cooking vessel	Paper brochure
16	Ecowatt Schweitz AG	Nouveau Cooking (Conduspeed cooktop)	Ceramic cooktop w/ T sensor	Web printout
17	National Fireproofing Co.	Fire Breaker Fuel Neutralizer	Manual fire extinguisher material (powder in bottle)	Web printout
18	Williams Pyro Inc.	Stovetop FireStop	Hood installed (magnet) extinguisher - No pressurized tank	Web printout
19	Bosch	NST 615F Sensor Cooker	Ceramic elec. Hob w/ IR pop-up cooking vessel T sensor	Product Brochure
20	Paloma	Gas cooktops	Gas cooktop w/ contact T sensor for pan bottom	Product Brochure
21	National	Gas cooktops	Gas cooktop w/ contact T sensor for pan bottom	Product Brochure
22	Purpose	Safull Gas cooktop	Gas cooktop w/ contact T sensor for pan bottom	Product Brochure
23	Siemens	Chimney hood w/ smog sensor	ultrasound sensor detect amount of smog/smoke and adjust it's intake - has radio contact btw cooker and hood	Web printout
24	Siemens	Cookers, Microwave Ovens and Cooker Hoods	General brochure of Siemens entire kitchen appliances	Product Brochure
25	Encon	Euro burners	Solid disc heating element w/ temperature limiter	Paper brochure
26	Rinnai	Gas cooktop RT-L5500GFT	Gas cooktop w/ contact T sensor for pan bottom	Care Manual

Arthur D Little

No.	Title	Description	Authors	Company	Journal	Date
1	Applications of Thermopile Infra-red Sensor to the Home Appliance	Using IR T sensor to measure external pot temperature on a gas range. Use to determine boiling point and boil dry condition by analyzing Temp. gradient	KoonSeok Lee, Sung Myun Baek, Jeong Hyeon Lim	LG Electronics Inc.	AMCE Proceedings	Oct-98
2	Advanced Cookware Sensing System for Vitroceramic Cooktops	Gold alloy tracks for pot sensing. Has transmitter & receiver track - detection by measuring amount of electromagnetic damping on track. Detect vitroceramic T around heat zone (thus cooking pot) by measuring specific resistance of the gold alloy track	Mike Schwert	Cherry Elec. Products	AMCE Proceedings	Sep-99
3	Functional Fantasies: Designing Dream Kitchens that Cooks	A comment by a restaurant & food industry consultant on the need for consumer input and consideration in the development of cooking equipments; form should follow function, etc.	Jan Weimer	Rest. & Food Indust. Consultant	AMCE Proceedings	Sep-99
4	Accurate and Reliable Gas Sensors for the Mass Market	Paper on the development of an accurate and reliable gas sensors that can be cheap enough to be manufactured for the mass market. The technology is based on Micro Electro Mechanical systems (MEMS). The company is in the process of developing a smaller less expensive NDIR gas sensor	Brian R. Kinkade	Ion Optics, Inc	AMCE Proceedings	Sep-00
5	New Micro-machined Water Sensor for Home Appliance Applications	Description of a new micromachined water vapor sensor that was developed using the MEMS (microelectromechanicas systems) technique.	Ralph Fenner, Meindert Kleefstra, etc.	Hygrometrix, Inc.	AMCE Proceedings	Sep-00
6	Optical Fire & Security Technology: Sensor Principle & Detection Intelligence	A discussion on optical sensor technology for fire detection. Basic physics of sensor mechanism is well understood, but actual design of cost effective detectors reliable under an extreme range of environment is still a highly demanding task	P. Reyser, G Pfister	Cerberus Ltd.	IEEE	1991
7	Fire Detection - The Least of Our Problems	A short discussion on limitations of various current fire detection technologies such as their sensitivity levels to different types of fire and their tendencies to cause false alarms	Andrew Morgan	Siemens Building Technologies Ltd	-	
8	Fire Detection w/ Combined Ultrasonic-Microwave Doppler Sensor	A description of a new development of a fire detection system that combined two sensors: ultrasound and microwave Doppler sensor to reduce the incidence of flase alarms	H. Ruser, V. Magori	Siemens AG	IEEE Ultrasonic Symposium	1998
9	SiC Thin-Film Thermistors	Thermistor using RF-sputtered SiC film developed specifically for cooking appliance Has been applied to detect Tpan bottom for gas cooktop. Thermistor is connected to a controller that adjust gas valve for burner - shows rapid thermal response	Takeshi Nagai, Masahiko Iioh	Matsushita Housing Products	IEEE Transactions on Industry Applications	1990
10	Temperature Control for Food in Pots on Cooking Hobs	Paper describing the technology applied on the development of Bosch's sensor cooktop. The temperature sensor used is a thermopile optical sensor.	Uwe Has, Dimitar Wassilew	Bosch, Siemens, DIAS Angewandte Sensorik	IEEE Transactions on Industry Applications	1999
11	Automated Cooking and Frying control using a gas sensor microarray	A discussion on a new development effort on a gas sensor microarray that is specifically to determine the doneness level of steak cooking. The sensor is located on the undersidse of the pan lid.	S. Ehrmann, J. Jungst, J. Goschnick	Institut fur Instrumentelle Analytik Hermann-..	Sensors and Actuators	2000
12	Japanese Industrial Standard: Gas burning cooking appliances for domestic use (JIS S 2103) 1991	Japanese standards for domestic gas cooker. Important info: there is a standard that contends all gas cooktop should limit the temperature of cooking oil in the cooking vessel to be below a certain level	Japanese Standards Association	Japanese Standards Association	-	1991
13	NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, 1998 Edition	US standards for fire protection systems for commercial cooking appliances including in-hood fire extinguishing system instalation	NFPA	NFPA	-	1996

Appendix A: Complete List of Technologies

DESCRIPTION OF CURRENT TECHNOLOGIES 111 IN TOTAL

BOIL-OVER/BOIL-DRY ONLY

No	Patent Number	Description	Company	
1	US 4665292	Cook modes (warm-simmer-boil) and regular Hi-Med-Lo settings available. Use pre-set Tthres then estimate time to completion & manipulate HS & set alarm on when time reached	General Electric Company	
2	US 6118105	Auto detect for boil, boil-over, boil-dry. T sensor for vessel bottom & cooktop, & power level indica. Temp signal plateu ≈ boil, temp signal increase after plateau, boil dry, etc.	General Electric Company	USE TEMPERATURE SENSOR
3	US 4465228	Preventing boil over incidents by monitoring pan bottom temperature and usind a pre-selected decrease in temperature gradient as food boiling point	Matsushita Elec. Ind Co., Ltd	
4	US 5947370	Cook modes (warm-simmer-boil) and regular Hi-Med-Lo settings available. Compare realtime data with stored empirical data w/ fuzzy logic to determine cooking state	Arthur D. Little, Inc.	
5	Simmer Sentry	Tsensor + acoustic sensor directly in contact w/ food. The sensor sticks out of the back panel of the cooktop and its sensor tip is immersed in the cooking liquid	GRI	
6	US 4633230	A temperature sensor is attached at the end of a 2 bar link arm that can be adjusted to contact the cooking container. The temperature sensor will convert the measured cooking vessel temperature into electrical signal that will signal alarm in cases of boil over or boil dry.	None	
7	US 5079407	Moisture sensor above pot (in hood/on top of pot) measure vapor and activate alarm (audible/visual) and manipulate heat source when boiling is detected	Whirlpool	USE MOISTURE SENSOI

FIRE EXTINGUSIHING/CONTAINMENT/ALARM

No	Patent	Description	Company	
1	US 4580638	A flexible incombustible curtain automatically drops over and contained cooking unit once fire is detected, then gas fire extinguisher released inside the partitioned area to avoid messy cleanup	Mon/Arc, Inc.	
2	US 6105677	Can(s) of particulate extinguishing mat'l inverted above range (in hood). Cap has fusible mat'l that melt at Temp ~ 220 F, releasing particulates that fall on cooktop by gravity	None	
3	US 3889754	Dry fire extinguish powder avoid splatter of grease. Auto deploy - fusible parts that lets go a spring actuated puncture for CO2 canister which allow pressurized deployment of extinguisher	None	USING FUSIBLE PARTS AS DETECTOR AND ACTUATOR
4	US 5490566	Panel w/ heat fusible parts, filled w/ extinguisher powder. Located above range in hood/as ceiling panels (Firemelt powder)	Firemelt Inc.	
5	US 4813487	Fusible part actuated fire extinguishing agent to stove and actuated spring loaded solenoid switch to turn off stove.	None	
6	US 6032663	A fusible part (nylon cord webbing extended above stove) is used as fire detection device. Once flame melt the webbing, this releases the gas valve/electric switch which was held in tension so burner is off	None	
7	Ansul System	In hood fire detection and suppression system. Fire detection and suppression actuator is a fusible links which will cause cartridge to propel gas into Ansulex liquid agent tank	Reliable Fire Equipment	
8	The Safety Gourmet	Waiting for Brochure	PEMALL	
9A	US 4773485	Pressurized extinguishing canister connected to valve networks within hood above stove. Actuator are cables in tension connected w/ fusible parts	21st Century Int'l Fire Equipment & Services	
9B	The Guardian I (US 4773485)	Fire detection-suppression system - concealed in hood or in kitchen cabinet above range When fire detected, **using fusible parts** (within hood), auto shuts off fuel supply to stove (gas & electric), while releasing extinguisher. Optional: audible alarm & pull stations	Twenty First Century	
10	JP 8107942	Nozzles connected to pressurized water source capable of delivering fine water mist/fog to suffocate and cool fire/stove. Using fusible parts to activate nozzles	NOHMI BOSAI LTD	
11	Fire Line	Hood installed extinguisher using fusible link	Ansul Fire Suppression System	
12	Firemelt hood system	Hood installed extinguisher using fusible parts and a new powder extinguisher that suppse to work well with grease fire too.	Firemelt	
13	US 3653443	Thermostat in hood detect fire. Circuit connected to thermo. activate removable fluid extinguisher tank in hood and cuts off electric/gas valve to range and turns on alarm	Mon/Arc Inc.	
14	US 5351760	T sensor - 1st temp threshold - fan turns on; 2nd temp threshold - alarm turns on; 3rd temp threshold - range shuts off; beyond 3rd temp threshold fusible link melt and dispense	None	
15	US 5868205	Fire extinguishing agent container above the cook range at the back of the range hood w/ a bimetal-actuating device. Actuated when ambient temp. reached certain temp.	Fail Safe Safety Systems, Inc.	USE NON-OPTICAL TEMI
16	US 6029751	TC or metallic alloy element responds to high threshold T, it sends signals to release fire suppressor & turns alarm on & turns off electrical/gas supply. When T sensor cools off, suppressor valve auto-closes	None	OR FIRE SENSOR.
17	JP 7132151	Fire detected by sensor, then gas valve is cut-off, then liquid fire extinguisher is pressure released. Finally alarm is activated to warn user	None	
18A	US 6044913	Heat sensor (diodes/thermistor) detect fire, activate fire extinguisher release and activates audible alarm which activates gas/electricity shut-off to heat source (sensor+alarm battery operated)	21st Century Int'l Fire Equipment & Services Corp.	
18B	The Guardian III (US 6044913)	Fire detection-suppression system - concealed in hood or in kitchen cabinet above range When fire detected, using heat sensors (diodes) within hood, auto shuts off fuel supply to stove (gas & electric), while releasing extinguisher. Optional: audible alarm & pull stations	Twenty First Century	
19	JP 58050096	IR sensor is used to detect fire above cooktop (on wall behind cooktop). Then from inside the rangehood, fire extinguisher will be released	MATSUSHITA ELECTRIC	

20	JP 58152575	Flame sensor behind the cooktop, at a level just above the cooking vessel, activated a spray nozzle that releases fire extinguisher from behind the cooktop onto the pot/pan on cooktop, and then cut-off gas valve. Sensor is IR	DAIKIN KOGYO KK	USE OPTICAL TEMPERATURE OR FIRE SENSOR
21	Stove Alarm and/or cut-off US 5196830	An auxiliary system using an IR temperature sensor, mounted above the cooktop on the wall behind it. Reacts to heat (if T of cookstove > Tthres) it will turn on an alarm and some version has an electric cut-off switch that cuts the power the the electric stove. Claim that user can adjust sensor's sensitivity (photo conductive cell)	Cabinova Sweden	
22	Safety system for cooktops and ovens	Preliminary stage: Detection of critical level smoke alarm prior to combustion (photo-electric) -- Then audible alarm that not reset by user after time delay (eg 45 sec) gas supply to appliance cuts-off. Else, if combo of smoke and T level will disconnect power supply immediately if flame occurs. Immediate power disconnect & provision of auxiliary output - extinguisher on, or contact outside services 911, etc.	Technology Research Corporation	USE SMOKE SENSORS
23	JP 4093529	A photoelectric sensor (light projector and receiver) is installed in downdraft cooking vent/hood. When smoke level in the vent is > pre-set value sensor will send signal to turn on alarm and turn off heater	Matsushita Electric Ind. Corp.	
24	JP 2182274	Range hood act as a fire enclosure/containment unit. T sensor detect ambient T around cook table then activate a buzzer and then drops down to cover entire surface cooking unit -- automatically activated with sensors to detect fire and activate release	None	FIRE CONTAINMENT, NO EXTINGUISHER AGENT
25	JP 11221297	Extinguish stove fire and prevent fire from expanding into hood duct. Nozzle that sprays water droplet is situated inside the duct of a range hood to spray into duct an onto stove surface. Sensor means unclear	BUNKA SHUTTER CO LTD	OTHER OR UNKNOWN FIRE DETERMINATION METHOD
26	JP 2045073	Water sprayed from surrounding pipe frame to cool and suppress fire. After flame has subsided, a metal plate covers pot automatically. Sensor means unclear	None	
27	Stovetop FireStop	Hood installed (magnet) extinguisher. No pressurized tank. There is an explosive material inside the powder extinguisher canister that will explode when it fuse mechanism experience a threshold environmental temperature.	Williams Pyro Inc.	
28	US 4483314	Pull out blanket from drawer underneath the burner/heat source. Used to manually smother fire	None	MANUAL FIRE EXTINGUISH AND COOKING FIRE DETERMINATION METHOD
29	JP 10201871	Manual fire extinguishing sheet. Fire extingusih agent is suspended in a flexible & fusible encasing from polyethylene film. When fire occurs drape sheet on stove to melt film and delivers extinguisher	None	
30	JP 9206393	Kitchen mat with incombustible material to smother fire manually	DUSKIN CO LTD	
31	JP 9117329	Incombustible back panel for wall cover. A passive wall attached on the wall behind the cooktop to reduce the spread of cooking fire.	MATSUSHITA ELEC. WORKS LTD	
32	JP 1015068	Range hood act as a fire enclosure/containment unit. Drops down to cover entire cooking unit -- manually activated	None	
33	Fire Breaker Fuel Neutralizer	Manual fire extinguisher material (powder in bottle). User has to squirt the plastic bottle containing the powder extinguisher on the source of fire.	National Fireproofing Co.	

PREIGNITION OF FOOD/OTHER

No	Patent Number	Description	Company	
1	US 5717188	Motion sensor (spec. area covearge) determine if user is present. If not depending on 2nd sensor (power level, heat sensor, etc.): No user detected, 1st alarm then some heat source manipulation	None	MOTION SENSOR & OTHER SENSOR (POWER/TEMP) TO
2	US 5380985	Motion sensor detect if person is near stove (specified area coverage). If not will turn off electric heater after a specified pre-determined time	None	USES MOTION SENSOR ONLY
	US 6130413	Motion sensor determine user presence. The 1st time user not detected after pre-set period, stove disabled temporarily for a pre-set period. When user enters it is auto-enabled. The 2nd time user leave,stove is disabled permanently until user manually reset it. Add on to old stove	None	
3	US 4775913	Motion sensor determine user presence. For the 1st time user not detected after pre-set period, stove disabled temporarily for a pre-set period. When user enters it is auto-enabled. The 2nd time user leave,stove is disabled permanently until user manually reset it. Integrated	None	
4	WO 00/53975	Motion detector determined user's presence near stove for a pre-set time. If no user is around controller sent a signal by which to manipulate (off) electric heater	None	
5	US 5457302	Can use cooking modes: broil (manual) and the rest is automated. Determine cook mode auto: (when not in broil mode) by the time required to increase temp.	Sanyo Electric Co. Ltd.	
6	US 4493981 ELECTRIC incl. US 4639578 for sensor failure	Cook modes: boil mode (warm-simmer-boil) and fry mode, and regular Hi-Med-Lo settings available. Detect boil dry condition when in boil mode -- When rate of increase of Tpot exceeds a predetermined reference rate, or the sensed Tpot exceeds a predetermined threshold temperature. If Tsensor fail: indicator signal user & it becomes conventional cooker	General Electric Company	
7	US 4493980 ELECTRIC incl. US 4639578 for sensor failure	Cook modes: boil mode (warm-simmer-boil) and fry mode, and regular Hi-Med-Lo settings available. Each mode is associated w a min SS temp and a SS power level. Cntlr compares Tpot & current power setting to selected mode settings and adjust to reach the Tthres quickly w/ minimum overshoot. If Tsensor fail - same as above	General Electric Company	
8	JP 63061820	Cooking T (To) is set by switch. Once it is achieved (Tpan bottom). Flame is reduced. Microprocessor then set Tthres = To + Delta T (pre-set in prog.). If after flame reduction Tpan > Tthres, turn off burner. For cooking with small food content	OSAKA GAS CO LTD	MEASURE PAN BOTTOM TEMP W/ CONTACT SENSOR PROCESS
9	JP 62010510	User selected switch. If on: if Tpan bottom > Tthres, burner switches on and off to maintain Tthres. When switch is off: if Tpan bottom > Tthres, burner switches off and remains so. Gas valve is latching solenoid valve. If switch is on & Tpan < Tthres, resistance in wire reduce & valve open	Matsushita Electric Ind Co LTD	SIGNAL W/ MICROPROCESSOR TO DETERMINE COOKING STATE AND ACTION FOR COOKTOP
10	JP 5052336	User select cook modes: boil or fry. If boil is selected, burner will terminate when Tpan bottom = T of food scorching (reference). If fry selected, burner terminate when Tpb = T of oil ignition	HARMAN CO LTD	HAS TO SELECT COOKING MODE/COOKING VESSEL TEMP TO ACTIVATE

11	JP 6193880 [illegible]	Contact T sensor for pan bottom on a gas fired cooktop. There seem to be a T limit [illegible] of 270 C for cut-off. There is also a controlling algorithm to allow a better handling of [illegible] temperature increase to the user selected cooking temperature [illegible]	RINNAI CORP [illegible]	SYSTEM [illegible]
12	US 5243172 [illegible]	Cook-top with automatic controls. The cooktop is equipped w/ a pot detector (weight sensor) and Tsensor means. It also incorporate a timer. When no pot is detected on vessel [illegible] Tselect heating element can be reduced/turned off. [illegible] keep element from shutting off for temporary pot removal due to shaking or flipping food content. (no sensor design but logic algorithm only) [illegible]	U.S. Philips Corp [illegible]	
13	US 3665159 [illegible]	Heating System Control [illegible] Thermistor is used as T sensor for the cooking vessel. Its signal is used to control vessel T and to speed-up the T rise to user selected T vessel while avoiding overshoot of T select due to heat capacity of system. It is achieved by constantly comparing current vessel and T select and adjusting the power of the electrical heating element [illegible]	Whirlpool Corp [illegible]	
14	RT-L5500GFT-R with 7 safety functions [illegible]	TC based T sensor for pan bottom Temp. For frying oil, select 3 preset temps and controller maintain burner. Boil-dry: once boiling is detected alarm on, turn down burner, wait 5 min then turn off burner. Can detect slow cooking is boil dry or when cooking vessel is empty [illegible] auto-off if food content [illegible] grease fire, burner auto-off then alarm on. When boil-over happens and spill over food turns off burner, gas valve auto-off. Burner auto off when on for more than 2 hrs [illegible]	Rinnai [illegible]	
15	[illegible] Conduspeed cooktop	Ceramic cooktop w/ integrated temperature sensor. Cook can select the cooking temperature. Claims that T sensor can be used to detect boil-over, boil-dry, and contaminated pot/pan surface (which will affect heat transfer to pot/pan), and can be applied to prevent oil/grease fire problems. Also claims quick and even heating due to its copec aloy construction — and the ceramic plate can cool in 30 seconds [illegible]	[illegible] Ecowatt Schweitz AG	
16	US 5294779 ELECTRIC	A sensor at the center of an electric hot plate, will contact cooking vessel and detect vessel presence and vessel bottom's temp (indicator only?) Will cut-off electrical supply to hot-plate when sense max. T is reached by a fuse connected to vessel bottom which melt at that T	SEB S.A. Selongey, France	
17	US 4723067 ELECTRIC	A sensor at the center of an electric hot plate, will contact cooking vessel and detect vessel temp. A separate temperature cut-out device made of temperature limiting rod is embedded beneath the hotplate for precision cut-off when Thot plate > Tthreshold	E.G.O. Elektro-Gerate Blanc U Fisher	
18	US 4492336	T sensor for pan bottom temp. T rise gradient at initial state of heating for a certain time is used as correction value for pan type, T rise gradient after certain T has been reached is used as correction value for amount of food. They are converted into preset T values for operating T for T sensor. Once the T operation is reached, heating is maintained. A Tcut-off also calculated from the operating T.	Matsushita Electric Ind Co LTD	
19	JP 8014573	A load sensor determine if there is pan/not on top of burner. When there is pan, a Tsensor which measure pan bottom T, will determine if Tbottom > Tthreshold A, if No, combustion is continued, if Yes, empty boil/over-heating detected -> turn off flame. If no pan detected, & Tsensor measure Tbottom > Tthreshold B, pan is temporarily removed/shaken -> reduce to weak flame	TOKYO GAS CO LTD	
20	JP 7012335	Tsensor detect pan bottom Temp. When Tpan bottom > Tthreshold for a pre-determined time period. Cut off gas valve. If Tpan bottom > Tthreshold temporarily (< pre-determined time) then nothing is done Reduce nuisance burner turn-off due to shaking of pan or temporary pan lifting (flipping pancake)	RINNAI CORP	MEASURE PAN BOTTOM TEMP W/ CONTACT SENSOR PROCESS SIGNAL W/ MICROPRO-CESSOR TO DETERMINE COOKING STATE AND ACTION OF COOKTOP AUTOMATIC ACTIVATION OF SAFETY SYSTEM (spans rows 16–28)
21	JP 5044939	Tpan bottom measured every 0.32s. (Tmax-Tmin) between 4 consecutive T measurement is calculated. Oil fire is prevented by comparing (Tmax-Tmin) with a reference value and by the time it takes for T to rise from 220 to 240 deg C	RINNAI CORP	
22	JP 8233278	Thermistor detect Tpan bottom & connected to valve coil of safety valve through intermediate switch. At pre-set Tthres thermistor operates the switch and turns off heat	Osaka Gas Co Ltd	
23	JP 4236012	Cooking mode is auto judged by bottom pot temperature/moisture sensor (liquid cooking/ frying). Prevent over-cook (boil/simmer) or fire (frying) by temperature rise pattern of pan/pot bottom	Matsushita Electric Ind Co LTD	
24	JP 61105025	Use electromotive force of TC for pan bottom. If this becomes larger than V drop of an electric resistance, signal is processed to output a pulse for heat source. If beyond Tthres, gas valve turns off	Matsushita Electric Ind. Corp	
25	JP 9148062 ELECTRIC	Pan/pot bottom T is measured by a T sensor below ceramic heat resistant slab for electric stovetop. When abnormal T is detected, heat source is manipulated (stop, heat retaining, or low)	Matsushita Electric Ind. Corp	
26	JP 4020718	In addition to overheat preventive function (Tpan bottom based), A contact sensor is installed to detect pot/pan on burner tripod/grill. If no pot is detected, alarm is on after a pre-set period	Harman Co Ltd	
27	Ctrl Sys. For Preventing Food Ignition on Gas R	A TC-based T sensor for pot bottom to determine the arrival of pre-ignition cond. T threshold of 590F was selected. When Tpan > 590F, burner is reduced to 40% output When Tpan < 590F burner up to full (selected) output. Specifically for gas burner	Energy International Inc.	
28	CPSC Prototype Detect preignition w/ Elec. Ranges	A TC-based T sensors (3) for pot bottom to determine the arrival of pre-ignition cond. Heater is cycled (1s on and 6s off) when Tpan is between 330-360 C, and when Tpan is larger than 360 C, heater turns off. Specifically for electric cooktop	CPSC	
29	Applications of Thermopile Infrar Sensor to the Home Appliance	Using IR T sensor to measure external pot temperature on a gas range. Use to [illegible] determine boiling point and boil dry condition by analyzing Temp gradient [illegible]	LG Electronics Inc [illegible]	MEASURE PAN TEMP W/ NON-CONTACT SENSOR SELECT FOR COOKING MODE [illegible] (spans rows 29–30)
30	NST615F Cooki Hob [illegible]	Thermopile IR sensor is used to detect the side wall T of pan/pot. Pot side has enamel strip w/ known emissivity (0.9). Sensor connects to controller which adjust heat source depending on selected T set-points for specific cooking modes. Heat source is cycled [illegible]	Bosch, Siemens [illegible] DIAS Angewandte Sensorik [illegible]	
31	JP 4080525 [illegible]	Fire prevention by the comparing the temperature gradient of the pan with [illegible] pre-set conditions. If gradient < preset value A then actual T is compared to [illegible] preset T a. If less, continue. If more stop [illegible]	NORITZ CORP [illegible]	
32	US 3781506 [illegible]	Non-contact T sensor for cooking vessel, specifically for induction electric [illegible] cooktop [illegible]	General Electric Co. Schenectady [illegible]	

33	US 4994652 ELECTRIC	Use cook mode switch. 2 T sensors are used, dependent on type off cooking selected: for roasting T contact (T dependent resistor) on the underside of ceramic plate and for other, through pot wall using contact and/or IR sensor. Signal fed to controller that'll manipulate heat source depending on mode	Fissler GmbH Germany	MEASURE PAN TEMP w/ W/ CONTACT OR NON-CONTACT T SENSOR
34	JP 11118153	A design for a reliable temperature sensitive metal and a magnet that can actuate gas valve in a case of fire. At pre-set Tthres, device will close valve	Paloma Ind Ltd	
35	JP 3236520	Gas valve is opened w/ spring force. TC (for Tpan) is in contact w/ an electromagnet attached to on/off gas valve switch. When pan > Tthres, TC produce electricity which attracted the electromagnet and compress the spring on the gas valve and closes it	Matsushita Electric Ind Co LTD	MEASURE PAN BOTTOM T NO SIGNAL PROCESSING USE ELECTROMAGNETIC
36	JP 3236519	Electromagnet is the T sensor for pan bottom. As Tpan increases to Tthres, sensor loses its property and releases the spring loaded gas valve and turns burner off	Matsushita Electric Ind Co LTD	SENSOR CONTACT T SENSOR
37	JP 8254320	TC for pan bottom provide/s electricity to a coil w/ electromagnet. This electromagnetic force kept gas valve attached to T-sensitive metal open. When cooker gets hot, T sensitive metal loses its magnetic permeability and valve is closed. Else when thermoelec. Force of TC has lowered, valve also closes	Paloma Ind Ltd	
38	JP 11094245	TC for pan bottom is combined with a bimetal switch and a temperature fuse. These sensors are all combined in series to create a safety valve circuit to connect TC with the solenoid safety valve	RINNAI CORP	MEASURE PAN BOTTOM T NO SIGNAL PROCESSING USE BIMETAL SENSOR
39	JP 11094258	Tsensor using bimetal switch is connected in series w/ a TC (pilot) & safety valve constituting an electrical closed circuit. It is also connected to a T fuse to turn off gas @ Tthres. No need for dry-cell	Hitachi Hometec Ltd	CONTACT T SENSOR
40	US 4217481	Electric cooktop with 2 cooking zones: boiling & roasting. Each hot plate has a Tsensor. For boiling zone, the temperature range is between 40-140 deg for boiling & warming. For roasting, temperature range is between 80-270 deg C. Sensor uses expansion liquid & capillary tube to connect thermostat	None	MEASURE PAN BOTTOM T NO SIGNAL PROCESSING USE EXPANSIBLE LIQUID
41	US 2786930	Cooktop element or burner has a T sensor made of expansible thermosensitive material (fluid) connected with a capillary tube to a mechanical power/gas controller to control the temperature of the cooking vessel which is in contact with the Tsensor	Robertshaw	SENSOR CONTACT T SENSOR
42	Thermal Eye or Burner-w/-a-Brain	Tsensor using expandible thermosensitive liquid within a capillary tube. Used to control the temperature of cooking vessel	Robertshaw Ctrls	
43	US 5945017	Tpan is used to determine near fire condition, it is bypassed if motion sensor detect person near stove within a pre-set period. It resets again after person is detected. If no motion detected, burner turns off	None	MOTION+Tpan SENSOR & MICROPROCESSOR TO ACTUATE CONTACT T SENSOR
44	JP 6265158	Tpan bottom = Tthres, controller counts set time, if during set period no motion (person) is detected, heater off. If yes, controller reset counting and continue, if set period is passed, heater lowered/off.	TOSHIBA CORP	
45	JP 7083442	User select button for frying function - actuate safety circuit. If no T change is determined from the IR motion sensor at the front of stove, burner will turn off after a specified time (~10 min)	TOKYO GAS	
46	US 5796346	To prevent fire from foreign object (eg. grease) that touches heating element to accidentally burns. When power level/heater above a threshold value, timer (and possibly alarm) will turn on. Depending on the measure power level, a a corresponding pre-set time will start to be counted down by the timer. If by the time the timer ends the count down the user does not provide action (e.g. press reset button), burner will turn off automatically	None	TIMER AND POWER LEVEL
47	JP 6050551	Pre-set time periods for auto-power off is determined by heat source power levels. When no switching operation is performed by user during pre-set period since the last time a switching operation is carried on during the on times of heating element, burner turns off to prevent user from forgetting to turn off cooktop after use	Toshiba Corp	
48	US 5416301	The cooking appliance automatically turns off the heater a predetermined time after a last pressed switch, i.e., automatic power off function. A caution lamp indicates that the heater will automatically be turned off a minute prior to the automatic power off function.	Matsushita Electric Ind. Corp	TIMER ONLY
49	JP 61038338	The IR smoke detector will detect a threshold amount of smoke, then set a timer on. After a pre-set time (eg 10min) has elapsed from the timer, check again. If smoke generation is increase/not reducing, shut-off valve; if not reset timer and repeat procedure	NIPPON DENSO CO LTD	SMOKE SENSOR
50	JP 4093529	A photoelectric sensor (light projector and receiver) is installed in downdraft cooking vent/hood. When smoke level in the vent is > pre-set value sensor will send signal to turn on alarm and turn off heater	Matsushita Electric Ind. Corp	
51	US 5611327	Smart range w/ multiple sensors & functions. For fire safety of cooktop, a nearness sensor check for authorized user and/or utensils. If unauthorized person/utensil is around/used, burner is locked - for authorization, transmitter has to be carried by person/embedded in utensils The pot support grid has a weight measuring device. If no weight is sensed then burner turns off. Timer is used for individual burner to turn it off automatically. Have bypass functions for when pot is temporarily lifted or pot is left on grid after finishing w/ cooking (lock burner off)	None	VARIOUS SENSORS
52	US 5608378	Power level (elec) or flame (gas) sensors. If sensor detect heat source is on, a warning indicator located next to exit door/audible alarm turns on when door is opened -- prevent unattended/accidental on	None	
53	JP 5018539	An odor sensor is used to determine what kind of food is cooked and also to determine if food is over-heating. It is connected to controller that can manipulate heat source	Sharp Corp	
54	JP 5018539	Auto detect of food type using odor sensor. Use food type info. for auto. cooking and use odor data to determine food fire and manipulate burner (shut-off) when that happens	Sharp Corp	
55	JP 8086445	A contact/touch sensor (combined with Tpan bottom sensor) is used to determine if pan/pot is on top of burner. When pan is not on burner, burner flame is either reduced or off so no cloth/sleeve catch fire	Tokyo Gas Co Ltd	
56	JP 9056601	Tsensor at suction passage below burner through its circumference and in smoke duct below burner system. When abnormal heat is detected, alarm turns on and gas valve is turned off	Yamaoka Kinzoku Kogyo KK	

57	JP 4006325	An energy (Temp) sensor is installed within a downdraft duct behind burner. When food overheat (oil) The energy sensor detected pre-set radiation energy from cooktop, turn off burner and stop blower	Matsushita Electric Ind. Corp	
58	JP 7171061	T sensor is directly inserted to pan/pot content. T sensor is attached to an alarm system that can generate synthesized voice to alert cooker of cooking fire danger when Tfood/oil ~ Tthres (eg. 200 C)	None	

SENSORS/ACTUATORS

No	Patent Number	Description	Company	
1	US 4710611	A T sensor for pan bottom T located at the center of an electric heat plate cooking hob T sensor could be a thermistor/liquid based. Conical sensor housing shape meant to reduce dirt from entering sensor	AB Electrolux Sweden	
2	US 3668372	Detailed design on how to mount the capillary type Tsensor using the capillary tube itself as the spring device that will maintain the contact of sensor head with cooking vessel bottom	Robertshaw	CONTACT TEMPERATUI SENSOR FOR COOKING
3	SiC Thin-Film Thermistors	Thermistor using RF-sputtered SiC film developed specifically for cooking appliance T Has been applied to detect T pan bottom for gas cooktop. Thermistor is connected to a controller that adjust gas valve for burner. Shows rapid thermal response	Matsushita Housing Products	VESSEL
4	US 5919385	Specifically for hob w/ halogen lamp as heat source and a ceramic cooktop which absorbs ~40% of halogen radiation. The Tsensor engages the bottom part of the ceramic cooktop	U.S. Phillips Corporation	
5	US 5397873	For Elec heater w/ glass ceramic cooktop. T sensor form PTC (positive T coeff. sensing element). It is attached to the underside of ceramic cooktop and measure T of cooking area (not pot bottom directly)	Emerson Electric Co.	
6	US 6075463	A wireless Tsensor consisting of an antenna, piezo-electric crystal and reflector is integrated to the bottom of the pot/pan. The sensor transmit wirelessly to the receiver beneath the ceramic top	AKO-Werke GmbH & Co. KG Wangen, Germany	NON-CONTACT TEMPERATURE SENSOR FOR COOKING VESSEL
7	US 5750963	Temperature sensor for cooking hob by using a field sensor that will measure the decay of the ma DC field which is a function of cooking vessel and food content. The signal from the field sensor will then be used to control the electric heat source to a user pre-determined temperature	AB Electrolux Sweden	
8	Advanced Cook-ware Sensing Sy for Vitroceramic	Gold alloy tracks for pot sensing. Has transmitter & receiver track - detection by measuring amount of electromagnetic damping on track. Detect vitroceramic T around heat zone (thus cooking pot) by measuring specific resistance of the gold alloy track	Cherry Elec. Products	
9	US 5283412	A device to measure pan or content temperature during induction heating independent of cooking vessel diameter/surface configuration (heat conductor w/ current measurement)	Compagnie Europeenne Pour l'Equipment Menager	
10	JP 00090365	A conductive thin plate is formed of copper foil printed in the thermoplastic resin film polyester film a notch is installed in copper foil. When flame is directly brought into contact with the thermoplastic resin film the thermoplastic resin film is contracted part of the notch in copper foil breaks and it does not conduct	NIPPON SIGNAL CO. LTD	FLAME/FIRE SENSOR
11	Fire Detection w/ Combo Ultrasonic µwave Doppler Sensor	A combined ultrasonic-microwave doppler sensor is developed for a sensitive and fast fire alarm that is robust against false alarm.	Siemens AG	FLAME/FIRE SENSOR
12	Micro-machined Water Sensor for Home Appliance	A new micro-machined relative humidity sensor was developed. Output signal is linearly proportional to relative humidity from 0%-100% RH. Claims: low cost and reliable sensor can be applied to cooking ranges of different types (electrics and gas)	Institut fur Instrumentelle Analytik Hermann-..	HUMIDITY SENSOR
13	Conference pape	Automated Cooking and Frying control using a gas sensor microarray A discussion on a new development effort on a gas sensor microarray that is specifically to determine the doneness level of steak cooking. The sensor is located on the underside of the pan lid.	Institut fur Instrumentelle Analytik	GAS/ODOR SENSOR

Appendix B: Technologies Eliminated in Initial Screen

TECHNOLOGIES ELIMINATED FROM CONSIDERATION FOR VARIOUS REASONS: 29

No	Technology	Description	Company	Explanation
1	JP 4080525	Fire prevention by the comparing the temperature gradient of the pan with pre-set conditions. If gradient < preset value A then actual T is compared to preset Ta, if less, continue. If more stop	NORITZ CORP	Find patent's figure later and realize it is for oven
2	JP 5018539	An odor sensor is used to determine what kind of food is cooked and also to determine if food is over-heating. It is connected to controller that can manipulate heat source	Sharp Corp	Find patent's figure later and realize it is for oven
3	JP 8086445	A contact/touch sensor (combined with Tpan bottom sensor) is used to determine if pan/pot is on top of burner. When pan is not on burner, burner flame is either reduced or off so no cloth/sleeve catch fire	Tokyo Gas Co Ltd	Address only small % of cooking fire
4	JP 4093529	A photoelectric sensor (light projector and receiver) is installed in downdraft cooking vent/hood. When smoke level in the vent is > pre-set value sensor will send signal to turn on alarm and turn off heater	Matsushita Electric Ind. Corp	Optical sensor easily soiled by grease & not accessible for daily cleaning
5	US 5283412	A device to measure pan or content temperature during induction heating independent of cooking vessel diameter/surface configuration (heat conductor w/ current measurement)	Compagnie Europeenne Pour l'Equipment Menager	Only work for induction type cooking hob - very small % in market
6	JP 9056601	Tsensor at suction passage below burner through its circumference and in smoke duct below burner system. When abnormal heat is detected, alarm turns on and gas valve is turned off	Yamaoka Kinzoku Kogyo KK	Detection threshold might easily be compromised - dirt/boil-over
7	JP 4006325	An energy (Temp) sensor is installed within a downdraft duct behind burner. When food overheat (oil) The energy sensor detected pre-set radiation energy from cooktop, turn off burner and stop blower	Matsushita Electric Ind. Corp	Sensor easily soiled by grease & not accessible for daily cleaning
8	JP 7171061	T sensor is directly inserted to pan/pot content. T sensor is attached to an alarm system that can generate synthesized voice to alert cooker of cooking fire danger when Tfood/oil ~ Tthres (eg. 200 C)	None	User have to install/uninstall sensor everytime used - nuisance
9	US 5608378	Power level (elec) or flame (gas) sensors. If sensor detect heat source is on, a warning indicator located next to exit door/audible alarm turns on when door is opened – prevent unattended/accidental on	None	Does not seem to be very effective High likelyhood of false alarms
10	US 5942816	Modified fuse for electric cooktop with build-in timer. Each heat element ctrl knob has 1 fuse. The modified fuse will turn off heat element to reset after a pre-determined period of time (pre-set or user-selected)	None	Timer period selection is arbritrary or dependent on user - not desireable to let user define safety limits
11	US 4577181	A contact sensor for electric heater to detect pan/pot presence above heater detailed sensor drawing	Fissler GmbH Germany	Only address fires from non-food mat'l small % of cooktop fire source
12	US 3781506	Non-contact T sensor for cooking vessel, specifically for induction electric cooktop.	General Electric Co. Schenectady	Not many induction cooktop in the market today
13	JP 5018539	Auto detect of food type using odor sensor. Use food type info. for auto. cooking and use odor data to determine food fire and manipulate burner (shut-off) when that happens	Sharp Corp	Find patent's figure later and realize it is for oven
14	US 4483314	Pull out blanket from drawer underneath the burner/heat source. Used to manually smother fire	None	User has to manually smother fire – harmful
15	JP 10201871	Manual fire extinguishing sheet. Fire extingusih agent is suspended in a flexible & fusible encasing from polyethylene film. When fire occurs drape sheet on stove to melt film and delivers extinguisher	None	User has to manually smother fire – harmful
16	JP 8107942	Nozzles connected to pressurized water source capable of delivering fine water mist/fog to suffocate and cool fire/stove. Using fusible parts to activate nozzles	NOHMI BOSAI LTD	Water is not recommended to turn off grease fire
17	JP 9117329	Incombustible back panel for wall cover	MATSUSHITA ELEC. WORKS LTD	Only contain fire from burning back wall
18	JP 9206393	Kitchen mat with incombustible material to smother fire manually	DUSKIN CO LTD	User has to manually smother fire – harmful
19	JP 11221297	Extinguish stove fire and prevent fire from expanding into hood duct. Nozzle that sprays water droplet is situated inside the duct of a range hood to spray into duct an onto stove surface	BUNKA SHUTTER CO LTD	Water is not recommended to turn off grease fire
20	JP 2045073	Water sprayed from surrounding pipe frame to cool and suppress fire. After flame has subsided, a metal plate covers pot automatically	None	Water is not recommended to turn off grease fire
21	JP 1015068	Range hood act as a fire enclosure/containment unit. Drops down to cover entire cooking unit – manually activated	None	Has to manually activate sys. Harmful to user
22	US 4633230	A temperature sensor is attached at the end of a 2 bar link arm that can be adjusted to contact the cooking container. The temperature sensor will convert the measured cooking vessel temperature into electrical signal that will signal alarm in cases of boil over or boil dry.	None	Very cumbersome setup. Will affect cook's performance to have this arm sticking out on the way. Can be harmful if it obstruct cook's movement and cause spills etc.
23	Conference paper	Automated Cooking and Frying control using a gas sensor microarray A discussion on a new development effort on a gas sensor microarray that is specifically to determine the doneness level of steak cooking. The sensor is located on the underside of the pan lid.	Institut fur Instrumentelle Analytik	Sensor can only judge the doneness of meat during steak frying only. Still at early stages of development
24	Conference paper	Fire Detection w/ Combined Ultrasonic-Microwave Doppler Sensor A description of a new development of a fire detection system that combined two sensors: ultrasound and microwave Doppler sensor to reduce the incidence of false alarms	Siemens AG	Sensor is still at early stage and looks to be too expensive an addition to cooktop or hood
25	Fire Breaker Fuel Neutralizer	Manual fire extinguisher material (powder in bottle)	National Fireproofing Co.	User has to manually spray the product on the fire – considered unsafe proximity
26	Stovetop FireStop	Hood installed (magnet) extinguisher - No pressurized tank	Williams Pyro Inc.	Product not applicable for grease fire since it is released w/ large pressure that can splatter the grease and fire to surrounding
27	Simmer Sentry	Tsensor + acoustic sensor directly in contact w/ food. The sensor sticks out of the back panel of the cooktop and its sensor tip is immersed in the cooking liquid	GRI	Only to detect the presence of boiling in liquid cooking. Also the protruding sensor is not practical in real cooking scenario
28	Fire Line	Hood installed extinguisher using fusible link	Ansul Fire Suppression System	System is applicable for commercial kitchens
29	Firemelt hood system	Hood installed extinguisher using fusible parts and a new powder extinguisher that suppse to work well with grease fire too.	Firemelt	No clear description of product and company did not return contacts

COOKING METHODS DEFINITIONS

1. **Sauté:**
   To sauté is to cook a food quickly in a small amount of fat over a relatively high direct heat. First, heat the pan over a medium flame, then add your fat. Once the fat begins to ripple, add your ingredient. It is very important not to crowd the pan or the liquid released from the food will actually cause steaming rather than sautéing.
2. **Searing:**
   To sear means to cook food over a very high, dry heat to seal a surface--and seal in juices. This is usually done in a skillet or under a broiler. The high heat caramelizes the naturally occurring sugars present in the food and produces a flavorful crust. Browning becomes apparent when the food's surface reaches approximately 310 F.
3. **Stir-fry:**
   To stir-fry means to cook food quickly, stirring constantly over extremely high heat in a small amount of fat. This technique is traditionally performed in a wok. Since the heat is intense, it's best to use a fat with a high smoke point, such as peanut, canola, corn or safflower oil, or lard. The wok must be very hot before the fat is added or the fat and food will stick.
4. **Blackened**
   Meat or fish is cooked in a cast-iron skillet that's been heated until almost red hot. The food is customarily rubbed with a cajun spice mixture before being cooked. The extra hot skillet combined with the seasoning rub gives food an extra crispy crust.
5. **Browning**
   To cook quickly over high heat, causing the surface of the food to turn brown while the interior stays moist. This method not only gives food an appetizing color, but also a rich flavor. Browning is usually done on top of the stove, but may also be achieved under a broiling unit.
6. **Caramelize**
   To heat sugar until it liquefies and becomes a clear syrup ranging in color from golden to dark brown (from 320 degrees to 350 degrees F on a candy thermometer).
7. **Blanching:**
   The term "blanching" refers to the technique of plunging a food, usually a vegetable or fruit, into boiling water until either its color has set or the food has softened slightly. This takes anywhere from a few seconds to several minutes, depending on what is being blanched.
8. **Parboiling:**
   It is a technique that is similar to blanching, but takes a bit longer. Parboiled food is actually partially cooked.
9. **Melting Chocolate:**
   Chocolate scorches easily, melt slowly over low heat. Place the chocolate in a double boiler over simmering water, remove from heat when halfway melted, and stir until smooth. 4 ounces of chocolate takes about 3 min.

10. Simmering:

To cook food gently in liquid at a temperature (about 185 degrees F) low enough that tiny bubbles just begin to break the surface. Cooking time varies from short (less than 10 minutes) to long (more than 1 hr)

11. Canning:

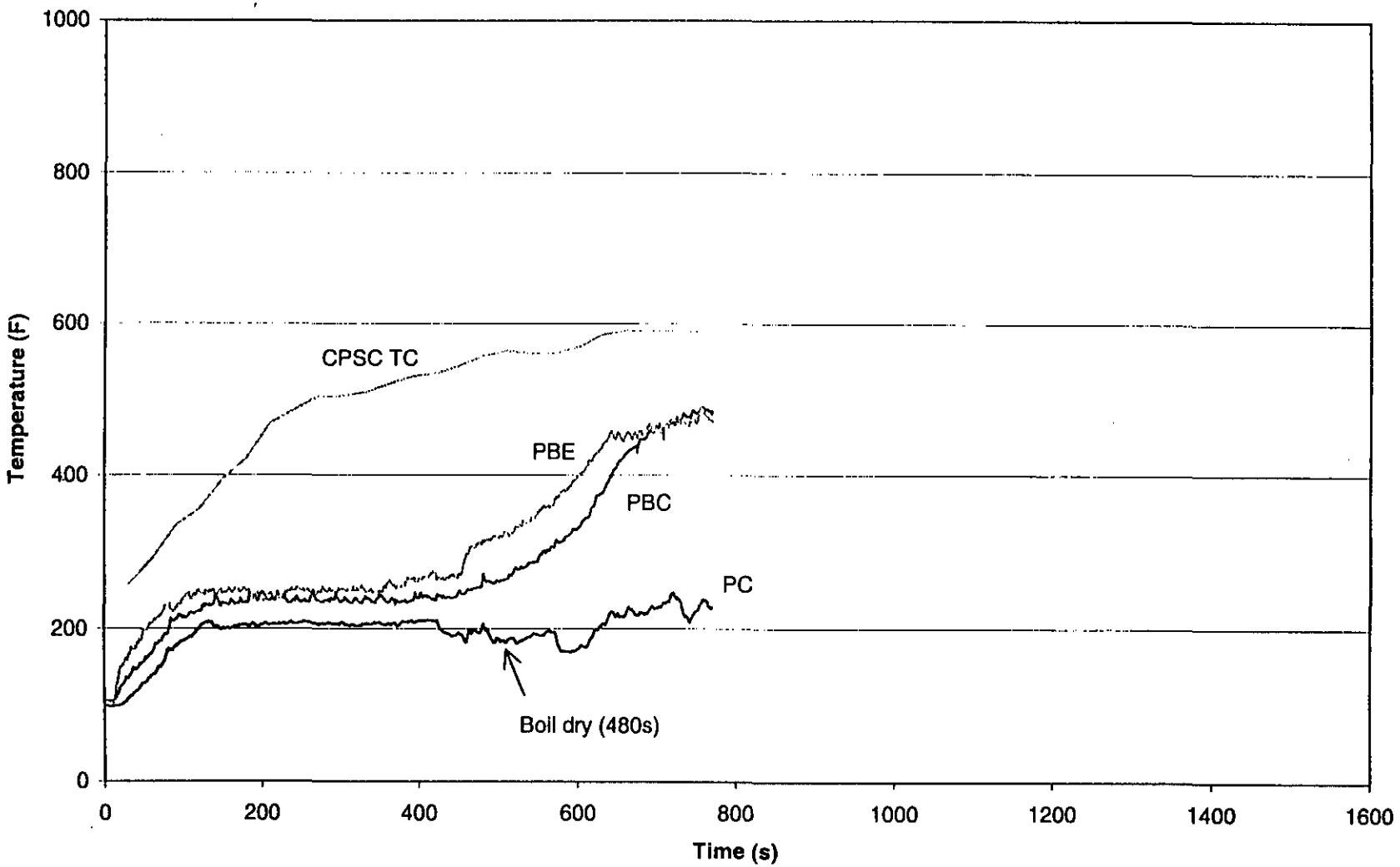
Boiling-Water Canners: These canners are made of aluminum or porcelain-covered steel. They have removable perforated racks and fitted lids. The canner must be deep enough so that at least 1 inch of briskly boiling water will be over the tops of jars during processing. To ensure uniform processing of all jars with an electric range, the canner should be no more than 4 inches wider in diameter than the element on which it is heated. Cooking time is between 10-45 min depending on type of canner used and type/amount of food canned. Boiling canner has a large diameter (found one w/ 16.5" diameter). Pressure canner w/ diameter of 12.25" to 15.25".

12. Braising

A cooking method by which food (usually meat or vegetables) is first browned in fat, then cooked, tightly covered, in a small amount of liquid at low heat for a lengthy period of time (Can be > 1hr). The long, slow cooking develops flavor and tenderizes foods by gently breaking down their fibers. Braising can be done on top of the range or in the oven. A tight-fitting lid is very important to prevent the liquid from evaporating.

Appendix D: Temperature Measurements from ADL Cooking Tests

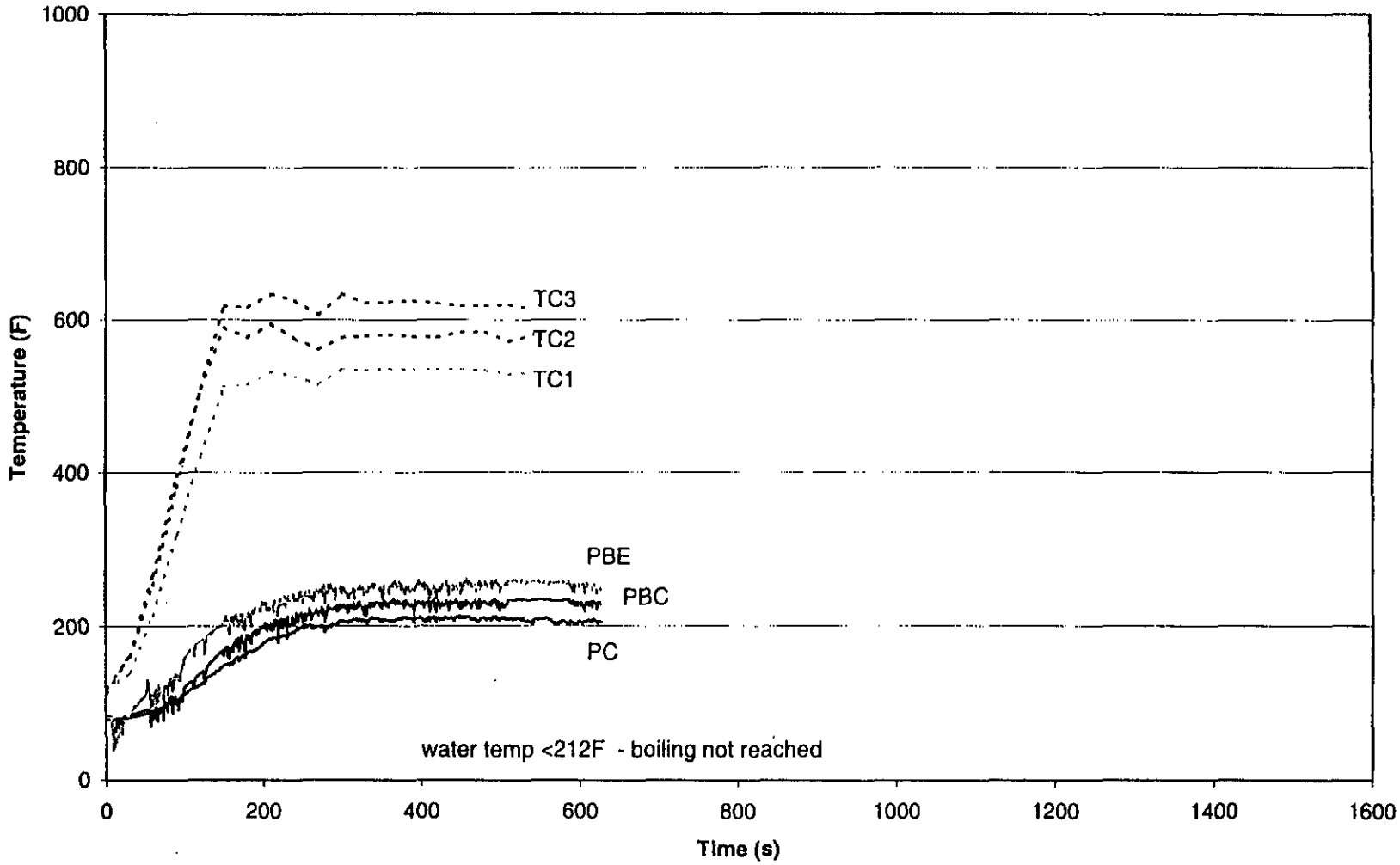
100ml Water Test in Stainless Steel Pan on CPSC Gas Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

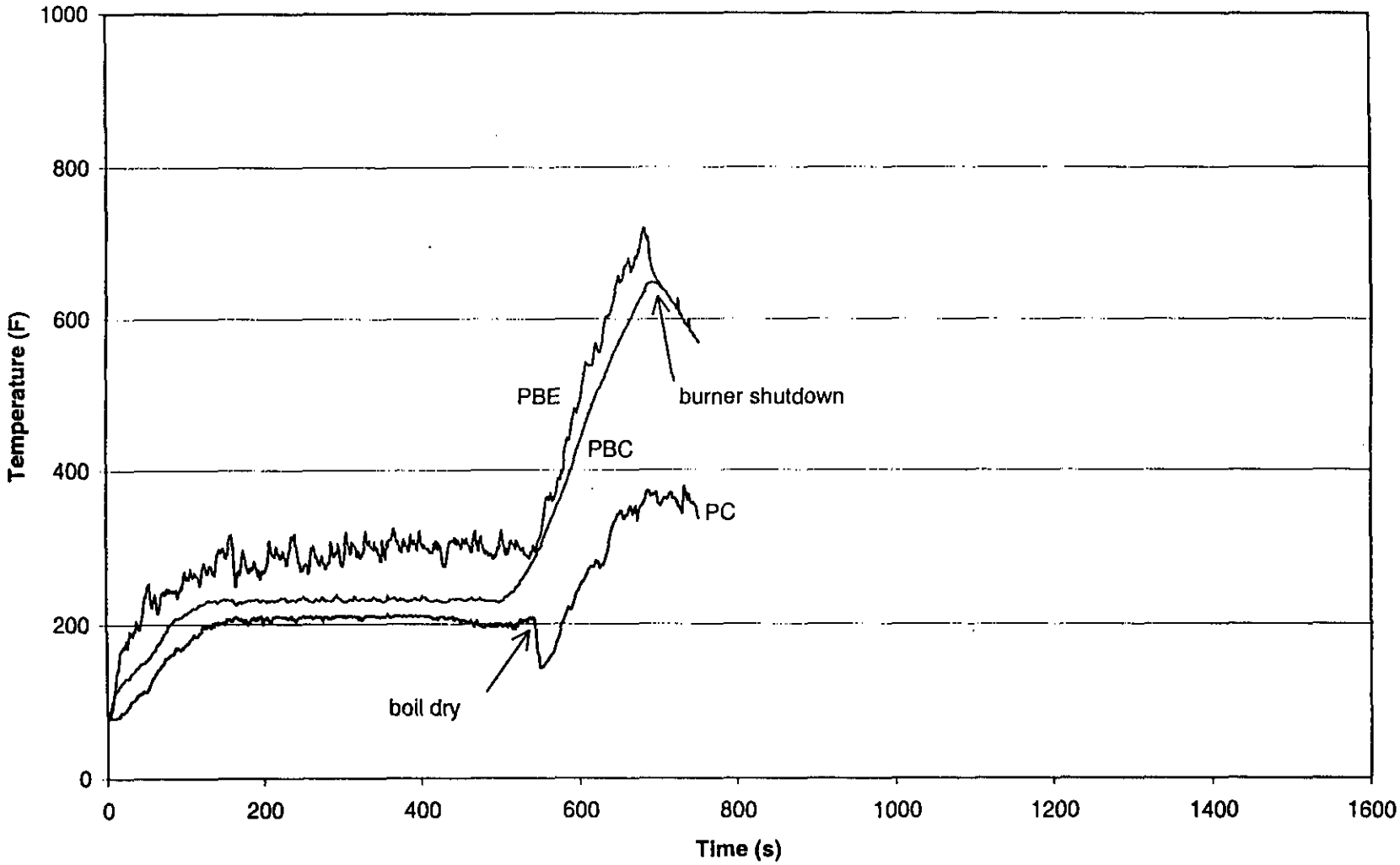
Arthur D Little

100ml Water Boil Test in Stainless Steel Pan on CPSC Electric Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

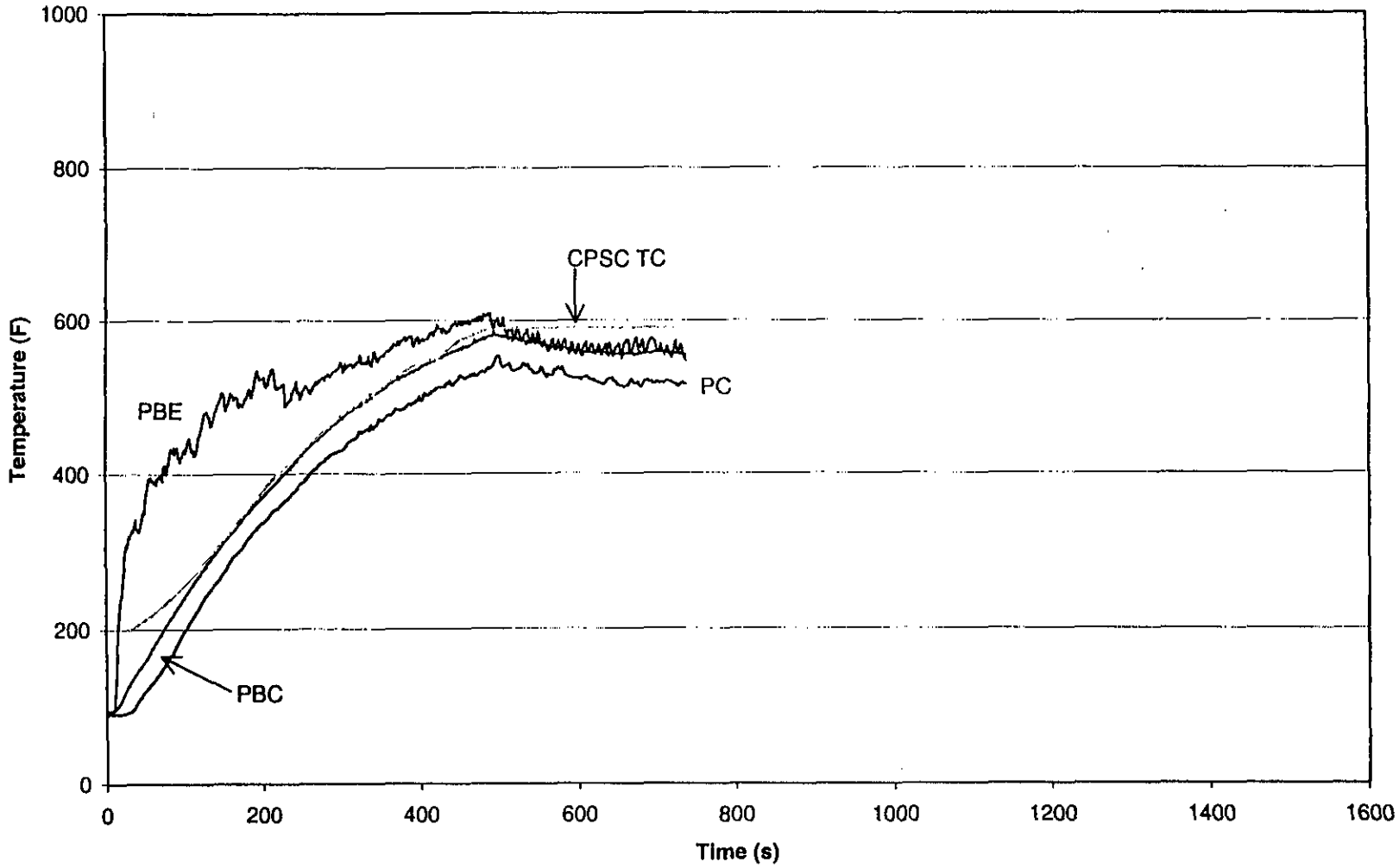
100ml Water Boil Test in Stainless Steel Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

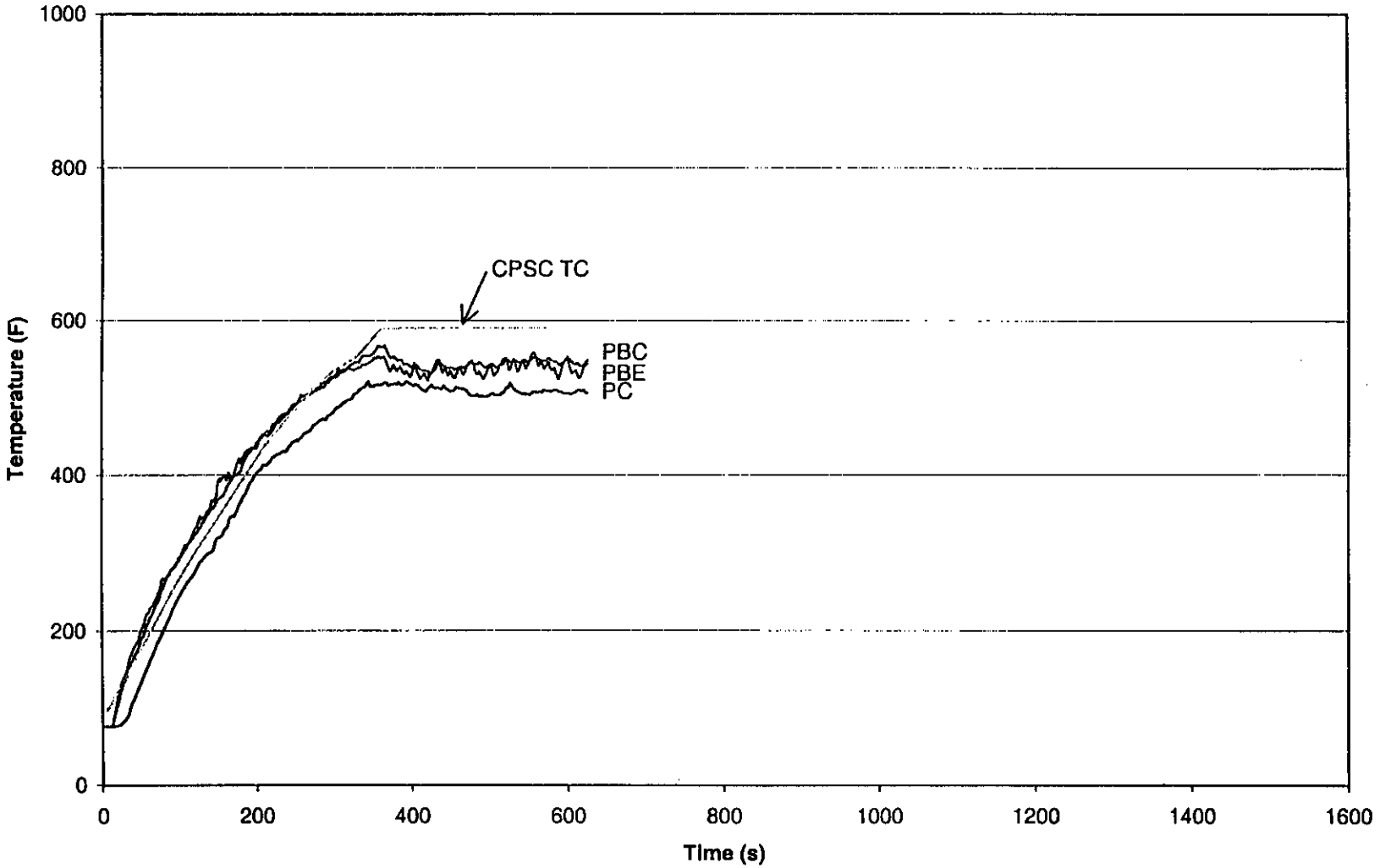
Arthur D Little

100ml Oil Test in Stainless Steel Pan on CPSC Gas Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

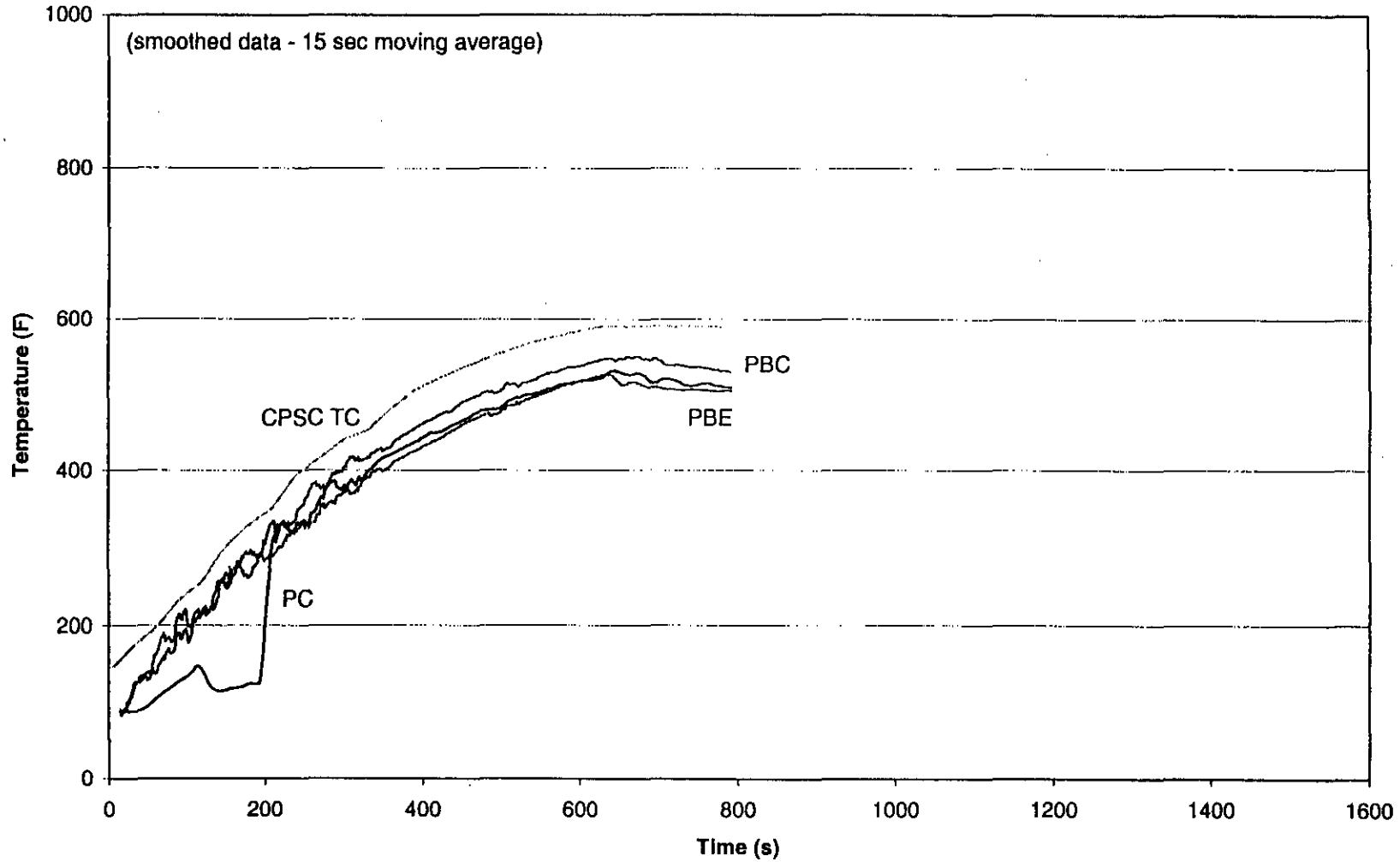
100ml Oil Test in Aluminum Pan on CPSC Gas Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

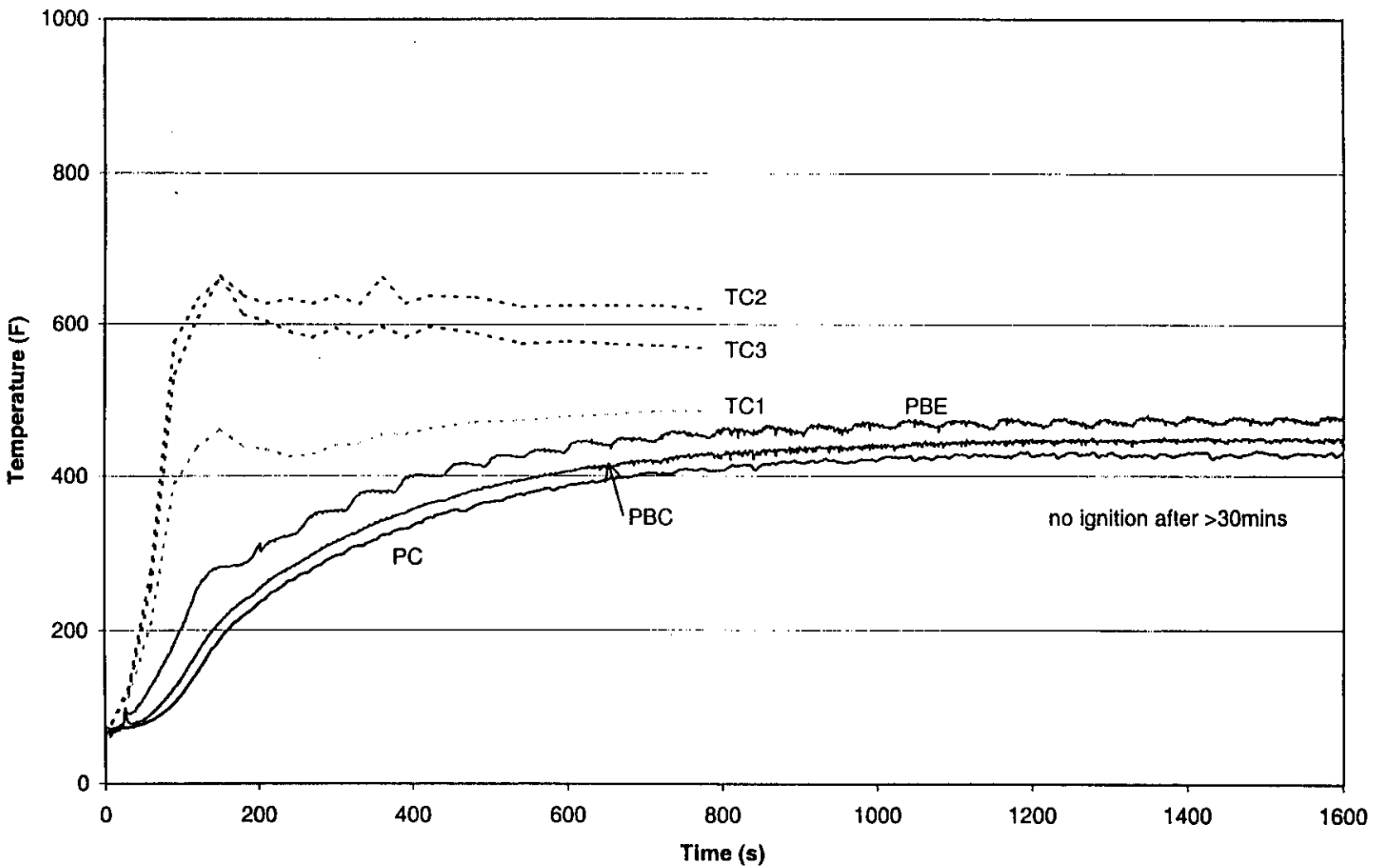
Arthur D Little

100ml Oil Test in Cast Iron Pan on CPSC Gas Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

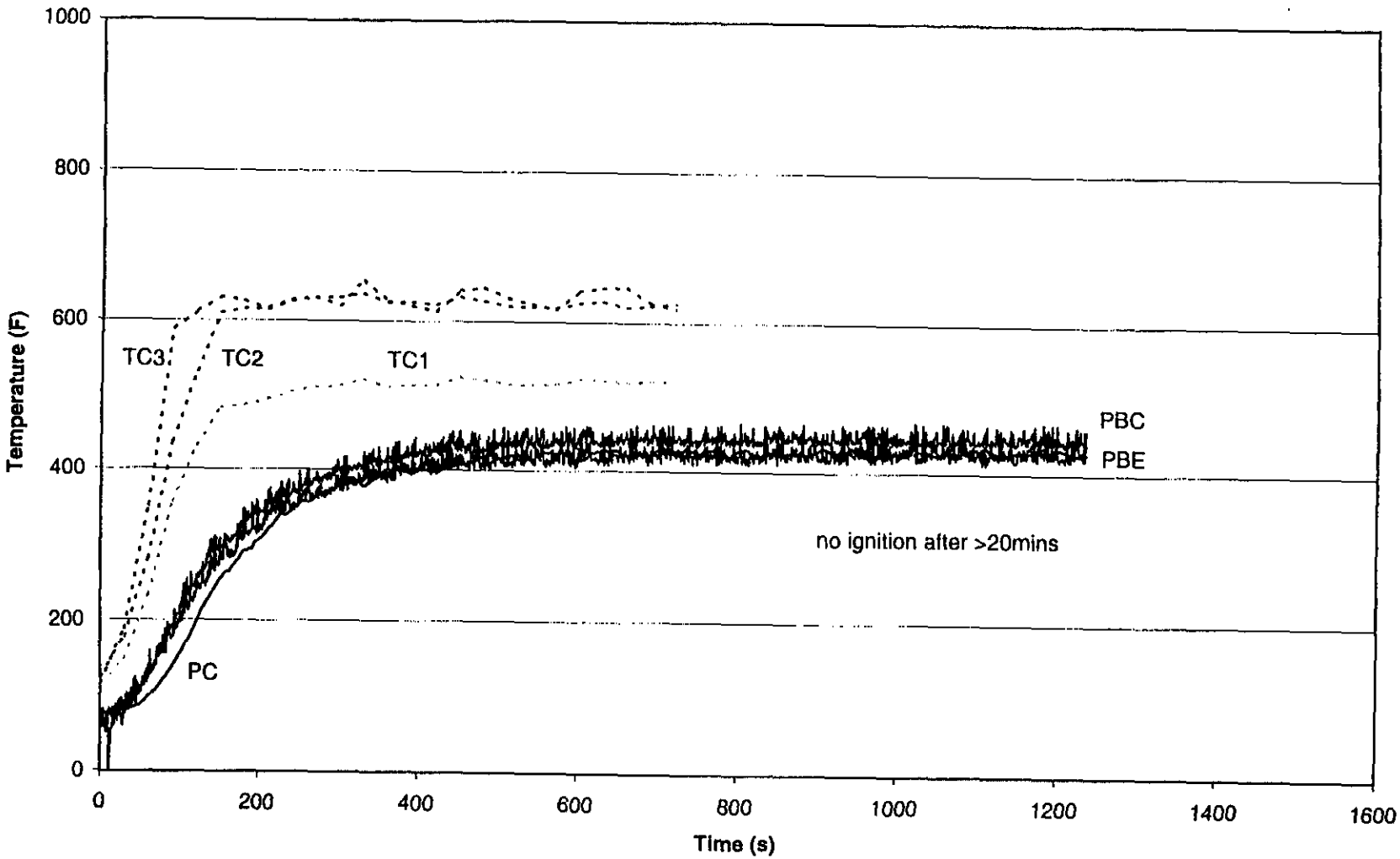
100ml Oil Test in Stainless Steel Pan on CPSC Electric Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

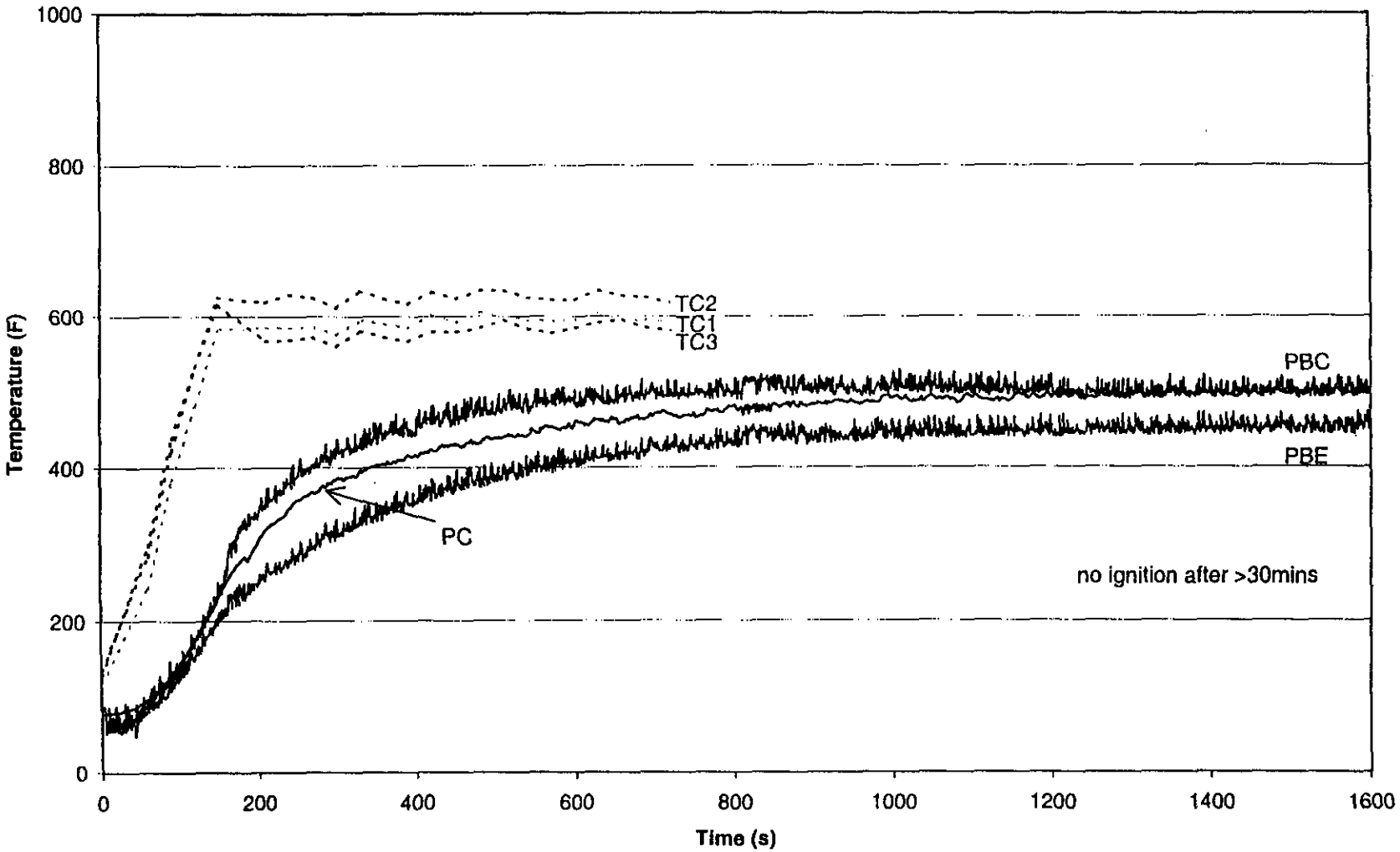
Arthur D Little

100ml Oil Test in Aluminim Pan on CPSC Electric Range



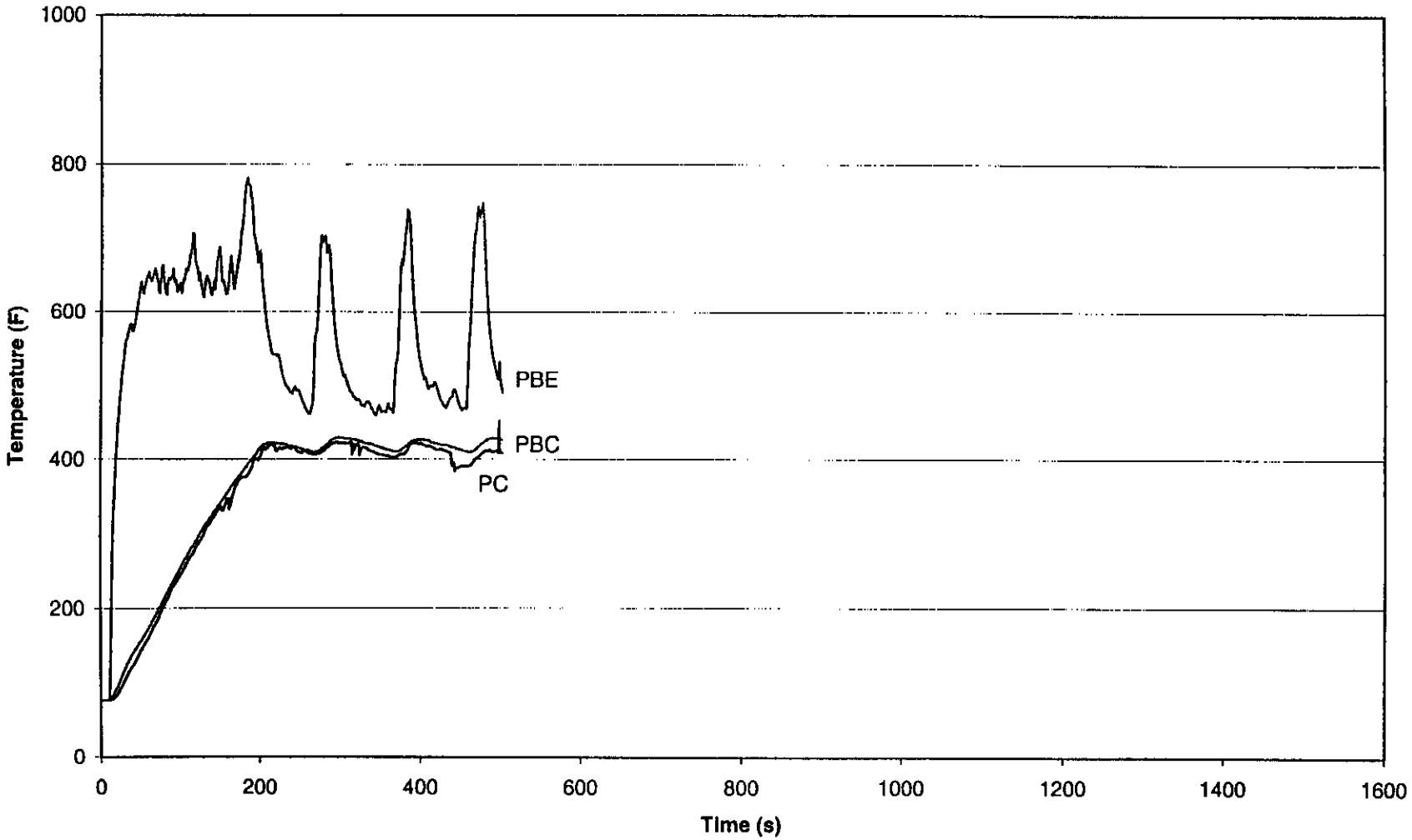
PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

100ml Oil Test in Cast Iron Pan on CPSC Electric Range



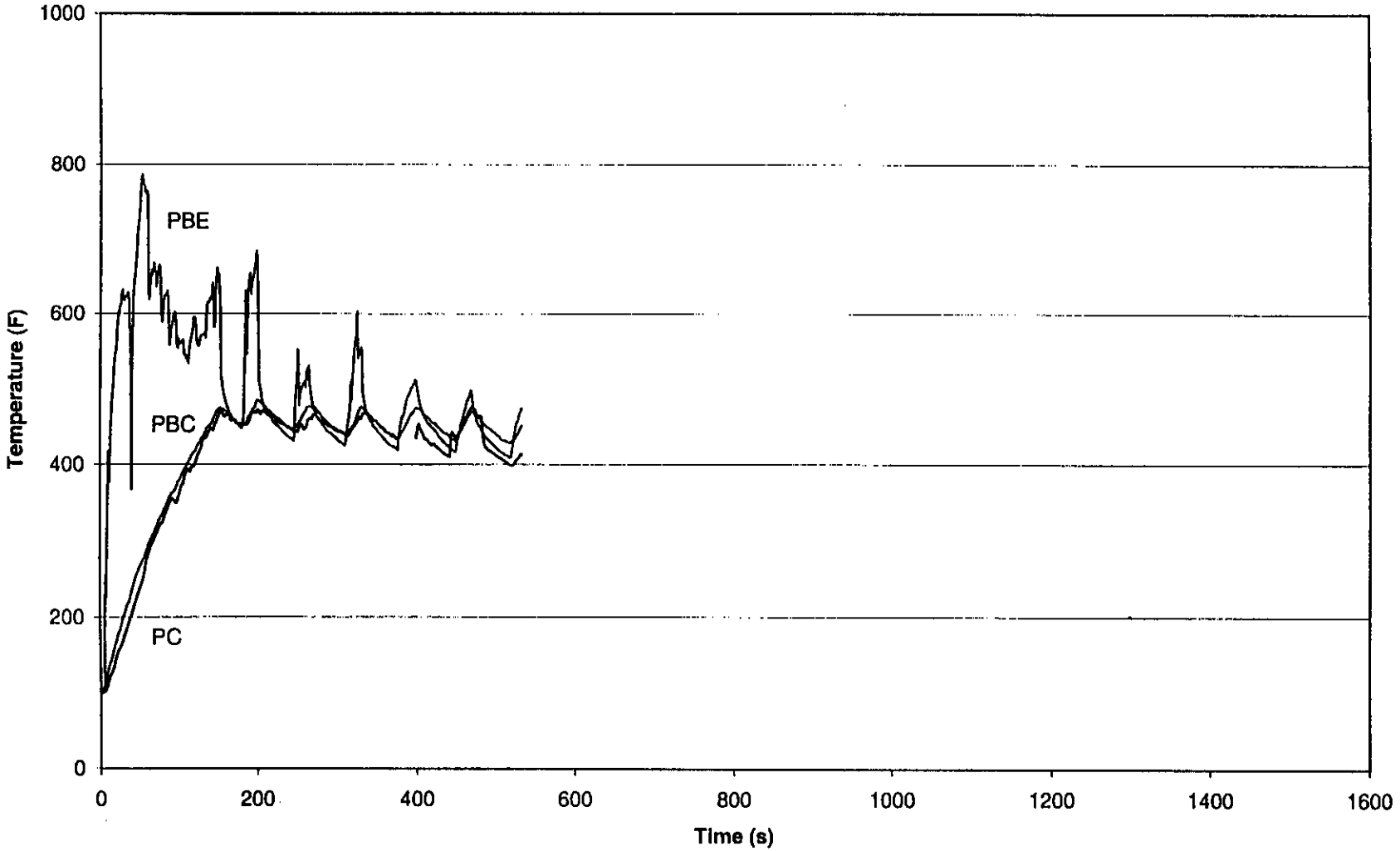
PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

100ml Oil Test in Stainless Steel Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

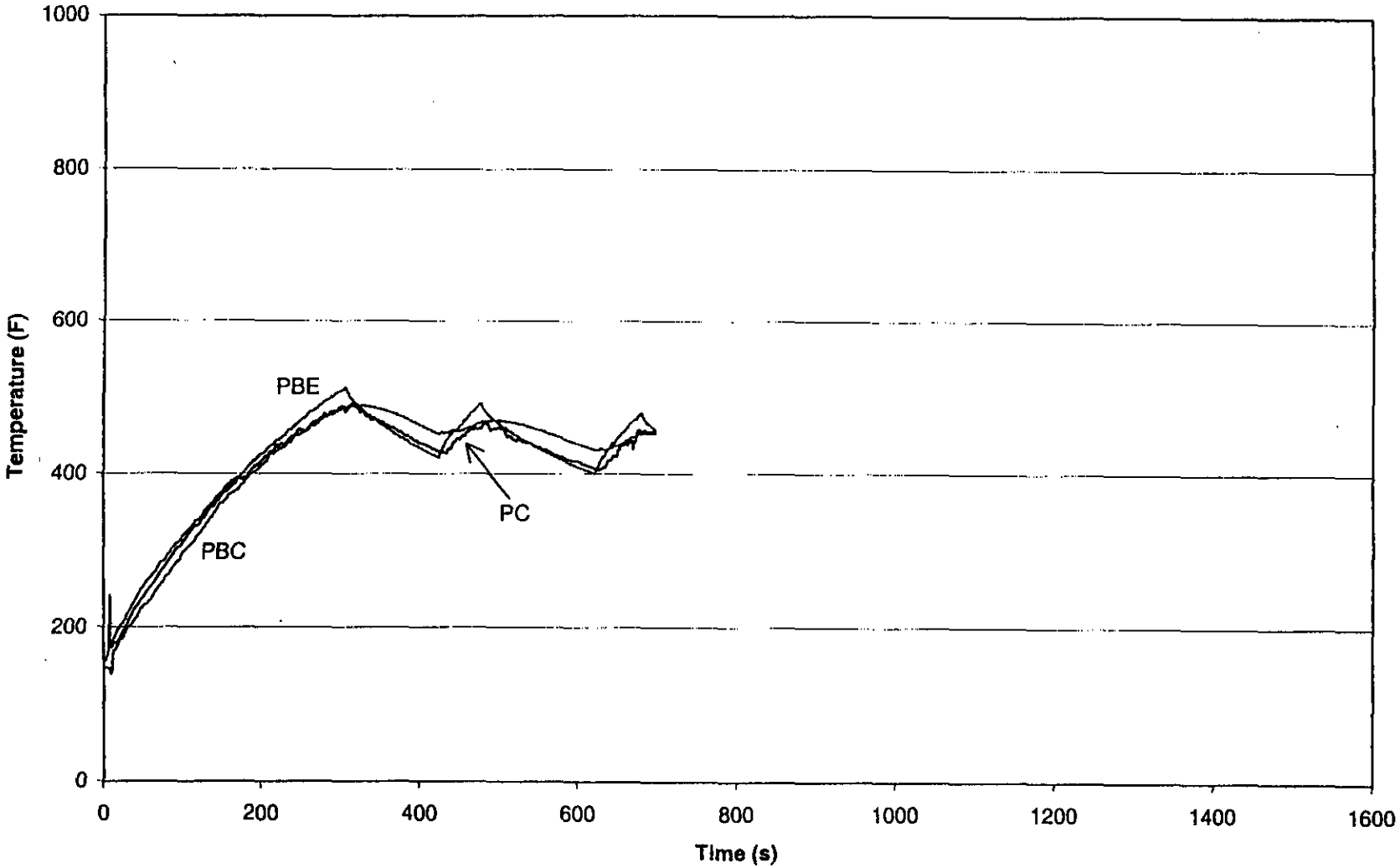
100ml Oil Test in Aluminum Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

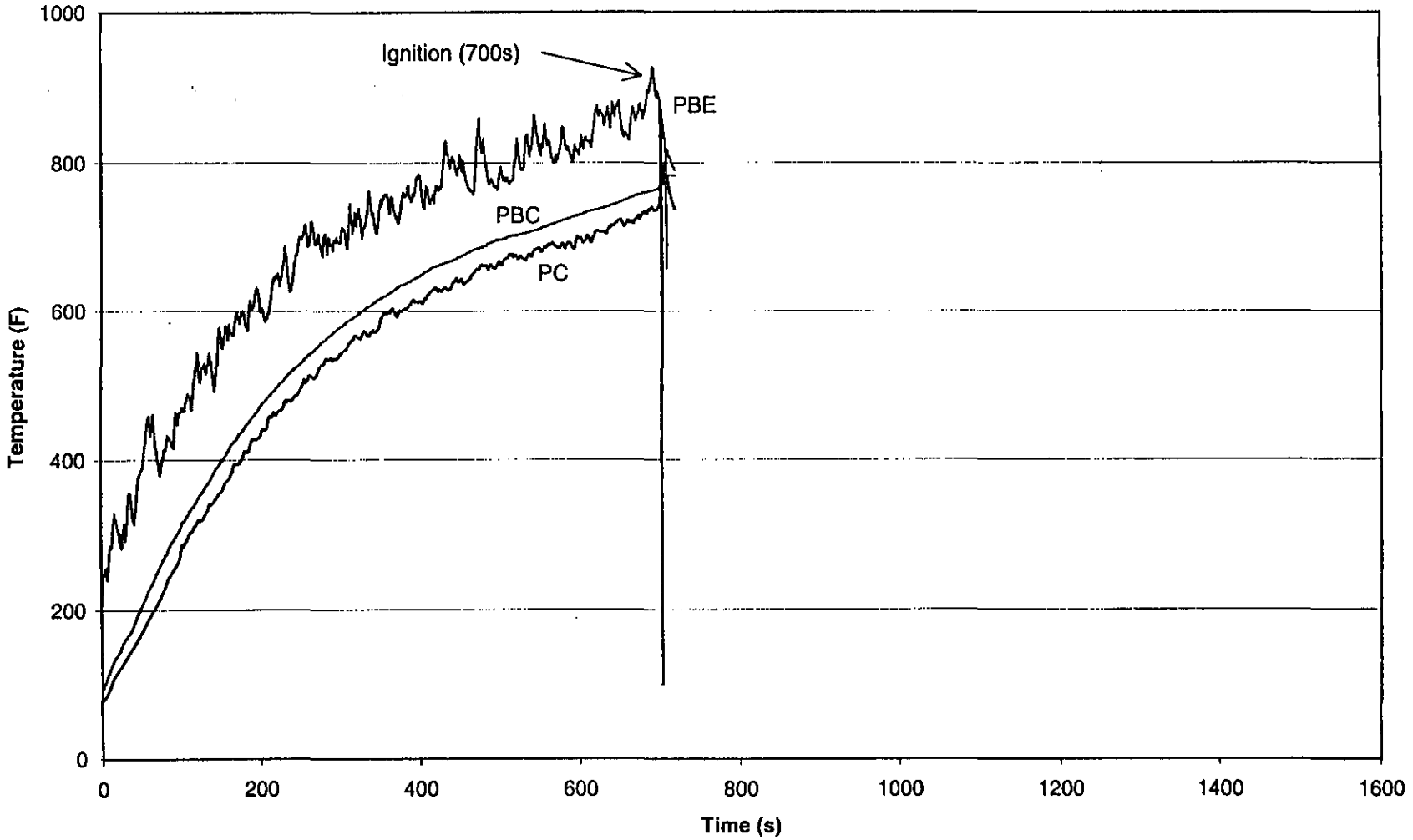
Arthur D Little

100ml Oil Test in Cast Iron Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

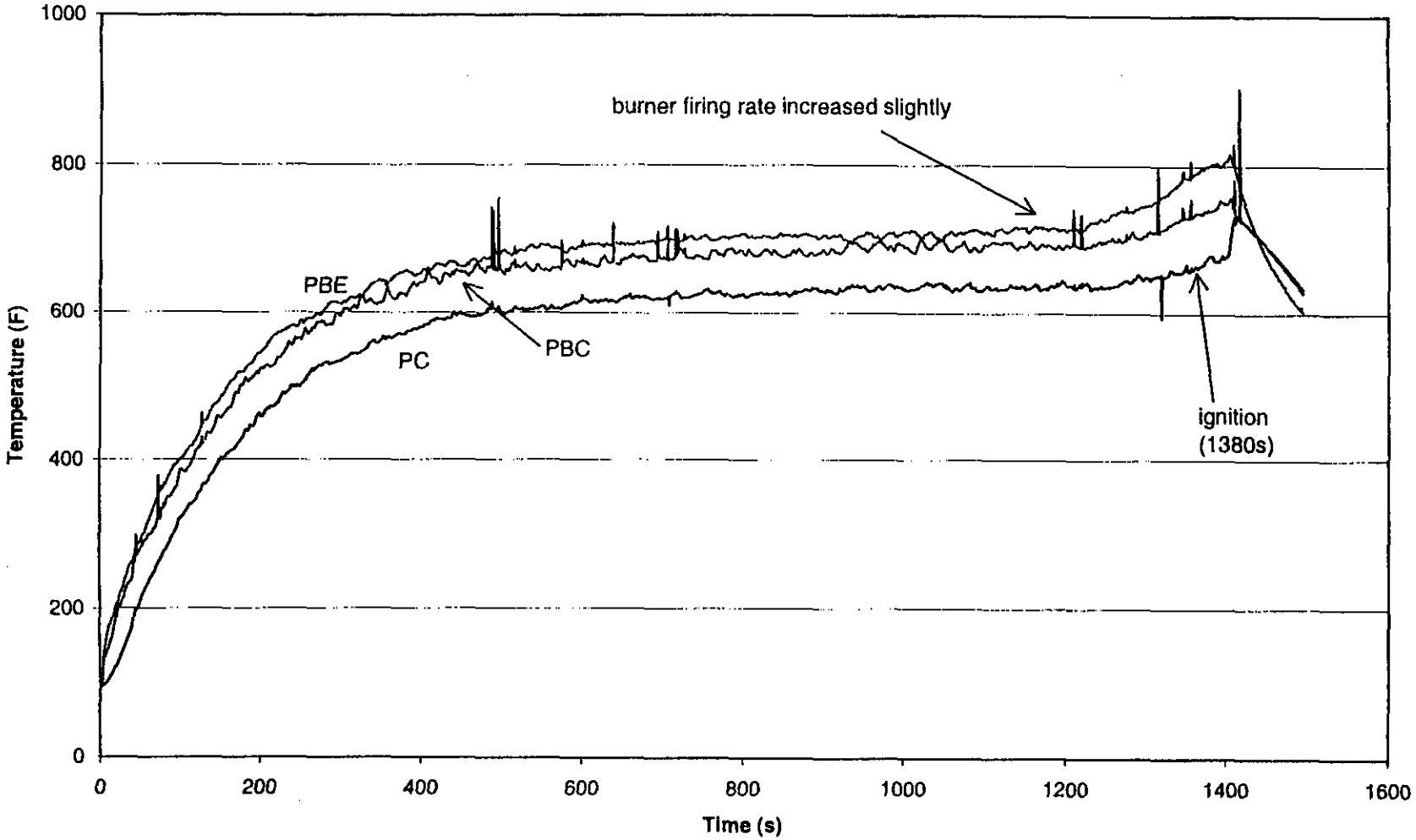
Oil Ignition Test on Rinnai Uncontrolled Burner in Stainless Steel Pan



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

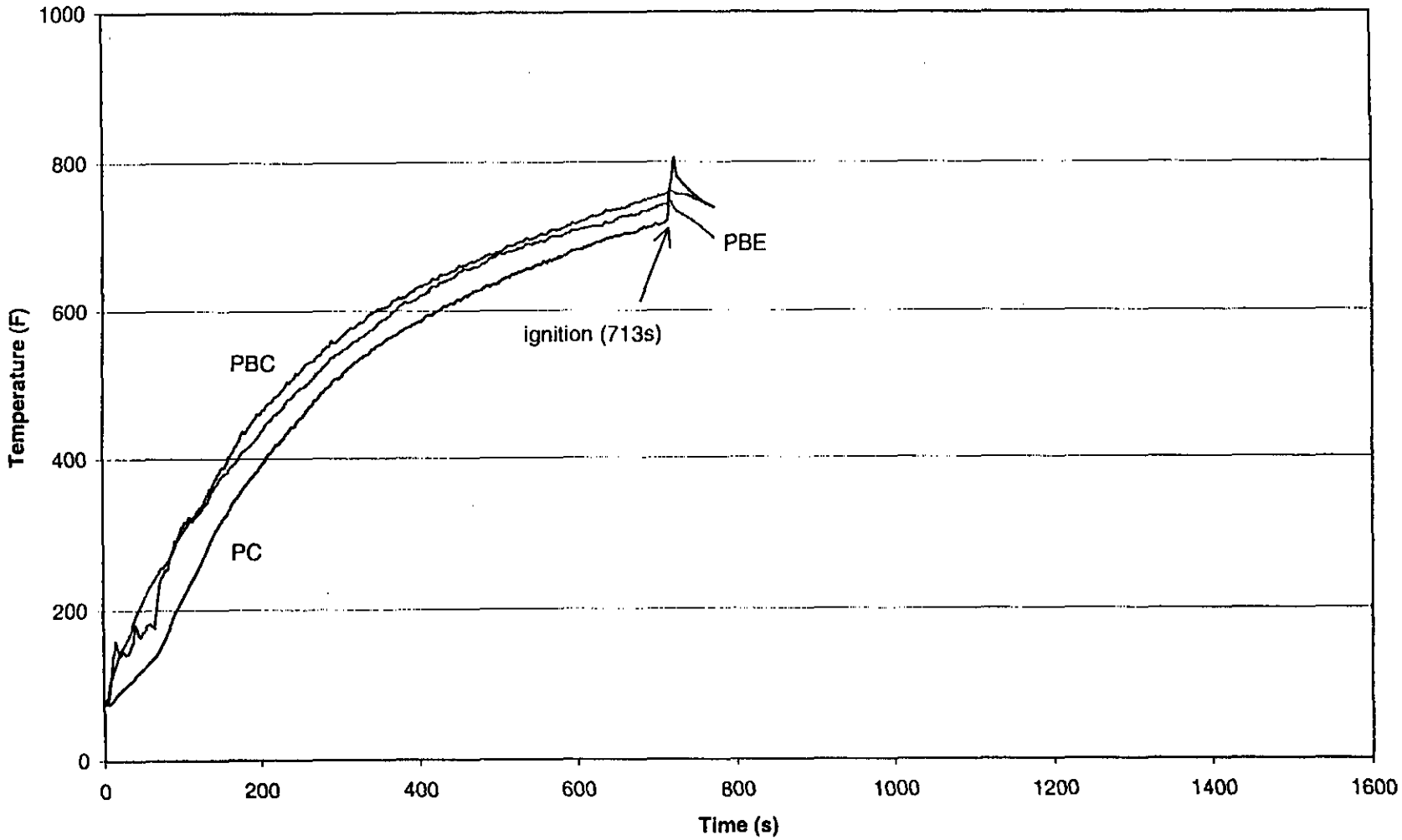
Arthur D Little

Oil Ignition Test on Rinnai Uncontrolled Burner in Aluminum Pan



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

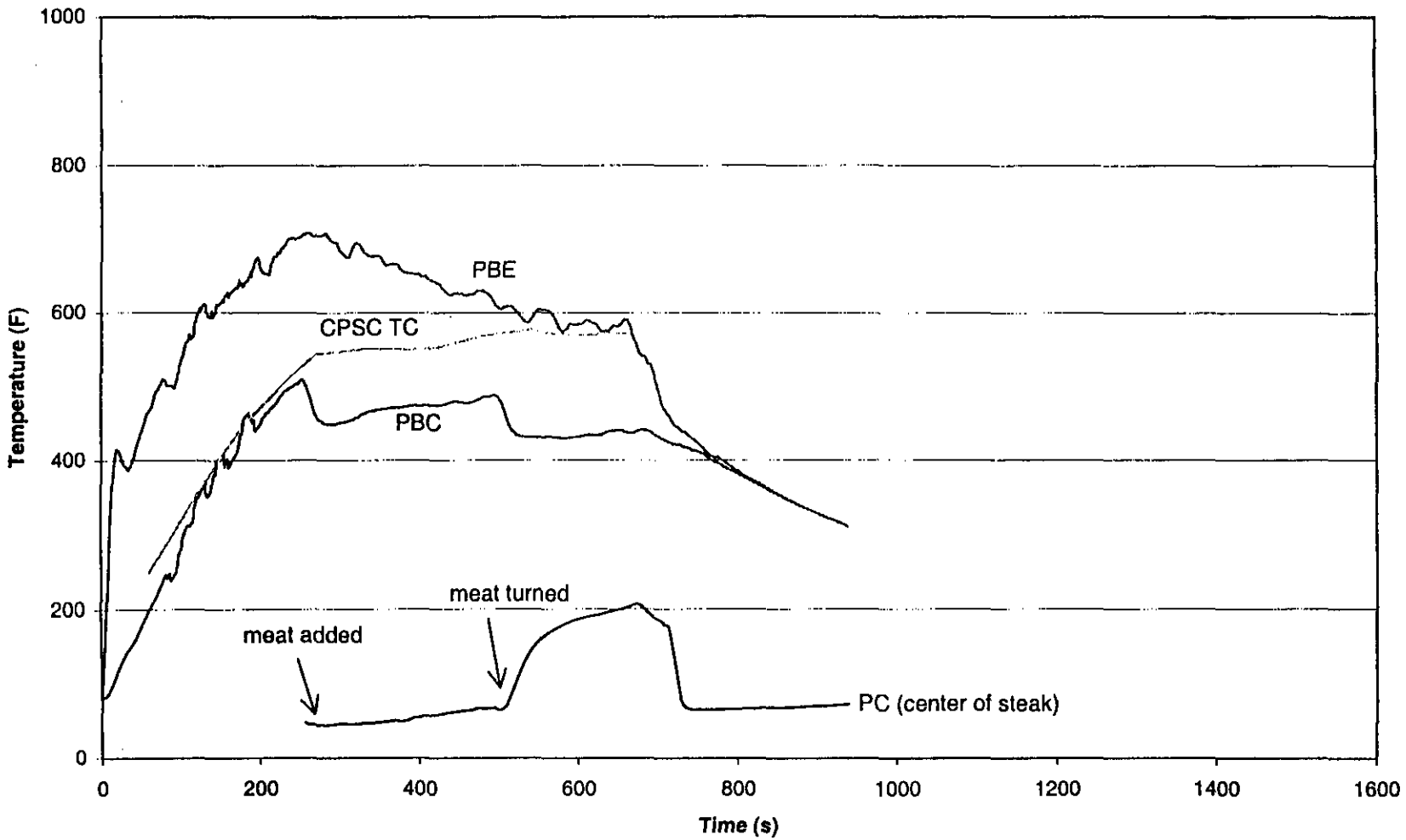
Oil Ignition Test on Rinnai Uncontrolled Burner in Cast Iron Pan



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

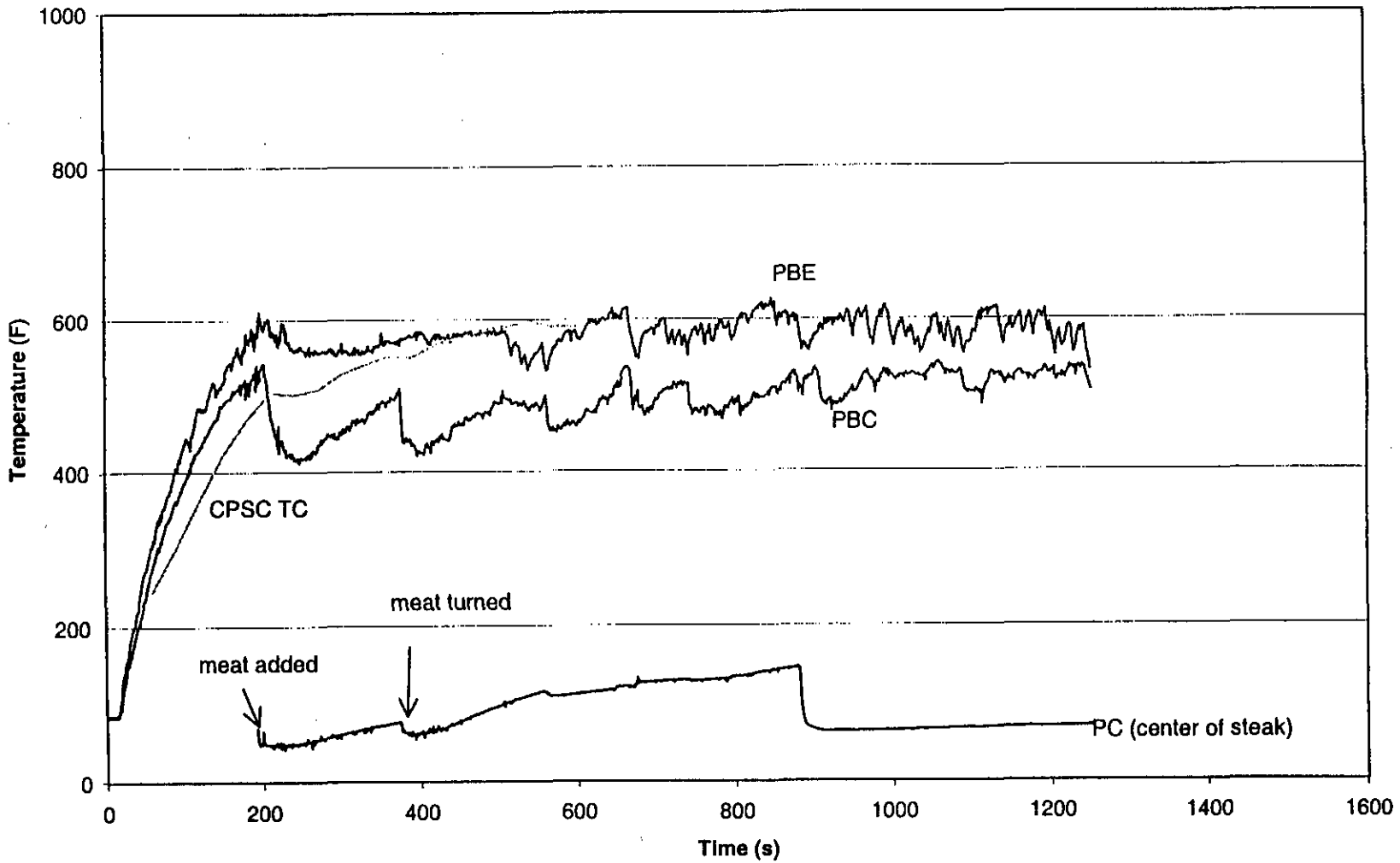
Arthur D Little

Searing Steak in Stainless Steel Pan on CPSC Gas Range



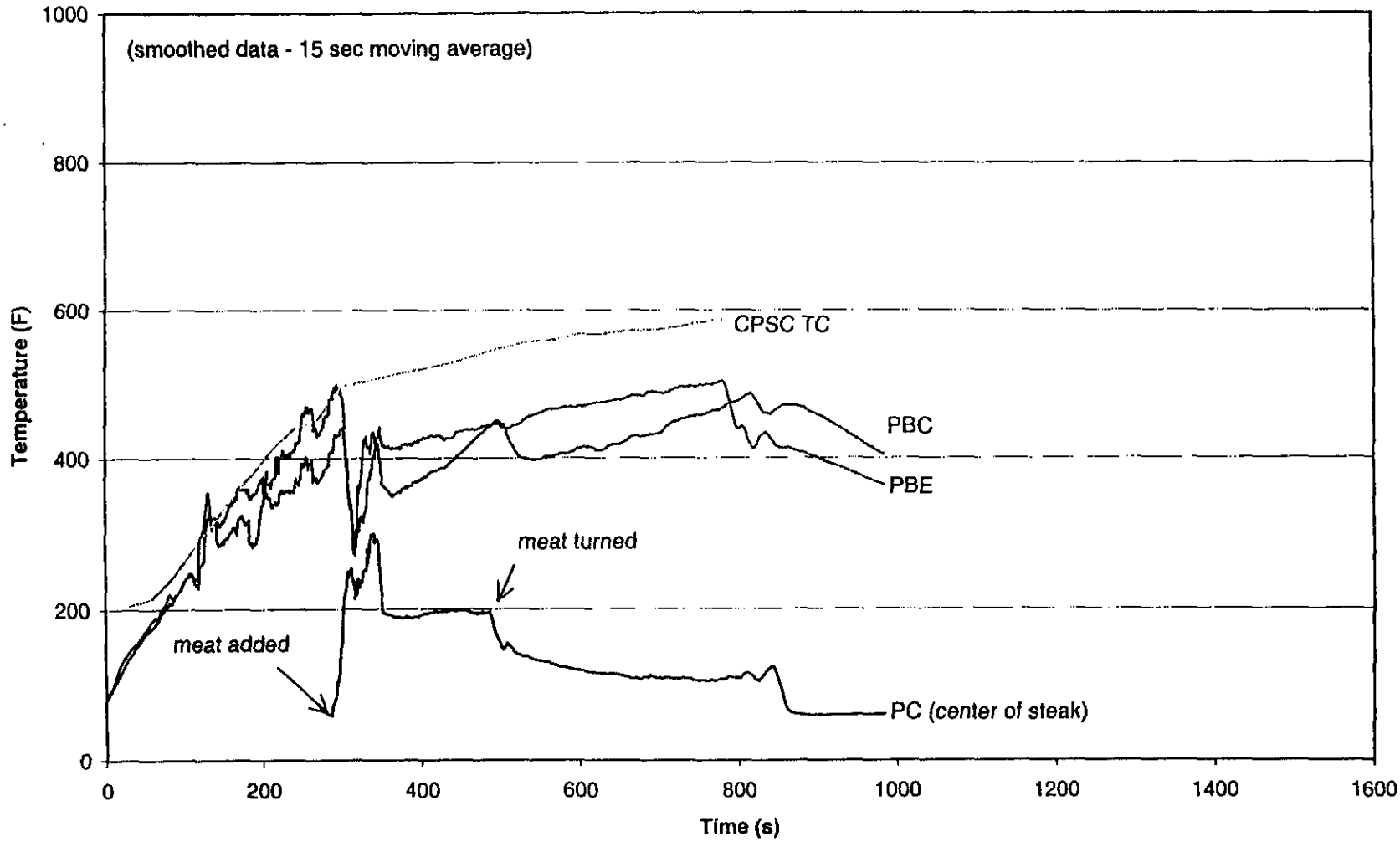
PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

Searing Steak in Aluminum Pan on CPSC Gas Range



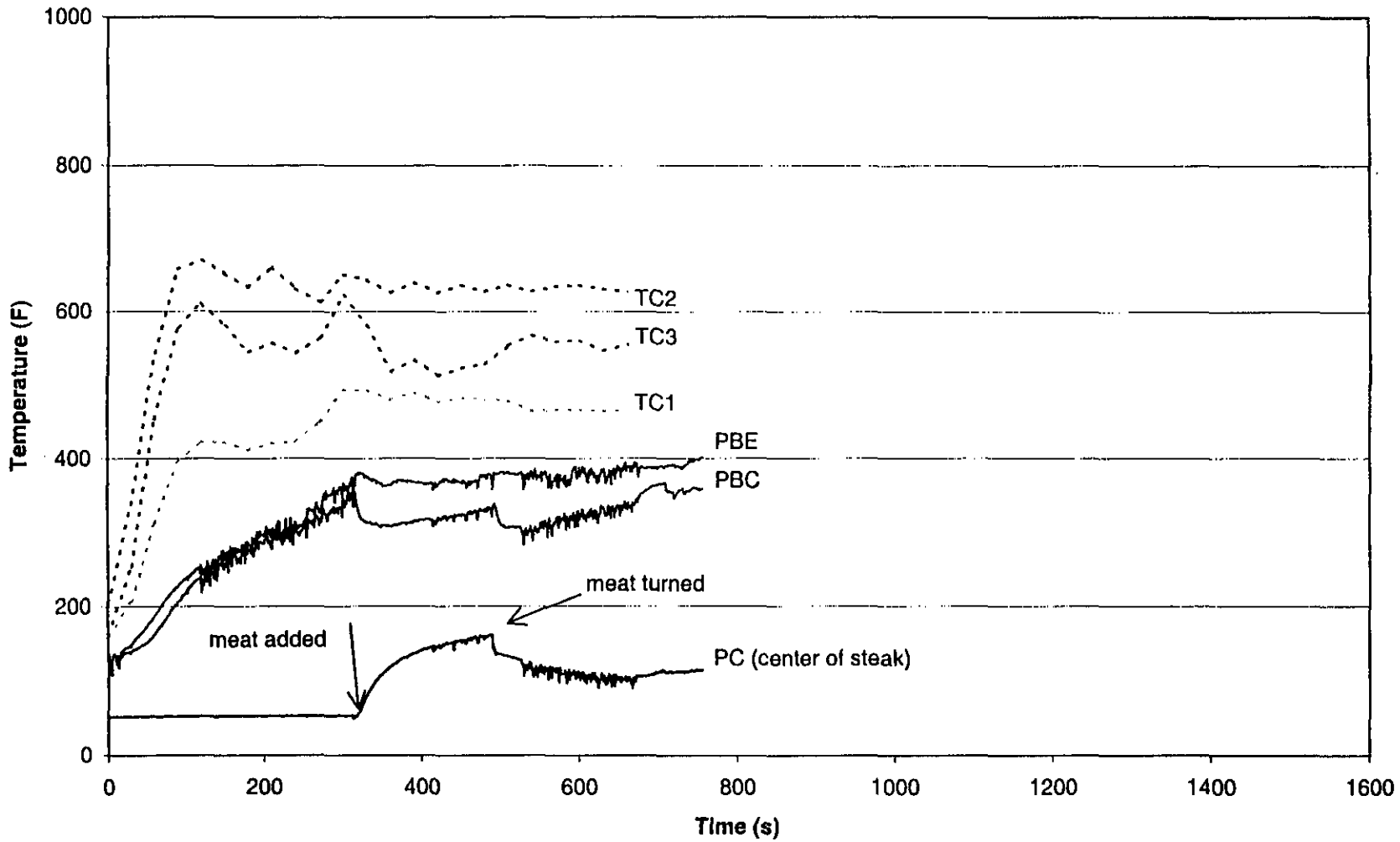
PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

Searing Steak in Cast Iron Pan on CPSC Gas Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge CPSC TC = built-in thermocouple

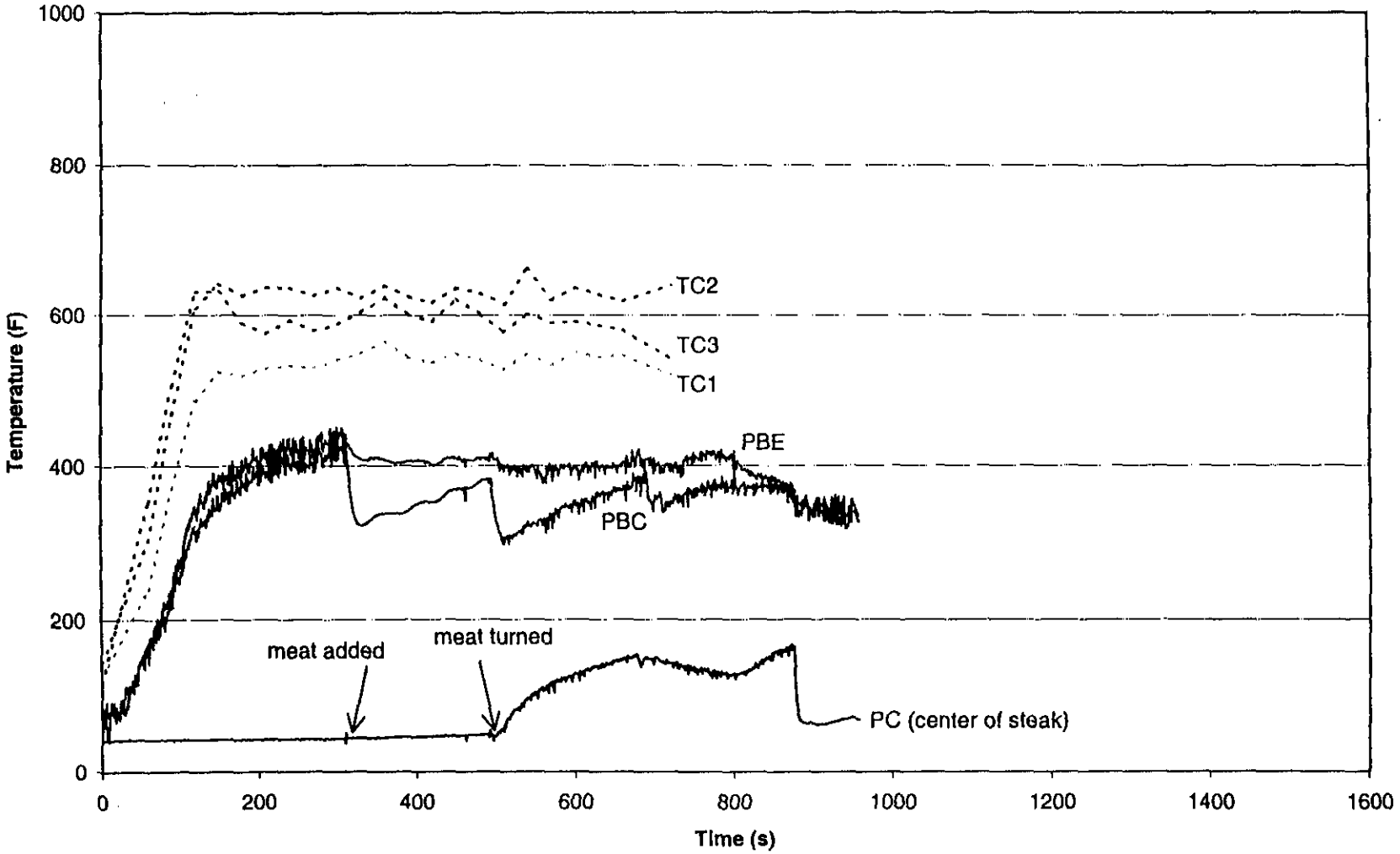
Searing Steak in Stainless Steel Pan on CPSC Electric Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

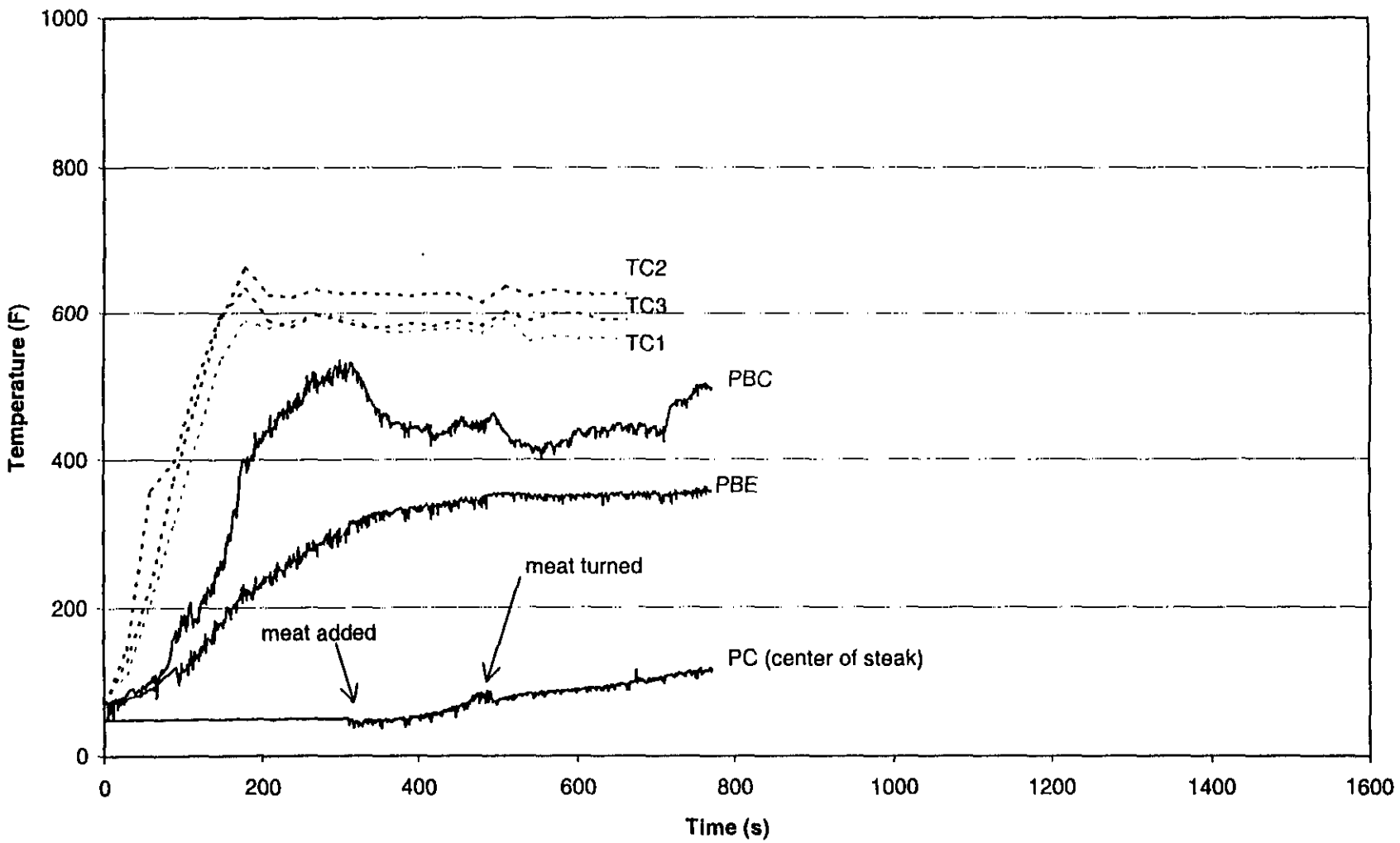
Arthur D Little

Searing Steak in Aluminum Pan on CPSC Electric Range



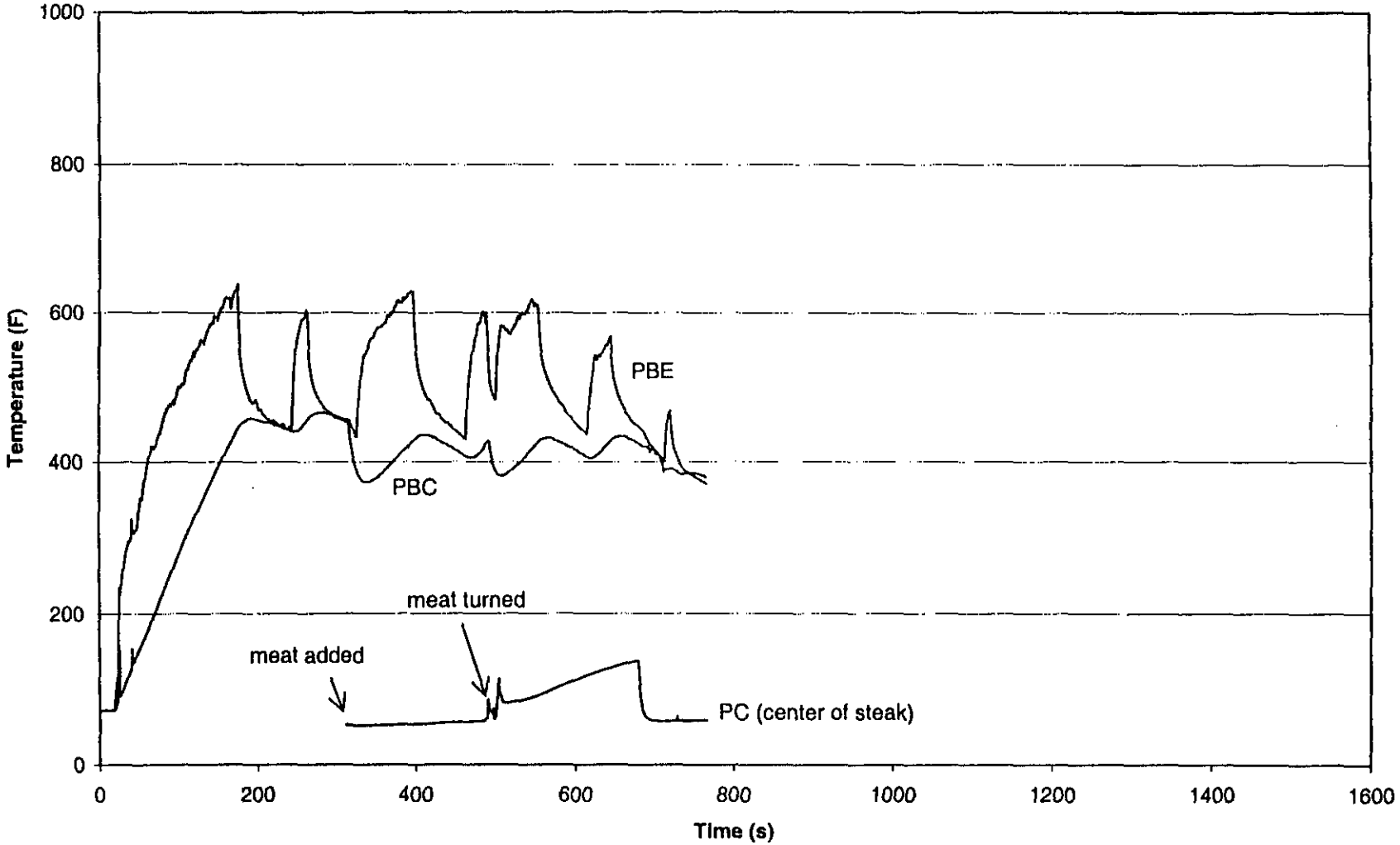
PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

Searing Steak in Cast Iron Pan on CPSC Electric Range



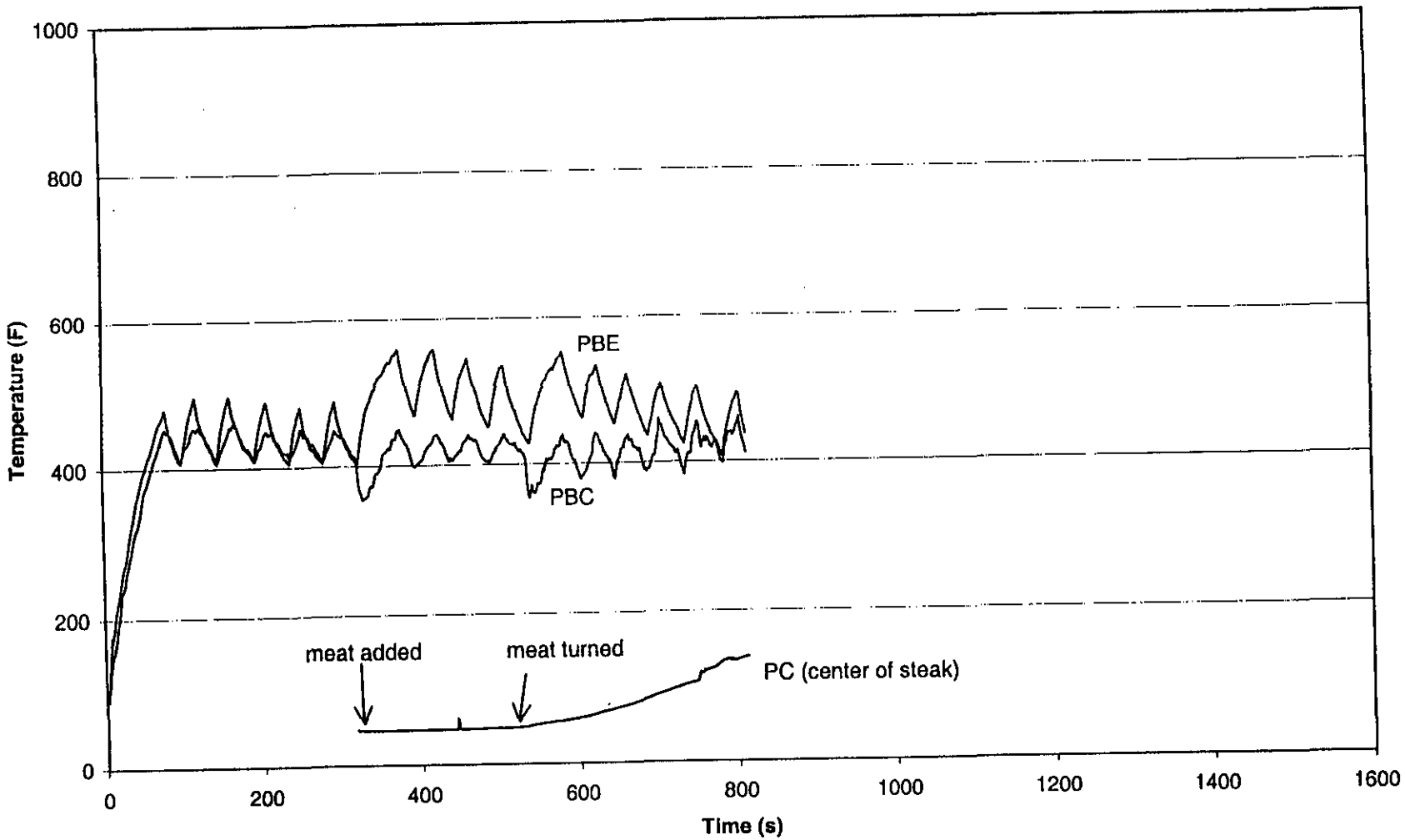
PC = pan contents PBC = pan bottom center PBE = pan bottom edge TC1, TC2 and TC3 = built-in thermocouples

Searing Steak in Stainless Steel Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

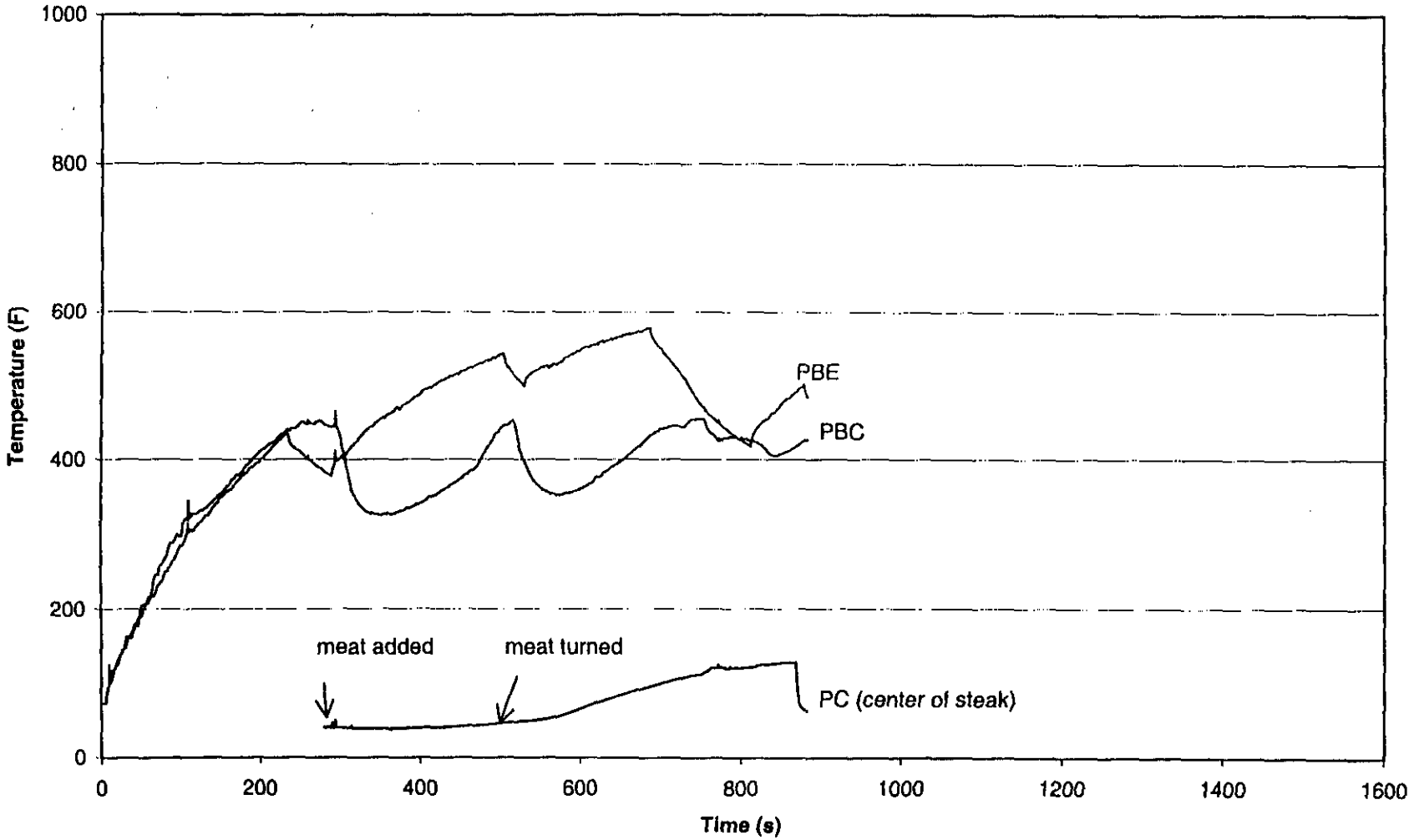
Searing Steak in Aluminum Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

Arthur D Little

Searing Steak in Cast Iron Pan on Rinnai Range



PC = pan contents PBC = pan bottom center PBE = pan bottom edge

No	Classification of Technologies	COOKING PERFORMANCE		OPERABILITY										RELIABILITY/DURABILITY			SAFETY		MANUFACTURABILITY/INSTALLATION			
		Cooking Process	Cooking Time	Consumer Behaviour	Limits cooktop features	Ease of system verification	Safety system maintenance	Cookware applicability	Range of Fire Incident covered	% New product sales	Degree of fire mitigation	Effect on cooktop after actuation	Effect of actuation on safety system	Potential for false actuation	Product life safety factor of 2	Reasonable forseeable misuse condition	Effect on current fail safe standards	System components pose added risks	Applicability Across Product Type/Model	Components Availability	Installation	Serviceability
1	Detect/Extinguish Fire Fusible Parts	9	9	9	9	5	1	9	9	5	5	1	1	9	5	5	1	9	5	5	1	1
2	Detect/Extinguish Fire Non-optical T sensor	9	9	9	9	5	1	9	9	5	5	1	1	9	5	5	1	9	5	1	1	1
3	Detect/Extinguish Fire Optical T sensor	9	9	9	9	1	1	5	5	5	5	1	1	1	1	5	1	9	5	1	1	1
4	Detect/Extinguish Fire Smoke + T sensor	5	9	9	9	1	1	9	9	5	5	1	1	5	1	1	1	9	5	1	1	1
5	Detect Fire - Warning Only Non-optical T sensor	9	9	9	9	1	5	9	9	5	1	1	1	9	5	5	1	9	5	1	1	1
6	Detect Fire - Warning Only Optical T sensor	9	9	9	9	1	1	5	5	5	1	1	1	1	1	5	1	9	5	1	1	1
7	Detect Fire - Warning Only Smoke	9	5	9	9	1	1	9	9	9	1	9	5	5	1	1	1	9	9	9	1	1
8	Contain/Manage Fire Passive	9	9	5	1	9	9	5	0	5	0	0	9	9	9	9	1	1	5	9	1	9
9	Contain/Manage Fire Active - use T sensor	9	9	9	9	1	1	9	9	5	5	1	1	9	1	1	1	5	1	1	1	1
10	Prevent Unattended Cooking Warning and Control Motion sensor only	1	9	1	9	5	9	9	5	9	9	9	5	5	5	5	9	9	9	5	9	5
11	Prevent Unattended Cooking Warning and Control Motion + T sensor	9	9	1	9	1	5	5	5	5	9	9	9	1	1	1	1	9	5	1	9	5
12	Prevent Unattended Cooking Warning and Control Motion + Power sensor	5	9	1	9	5	9	9	5	5	9	9	5	1	5	5	9	9	1	5	9	5
13	Prevent Unattended Cooking Warning and Control Power level sensor + timer	5	9	1	9	5	9	9	5	5	9	9	5	1	5	5	9	9	1	5	9	5
14	Prevent Unattended Cooking Warning Only Motion sensor only	9	9	1	9	5	9	9	1	9	1	9	5	5	5	5	9	9	9	5	9	5
15	Prevent Unattended Cooking Warning Only Motion + Power	9	9	1	9	5	9	9	1	5	1	9	5	1	5	5	9	9	1	5	9	5
16	Prevent Unattended Cooking Warning Only Power level sensor + timer	9	9	1	9	5	9	9	1	5	1	9	5	1	5	5	9	9	1	5	9	5
17	Prevent Food Ignition in Pan Elec. Signal Processing Select Mode or T T sensor contacts pot	9	5	1	9	1	5	5	5	5	9	9	9	1	1	1	1	9	5	1	9	5
18	Prevent Food Ignition in Pan Elec. Signal Processing Select Mode or T Non-contact T sensor	9	5	1	9	1	5	1	5	5	9	9	9	1	1	5	1	9	5	1	9	5
19	Prevent Food Ignition in Pan Elec. Signal Processing Auto-activation T sensor contacts pot	5	5	9	9	1	5	5	5	5	9	9	9	1	1	1	1	9	5	1	9	5
20	Prevent Food Ignition in Pan Elec. Signal Processing Auto-activation Non-contact T sensor	5	5	9	9	1	5	1	5	5	9	9	9	1	1	5	1	9	5	1	9	5
21	Prevent Food Ignition in Pan No Signal Processing Mechanical actuation	5	1	9	9	1	5	5	5	5	9	9	9	1	1	1	1	9	5	1	9	5
22	Prevent Boil Dry/Spill Over T sensor	9	9	5	9	1	5	5	1	5	0	9	9	1	1	1	1	9	5	1	9	5
23	No Cooktop Fire Prevention Technology (Do Nothing)	9	9	9	9	0	9	9	0	0	0	0	0	0	9	9	9	9	9	9	9	9

Appendix F: Basis for Technology Screening Scores

1. DETECT/EXTINGUISH FIRE -- FUSIBLE PARTS
   - **Effect on Cooking Process**: None, system only actuates when a fire occurs
   - **Effect on Cooking Time**: None, system only actuates when a fire occurs
   - **Effect of System on Consumer Behavior While Operating the Cooktop**: None, system only actuates when a fire occurs
   - **Limits availability or efficacy of marketed cooktop features**: None
   - **Ease of System Verification**: If a pressurized extinguisher is used, a pressure indicator is installed so user can verify level manually. Fusible part is just a material with a certain melting point – this property is unlikely to change within its operating lifetime
   - **Safety System Maintenance**: System maintenance requires significant additional procedures/parts (e.g. extinguisher material refilling) that might require specialist help. Additional parts within the hood would need to be cleaned up.
   - **Cookware Applicability**: All cookware can be used with cooktop in any normal environment
   - **Range of Fire Incident Coverage (Based on existing fire data)**: Will address all fire incidents since it will actuate whenever a fire is detected
   - **Percent of new product sales covered by this technology**: Less than 90% since downdraft installations or island installations not compatible with a hood
   - **The degree of mitigation of fires addressed**: Extinguishes fire
   - ***Effect of Safety System on Cooktop Performance After Actuation of System:*** *Significant cleaning and* adjustment needed after actuation since extinguisher material has been released over cooktop surface and fire has occurred
   - **Effect of Actuation on the Safety System**: Service call or component replacement/recharging necessary to return system to its ready state (refill extinguisher material)
   - **Potential for False Actuation**: None, a significantly high temperature (more than under normal cooking conditions) is needed to melt the fusible parts
   - **Can operate over product life w/o failure (safety factor of 2)**: Looks good but no data. Similar applications have been implemented for some time in commercial kitchens.
   - **Can operate within reasonably foreseeable misuse conditions (durability)**: Looks good but no data. System is out of reach of user during normal cooking operation.
   - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down)**: Cooktop will still able to work even though safety system is not on/operating
   - **Safety system components might pose added risk to consumer**: None expected
   - **Applicability across product types and product models**: Can work for all models for one product type (for vented or non-vented hoods, and under cabinet or free standing hoods), but cannot work for downdraft or island installations where no hood is available
   - **Components/system availability**: Most parts are available off-the-shelf or have been manufactured in high volume at low cost
   - **Installation**: Specialist help required
   - **Serviceability**: Specialist help required to refill or service extinguisher tank

2. DETECT/EXTINGUISH FIRE -- NON-OPTICAL T SENSOR
   - **Effect on Cooking Process**: None, system only actuates when a fire occurs
   - **Effect on Cooking Time**: None, system only actuates when a fire occurs
   - **Effect of System on Consumer Behavior While Operating the Cooktop**: None, system only actuates when a fire occurs
   - **Limits availability or efficacy of marketed cooktop features**: None
   - **Ease of System Verification**: Some systems available in the market automatically verify system readiness. Still need user to manually verify pressure level of extinguisher canister.
   - **Safety System Maintenance**: System maintenance requires significant additional procedures to ensure that temperature sensor is clean and fire extinguisher is fully charged
   - **Cookware Applicability**: All cookware can be used with cooktop in any normal environment
   - **Range of Fire Incident Coverage (Based on existing fire data)**: Will address all fire incidents since it will actuate whenever a fire is detected
   - **Percent of new product sales covered by this technology**: Less than 90% since downdraft installation or island installation not compatible with a hood
   - **The degree of mitigation of fires addressed**: Extinguishes fire

- **Effect of Safety System on Cooktop Performance After Actuation of System:** Significant cleaning and adjustment needed after actuation since extinguisher material has been released over cooktop surface and fire has occurred
- **Effect of Actuation on the Safety System:** *Service call or component replacement/recharging necessary to* return system to its ready state (refill extinguisher material)
- **Potential for False Actuation:** None, a significantly high temperature (more than under normal cooking conditions) must be detected by temperature sensor before system will actuate
- **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data. Product has been developed and sold in the market for some time.
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good but no data. System is out of reach of user during normal cooking operation.
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** *Cooktop will continue working even though the safety system is not on/operating*
- **Safety system components might pose added risk to consumer:** None expected
- **Applicability across product types and product models:** Can work for all models for one product type (for vented or non-vented hood, and under cabinet or free standing hoods), but will not work for non-hood *installations such as downdraft or island installations*
- **Components/system availability:** Most parts have been developed but have not been manufactured in high volume at low cost.
- **Installation:** Additional tradesmen/technicians needed to install system
- **Serviceability:** Servicing the electronics and temperature sensors requires specialized equipment and staff *expertise or licensing. Specialist needed to refill or service extinguisher canister.*

3. DETECT/EXTINGUISH FIRE -- OPTICAL T SENSOR
   - **Effect on Cooking Process:** None, system only actuates when a fire occurs
   - **Effect on Cooking Time:** None, system only actuates when a fire occurs
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** *None*
   - **Limits availability or efficacy of marketed cooktop features:** None
   - **Ease of System Verification:** Needs service technician's help to verify system operation
   - **Safety System Maintenance:** Significant additional procedures needed, including cleaning optical sensor, changing battery, recharging extinguisher material
   - **Cookware Applicability:** *Depending on location of sensor, it could mistake burner flame or radiant* heating element as fire condition. Cooking with small pot/pans, where radiant heat source is not fully shielded from view of the sensor might affect system.
   - **Range of Fire Incident Coverage (Based on existing fire data):** Will address between 40-90% of *cooking fire incidents -- due to the fact that this system is currently not applicable to gas ranges.*
   - **Percent of new product sales covered by this technology:** Less than 90% . It will not work for gas cooktops since heat from burner would be mistaken as cooking fire, probably the same with radiating electric heat elements
   - **The degree of mitigation of fires addressed:** Will extinguish fires
   - ***Effect of Safety System on Cooktop Performance After Actuation of System:*** *Significant cleaning and* adjustment needed after actuation since extinguisher material has been released over cooktop surface and fire has occurred
   - **Effect of Actuation on the Safety System:** User will need to recharge/refill the fire extinguisher before it can operate again
   - **Potential for False Actuation:** Potential for false negative if optical sensors, which are not part of daily cooktop clean up, are not properly cleaned and become coated by airborne food or grease particles.
   - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic but no data. Sensor optical window, which is not part of daily cooktop clean-up, could easily get covered up with airborne *cooking oils/particles and would need periodic calibration. Extinguisher needs to be recharged*
   - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good but no data. Sensor is away from user's reach
   - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will still work even though the safety system is not operating/off
   - **Safety system components might pose added risk to consumer:** None expected

- **Applicability across product types and product models:** Can work for all models of one product type for electric cooktops (for vented or non-vented hood, and under cabinet or free standing hoods), but will not be applicable to gas cooktops since the burner flame can be mistaken for a cooking fire
- **Components/system availability:** Needs to be developed and manufactured or adapted from other industries
- **Installation:** Additional tradesmen/technicians needed
- **Serviceability:** Special equipment and staff expertise or licensing needed

4. DETECT/EXTINGUISH FIRE -- SMOKE + T SENSOR
   - **Effect on Cooking Process:** Will negatively affect high temperature cooking with high particulate emissions, such as searing or stir frying.
   - **Effect on Cooking Time:** None
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will need to read manual to figure out that cooktop will sound alarm whenever an excessive amount of smoke is produced during cooking
   - **Limits availability or efficacy of marketed cooktop features:** None
   - **Ease of System Verification:** Specialist help needed to verify operation of the safety system
   - **Safety System Maintenance:** Additional procedures needed, including cleaning the smoke detector and temperature sensor, recharging the extinguisher tank (checking tank pressure etc.)
   - **Cookware Applicability:** Works for all types of cookware in any normal environment
   - **Range of Fire Incident Coverage (Based on existing fire data):** Will detect more than 90% of cooking fire incidents since it will actuate whenever a fire occurs.
   - **Percent of new product sales covered by this technology:** Will cover less than 90% of new product sales since non-hood installations (downdraft and island cooktop) need different approach
   - **The degree of mitigation of fires addressed:** Will extinguish fires
   - **Effect of Safety System on Cooktop Performance After Actuation of System:** Significant cleaning and adjustment needed after actuation since extinguisher material has been released over cooktop surface and fire has occurred
   - **Effect of Actuation on the Safety System:** Will need service technician help to return safety system to readiness (recharge the extinguisher tank, etc.)
   - **Potential for False Actuation:** Potential for false positive during high particulate cooking (searing) where the smoke sensor might trigger the alarm unnecessarily
   - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic but no data -- smoke sensor might get soiled and covered up by airborne cooking or grease particles and need replacement.
   - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data -- smoke sensor might get soiled and covered up by airborne cooking or grease particles
   - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will still operate even though the safety system is off
   - **Safety system components might pose added risk to consumer:** None expected
   - **Applicability across product types and product models:** Can work for all models for one product type (for vented or non-vented hood, and under cabinet or free standing hoods), need different solution for non-hood installation such as downdraft or island installations.
   - **Components/system availability:** Most parts have been manufactured, but not in high volume and at low costs. Some need to be adapted from other industries.
   - **Installation:** Need additional tradesmen to install the alarm, extinguisher and heat sensor
   - **Serviceability:** Specialized equipment and/or staff expertise or licensing necessary

5. DETECT FIRE - WARNING ONLY -- NON-OPTICAL T SENSOR
   - **Effect on Cooking Process:** None, does not affect the operation of the cooktop
   - **Effect on Cooking Time:** None, does not affect the operation of the cooktop
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** None, alarm will only activate when temperature sensor measures a relatively high ambient temperature
   - **Limits availability or efficacy of marketed cooktop features:** None
   - **Ease of System Verification:** Verification of operation requires the help of a service technician
   - **Safety System Maintenance:** Need to keep temperature sensors clean
   - **Cookware Applicability:** Works for all types of cookware in any normal environment

- **Range of Fire Incident Coverage (Based on existing fire data):** Will detect more than 90% of cooking fire incidents since it will actuate whenever a fire occurs.
- **Percent of new product sales covered by this technology:** Will cover less than 90% of new product sales since non-hood installations (downdraft and island cooktop) need a different approach
- **The degree of mitigation of fires addressed:** Will only warn of the presence of cooking fire
- **Effect of Safety System on Cooktop Performance After Actuation of System:** Since there is a high probability that a fire has commenced when the system is triggered, the cooktop could be damaged by the high heat that could occur before anyone responds to the alarm. Even if the user acts quickly and extinguishes the flame with a portable fire extinguisher, clean-up will be necessary.
- **Effect of Actuation on the Safety System:** User might have to reset the alarm once the fire has been controlled. The sensor could also be damaged by the high heat that might occur before anyone responds to the alarm
- **Potential for False Actuation:** No chance of false alarm, since a significantly higher temperature than during normal cooking would need to be detected by the temperature sensor in order for the system to actuate
- ***Can Operate Over product life w/o failure (safety factor of 2):*** *Looks good, but no data*
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, since it will be out of the way of the user during normal cooking operation, but no data
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will still operate even though the safety system is off
- ***Safety system components might pose added risk to consumer:*** *None expected*
- **Applicability across product types and product models:** Can work for all models for one product type, but need another approach on island installations or others where there is no wall or hood space to locate the sensor/alarm.
- **Components/system availability:** Need to be adapted from other industries
- ***Installation:*** *Need additional tradesmen to install the alarm and temperature sensor*
- **Serviceability:** Specialized equipment and/or staff expertise or licensing necessary

6. DETECT FIRE - WARNING ONLY -- OPTICAL T SENSOR
   - **Effect on Cooking Process:** None, safety system only actuates when a fire occurs
   - **Effect on Cooking Time:** None, safety system only actuates when a fire occurs
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** None
   - **Limits availability or efficacy of marketed cooktop features:** None
   - **Ease of System Verification:** Service technician's help needed to verify system operation
   - **Safety System Maintenance:** Significant additional procedures needed, including cleaning the optical sensor, changing the battery, etc.
   - **Cookware Applicability:** Depending on location of sensor, it could mistake burner flame or radiant heating element as fire condition. Cooking with small pot/pans, where radiant heat source is not fully shielded from view of the sensor might affect system.
   - **Range of Fire Incident Coverage (Based on existing fire data):** Will be between 40-90% of cooking fire incidents -- due to the fact that this system is currently not applicable to gas ranges.
   - **Percent of new product sales covered by this technology:** Will not work for gas cooktops since heat from burner could be mistaken as cooking fire, probably the same with radiating electric heat element
   - **The degree of mitigation of fires addressed:** Warning only
   - **Effect of Safety System on Cooktop Performance After Actuation of System:** Since there is a high probability that a fire has commenced when the system is triggered, the cooktop could be damaged by the high heat that could occur before anyone responds to the alarm. Even if the user acts quickly and extinguishes the flame with a portable fire extinguisher, clean up will be necessary.
   - **Effect of Actuation on the Safety System:** User might have to reset the alarm once the fire has been controlled. The sensor could also be damaged by the high heat that might occur before anyone responds to the alarm
   - **Potential for False Actuation:** Potential for false negative when sensor is not properly cleaned and might miss a fire incident. Sensor location is not in area that will be part of daily clean-up.
   - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic but no data. Sensor optical window could easily get covered with airborne cooking oils/particles and would need periodic calibration
   - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good but no data. Sensor is out of user's reach

- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop wills still work even though the safety system is not operating/off
- **Safety system components might pose added risk to consumer:** None is expected
- **Applicability across product types and product models:** Can work for all models for one electric product type, but need another approach for island installations or others where there is no wall or hood space to locate the sensor/alarm. Probably not applicable to gas cooktops since the burner flame can be mistaken for a cooking fire.
- **Components/system availability:** Need to be developed and manufactured or adapted from other industries
- **Installation:** Need additional tradesmen or technicians
- **Serviceability:** Need special equipment and staff expertise or licensing

7. DETECT FIRE - WARNING ONLY -- SMOKE SENSOR
   - **Effect on Cooking Process:** None, can cook at any temperature
   - **Effect on Cooking Time:** Will negatively affect high temperature cooking with high particulate emission (searing or frying), since alarm will most likely turn on often, requiring cook to constantly reset/turn it off during cooking.
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will need to read manual *to figure out that cooktop will sound alarm whenever an excessive amount of smoke is produced during* cooking
   - **Limits availability or efficacy of marketed cooktop features:** None
   - **Ease of System Verification:** Will need a service technician to verify sensor is working at factory-set level
   - **Safety System Maintenance:** System maintenance might require specialist help to clean the smoke sensor and make sure it is working at calibrated level. For new houses, where smoke sensor power is connected to main electrical wiring , any servicing will require specialist help.
   - **Cookware Applicability:** All cookware can be used with cooktop at any normal environment
   - **Range of Fire Incident Coverage (Based on existing fire data):** Probably will mitigate less than 40% of cooking fire incidents, since it will simply warn user that an excessive amount of smoke is being generated during cooking. No guarantee that fire will be prevented or managed. Also danger of user becoming desensitized to the sound of the alarm if too many false alarms occur during high temperature cooking.
   - **Percent of new product sales covered by this technology:** More than 90% -- sensor can be located near any type of cooktop.
   - **The degree of mitigation of fires addressed:** Warning that fire is about to occur
   - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, as long as user is *around to take preventive measure and stop the fire from actually occurring*
   - **Effect of Actuation on the Safety System:** User needs to manually reset the alarm when he/she has addressed the source of the smoke. Most likely alarm will turn on much earlier before a fire actually occurs. Therefore, if addressed promptly, no damage should be done to the sensor or alarm
   - **Potential for False Actuation:** False positive, smoke detector will turn on although no pre-ignition condition is present (e.g. during searing or frying)
   - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic but no data -- sensor might get soiled and covered up by airborne cooking or grease particles
   - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic but no data -- sensor might get soiled and covered up by airborne cooking or grease particles
   - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will still work even though the safety system is not operating/off
   - **Safety system components might pose added risk to consumer:** None
   - ***Applicability across product types and product models:*** *Will work for all models*
   - **Components/system availability:** All parts available off-the-shelf
   - **Installation:** Additional tradesmen needed for installation (especially for new houses where alarm power source is from the main electric line)
   - **Serviceability:** Additional tradesmen needed for servicing (especially for new houses where alarm power source is from the main electric line)

8. CONTAIN/MANAGE FIRE – PASSIVE (THREE SIDE-WALLED COOKTOP)
   - **Effect on Cooking Process:** None

- **Effect on Cooking Time:** None
- **Effect of System on Consumer Behavior While Operating the Cooktop:** Have to position pot handles to avoid walls. Access to rear heat sources is limited; cannot use them for active cooking where user needs to constantly manipulate the foodstuff in the vessel.
- **Limits availability or efficacy of marketed cooktop features:** Yes, cannot smoothly transfer foodstuffs or cooking vessels from surrounding tabletop to the cooktop or vice-versa (e.g. during deep frying). Almost impossible to use the back burners when the front ones are also in use.
- **Ease of System Verification:** Nothing to verify, it is just a permanently mounted fire-resistant wall.
- **Safety System Maintenance:** Only requires cleaning of extra surface area of the three side walls.
- **Cookware Applicability:** Larger cooking vessels or those with long handles cannot be used
- **Range of Fire Incident Coverage (Based on existing fire data):** Not applicable since system only contains fire to the back and sides of the cooktop but does not contain the top or front side. If not extinguished by user, fire will eventually spread throughout the kitchen.
- **Percent of new product sales covered by this technology:** Almost everything except island versions.
- **The degree of mitigation of fires addressed:** Not applicable: does not warn, prevent, extinguish or contain fire continuously
- **Effect of Safety System on Cooktop Performance After Actuation of System:** Not applicable, since if a fire did occur and the user did not extinguish it manually, cooktop would continue to burn and fire would spread
- **Effect of Actuation on the Safety System:** Fire-resistant wall surface will just need cleaning (though the rest of the cooktop/kitchen could be ruined by fire)
- **Potential for False Actuation:** None, nothing actuates
- **Can Operate Over product life w/o failure (safety factor of 2):** Side walls will have at least the same product life as the rest of the cooktop
- **Can operate within reasonably foreseeable misuse conditions (durability):** Side walls most likely made from a strong fire resistant material that can endure reasonably foreseeable misuse conditions
- ***Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail* safe (cooking system shut-down):** Cooktop will continue working normally if side walls were taken down by user
- **Safety system components might pose added risk to consumer:** Long cooking vessel handles will jut out of the front, creating risk of user accidentally knocking the hot pot and contents off cooktop. When front burners are on, user risks burning arm when reaching for food/cooking vessels on the back burners.
- **Applicability across product types and product models:** Almost everything except island versions
- **Components/system availability:** Easily available, off-the-shelf parts
- **Installation:** Additional installation effort/procedures for the side walls needed
- **Serviceability:** No new training or new equipment necessary for servicing the walls

9. CONTAIN/MANAGE FIRE – ACTIVE
   - **Effect on Cooking Process:** None, only actuates when a fire occurs
   - **Effect on Cooking Time:** None, only actuates when a fire occurs
   - **Effect of System on Consumer Behavior While Operating the Cooktop:** None, only actuates when a fire occurs
   - **Limits availability or efficacy of marketed cooktop features:** None, only actuates when a fire occurs
   - **Ease of System Verification:** Professional help needed to verify system operability
   - **Safety System Maintenance:** Significant additional maintenance procedures and specialist help required to maintain the drop hood, release mechanism and temperature sensor
   - **Cookware Applicability:** All cookware can be used with cooktop in any normal environment
   - **Range of Fire Incident Coverage (Based on existing fire data):** All cooktop fires (over 90%) will be addressed by this fire containment system, since it actuates after the detection of a fire
   - **Percent of new product sales covered by this technology:** Less then 90%, since island cooktop installation and under-cabinet installations probably not compatible with the drop hood
   - **The degree of mitigation of fires addressed:** Extinguishes fire once it has commenced
   - **Effect of Safety System on Cooktop Performance After Actuation of System:** Will require significant cleaning and adjustment after actuation, since fire has already started and the hood has been dropped on top of the cooktop.
   - **Effect of Actuation on the Safety System:** Specialist help needed for adjustment of drop hood back to its original position and for resetting of the actuation and release mechanism

- **Potential for False Actuation:** *None, since temperature sensor has to register a relatively high* temperature to actuate system
- **Can Operate Over product life w/o failure (safety factor of 2):** Drop hood release mechanism has no data and looks problematic, as hood is being released under gravity. Unknown impact force, hood might get damaged when it impacted the cooktop surface.
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic but no data. Safety system is out of reach of user during cooktop operation, but drop hood is released under gravity. Unknown impact force, hood might get damaged when it impacted the cooktop surface.
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** If the drop hood release mechanism is not working properly there is no indication that cooktop will not continue operating
- **Safety system components might pose added risk to consumer:** The falling hood can catch or pinch user's body parts (finger, arm) if they do not move out of the way. Can be modified by having an alarm that will alert user that hood is about to actuate before it actually does.
- **Applicability across product types and product models:** Each cooktop model may require different design for functionally different models within a product type, since they come in different dimensions. The enclosing hood must have the appropriate dimension for each one of them. Non-hood installations such as island and downdraft versions need a different solution.
- **Components/system availability:** Need to develop all of system components
- **Installation:** Special tradesmen/specialist need
- **Serviceability:** Additional training and new equipment needed

10. PREVENT UNATTENDED COOKING -- WARNING AND CONTROL -- MOTION SENSOR ONLY
    - **Effect on Cooking Process:** User cannot leave food to simmer/boil while out of the room
    - **Effect on Cooking Time:** None, as long as user is near the cooktop
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will need to read the manual to learn that burner will manipulate heat when he/she leaves cooktop area. Simmering will need to be attended
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can verify easily if system is working by turning the burner on, leaving the room and checking what happens.
    - **Safety System Maintenance:** Cleaning the sensor surface requires only wiping the front sensor window cover, which is part of the regular daily cooktop cleaning
    - **Cookware Applicability:** Will work with any cookware in any environment
    - **Range of Fire Incident Coverage (Based on existing fire data):** Will at least address unattended cooking (~53.5% of fire incident from NFIRS+NFPA data from 1994-1996)
    - **Percent of new product sales covered by this technology:** Should be able to cover more than 90% of new product sales
    - **The degree of mitigation of fires addressed:** Will prevent fires due to unattended cooking from starting
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, fire will not even start so cooktop should be ready to work normally again after safety actuation
    - **Effect of Actuation on the Safety System:** Depends on the algorithm used. On some, safety system should be ready to work normally again once user presence is detected. On others, user has to reset the system manually.
    - ***Potential for False Actuation:*** *Potential for false positive when user leaves a pot of food to simmer.* Potential for false negative, where sensor might mistake pets, curtains or small children etc for the cook, can probably be eliminated by using an appropriate sensor data analysis algorithm.
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data.
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good but no data
    - ***Safety system's effect on cooktop's conformity with current safety standards* (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will not work if no signal from motion sensor is detected
    - **Safety system components might pose added risk to consumer:** None expected
    - **Applicability across product types and product models:** Developed to be applicable for all cooktop systems
    - **Components/system availability:** Most parts available off-the-shelf or have been manufactured in high volume at low cost
    - **Installation:** No added effort beyond that for installing conventional ranges
    - **Serviceability:** Some training or new equipment necessary for servicing the sensor

11. **PREVENT UNATTENDED COOKING -- WARNING AND CONTROL -- MOTION + T SENSOR**
    - **Effect on Cooking Process:** Should be none, since high temperature cooking is still possible as long as the cook is near the cooktop. Simmering should also still be possible, since cooktop should only manipulate heat source when food temperature is significantly higher than simmering/boiling temperature.
    - **Effect on Cooking Time:** Should be none if user is around during high temperature cooking. Simmer/boiling will not be affected since temperature is well below food ignition temperature
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** Consumers need to read manual to figure out that cooktop will alarm and manipulate burner when cooking vessel temperature is relatively high and no one is in attendance.
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Specialist help needed to verify the operation of safety system
    - **Safety System Maintenance:** Additional procedures required, in particular cleaning the temperature sensors regularly of grease or food build-up. Cleaning the motion sensor surface involves no more than wiping off the front sensor window cover, which is part of the regular daily cooktop cleaning.
    - **Cookware Applicability:** Some cookware materials or shapes can compromise safety system performance, since the sensor will need to be in contact to the cooking vessel (e.g. glass/ceramic ware, cookware with concave bottom)
    - **Range of Fire Incident Coverage (Based on existing fire data):** Should cover at least more than 50% of the cooking fire incidents due to unattended cooking.
    - **Percent of new product sales covered by this technology:** Multiple designs applicable for gas and solid or coil electric element cooktops.
    - **The degree of mitigation of fires addressed:** Will prevent cooking fires from occurring
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None -- since it prevents any fire from occurring, no extra cleaning or adjustment is necessary after each actuation
    - **Effect of Actuation on the Safety System:** None, system is always on during cooktop operation
    - **Potential for False Actuation:** Potential for false negative if temperature sensor and cooking vessel do not have good contact due to surface dirt or misalignment
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic, no data. Sensor is unprotected
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data. Sensor is out in the open and have high likelihood to be impacted by cooking wares
    - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop might still work if safety system is off
    - **Safety system components might pose added risk to consumer:** None expected
    - **Applicability across product types and product models:** Can work for all models of one product type
    - **Components/system availability:** Most parts are new parts that would need to be developed and manufactured
    - **Installation:** No different from conventional range
    - **Serviceability:** Current staff needs some training and/or new equipment to test/service the sensor

12. **PREVENT UNATTENDED COOKING -- WARNING AND CONTROL -- MOTION + POWER SENSOR**
    - **Effect on Cooking Process:** None as long as user is near the cooktop. User can leave the room while simmering food, since it should be at a low heat setting, below the threshold at which the system would actuate. User would need to be around when boiling hot water – usually done at high heat settings
    - **Effect on Cooking Time:** As long as user is near the cooktop there is none. If user leaves room while simmering food, then it must be done at low heat setting otherwise system will manipulate heat source and this may delay cooking.
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will need to read the manual to learn that system will manipulate heat when he/she leaves cooktop area.
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can verify easily if system is working by turning the burner on at certain power level and leaving the room to see what happens.
    - **Safety System Maintenance:** Cleaning the sensor surface requires no more than wiping the front casing/cover, which is part of the regular daily cooktop cleaning. Power level sensor will most likely be located out of reach of cooking particulates/grease.
    - **Cookware Applicability:** All cookware can be used with cooktop in any normal environment
    - **Range of Fire Incident Coverage (Based on existing fire data):** If working properly, will at least address unattended cooking (~53.5% of fire incident from NFIRS+NFPA data from 1994-1996)

- **Percent of new product sales covered by this technology:** Will work fine with electric cooktop, but the power sensor for a gas burner will need some development.
- **The degree of mitigation of fires addressed:** Will prevent a fire from occurring if working properly
- **Effect of Safety System on Cooktop Performance After Actuation of System:** None, fire will not even start, so cooktop should be ready to work normally again after safety system actuation
- **Effect of Actuation on the Safety System:** Cooktop should reactivate automatically when user's presence is detected
- **Potential for False Actuation:** Potential for false negative if food/oil is already hot when burner was turned on. Potential for false negative, where sensor might mistake pets, curtains or small children etc for the cook, can probably be eliminated using appropriate sensor data analysis algorithm.
- **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data.
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, but no data
- ***Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail* safe (cooking system shut-down):** Cooktop will not work if no signal from motion sensor or power level sensor is detected
- **Safety system components might pose added risk to consumer:** None expected
- **Applicability across product types and product models:** Will need more development for application to gas cooktops – specifically of the power level sensor. No patents found that specifically address this type of technology on gas cooktops, although it does not seem difficult to do.
- **Components/system availability:** Most parts available off-the-shelf or have been manufactured in high volume at low cost
- **Installation:** No added effort beyond that required for installation of a conventional range
- **Serviceability:** Some training or new equipment is necessary for servicing the sensor

13. **PREVENT UNATTENDED COOKING -- WARNING AND CONTROL -- POWER LEVEL SENSOR + TIMER**
    - **Effect on Cooking Process:** All cooking procedures can be done on the cooktop as long as user is present to maintain cooking operation – unattended simmer is also possible as long as power level is kept at a minimum. Continuous searing might be affected as heat source might repeatedly turn on and off, affecting temperature of cooking vessel.
    - **Effect on Cooking Time:** As long as user is in attendance, cooking time will be no different
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will need to read manual to learn that constant supervision and user input is necessary to keep cooktop from manipulating heat source automatically
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can easily verify operation by turning power level to high and waiting to see whether cooktop will activate warning signal and then manipulate the heat source
    - **Safety System Maintenance:** user maintenance procedure is the same as for conventional cooktop. Power level sensor will most likely located away from grease and food build-up under the cooktop surface.
    - **Cookware Applicability:** All cookware can be used with cooktop in any normal environment
    - **Range of Fire Incident Coverage (Based on existing fire data):** Depending on the timer duration and power level threshold selected, it is probable that system could address 60% of fire incidents
    - **Percent of new product sales covered by this technology:** Power level sensor for gas burner needs more development.
    - **The degree of mitigation of fires addressed:** Prevents pre-ignition conditions from arising
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** If system works as intended, no fire will ever occur, so no cleaning or adjustment is necessary after system actuation
    - **Effect of Actuation on the Safety System:** User needs to reset system by pressing a button or turning a control knob
    - **Potential for False Actuation:** Potential for false negative if food/oil was already hot when burner was turned on.
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, but no data
    - ***Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail* safe (cooking system shut-down):** Burner will not turn on when no signal from power level sensor is received.
    - **Safety system components might pose added risk to consumer:** None expected

- **Applicability across product types and product models:** Will need more development for application to gas cooktops – specifically of the power level sensor. No patent found that specifically addresses this type of technology on gas cooktops, although it does not seem difficult to do.
- **Components/system availability:** Most components are off-the-shelf or have been manufactured in high volume and low cost
- **Installation:** No added effort beyond that for installing a conventional range
- **Serviceability:** Some training or new equipment is necessary for servicing the sensor

14. PREVENT UNATTENDED COOKING -- WARNING ONLY -- MOTION SENSOR ONLY
    - **Effect on Cooking Process:** None, nothing affects burner operation
    - **Effect on Cooking Time:** None, nothing affects the burner operation
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** user needs to read manual to learn that he/she needs to be present near the cooktop even during simmering to prevent the alarm
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can verify easily if system is working by turning on the burner and leaving the room to see what happens.
    - **Safety System Maintenance:** Cleaning the motion sensor surface requires no more than wiping the front casing/cover, which is part of regular daily cooktop cleaning.
    - **Cookware Applicability:** Any utensil in any environment will work
    - **Range of Fire Incident Coverage (Based on existing fire data):** Probably will catch less than 40% of cooking fire incidents, since it only warns user that nobody is near the cooktop. If cook is far enough from the kitchen not to hear the warning then it is useless.
    - **Percent of new product sales covered by this technology:** Should be able to cover more than 90% of new product sales
    - **The degree of mitigation of fires addressed:** Only warns user of possible cooking fire
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None as long as user hears the alarm and return to kitchen. Cooktop should perform normally since no control is applied to cooktop
    - **Effect of Actuation on the Safety System:** Depends on algorithm selected; either alarm will turn off when user presence is detected again or user will need to reset system by manipulating a button or a knob.
    - **Potential for False Actuation:** Potential for false positive when user simmers food without staying near cooktop. The potential for a false negative, where sensor might mistaken pets, curtains or small children etc. for cook, can probably be eliminated using appropriate sensor data analysis algorithm.
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data.
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, but no data.
    - ***Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail* safe (cooking system shut-down):** Alarm will continually sound if cooktop is operated and no signal from motion sensor is detected
    - **Safety system components might pose added risk to consumer:** None expected
    - **Applicability across product types and product models:** Developed to be applicable for all cooktop systems
    - **Components/system availability:** Most parts are available off-the-shelf or have been manufactured in high volume at low cost
    - **Installation:** No added effort beyond that for installing a conventional range
    - **Serviceability:** Some training or new equipment is necessary for servicing the sensor

15. PREVENT UNATTENDED COOKING -- WARNING ONLY MOTION + POWER
    - **Effect on Cooking Process:** None, nothing affects burner operation
    - **Effect on Cooking Time:** None, nothing affects burner operation
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** user needs to read manual to learn he/she needs to be present near the cooktop to prevent an alarm
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can verify easily if system is working by turning the heat source to high power and leaving the room to see what happens.
    - **Safety System Maintenance:** Cleaning the motion sensor surface requires no more than wiping the front sensor window cover, which is part of regular daily cooktop cleaning. Power level sensor will most likely be located away from grease and food build-up under the cooktop surface.
    - **Cookware Applicability:** All cookware can be used with cooktop in any normal environment

- **Range of Fire Incident Coverage (Based on existing fire data):** Probably will catch less than 40% of cooking fire incidents since it will only warn user that cooking is unattended and heat source is set at dangerous level. If user is far enough from the kitchen not to hear the alarm, then the system is useless.
- **Percent of new product sales covered by this technology:** Less than 90% since more development work needed to produce a gas cooktop power sensor.
- **The degree of mitigation of fires addressed:** Only warns of possible pre-ignition condition
- **Effect of Safety System on Cooktop Performance After Actuation of System:** None -- provided user acts on the alarm, no extra cleaning or adjustment is necessary. Alarm will turn on before fire occurs.
- **Effect of Actuation on the Safety System:** User might have to reset the mechanism once system alarm is on.
- **Potential for False Actuation:** Potential for false negative depending on the selection of power level threshold. Food/oil can still get really hot with lower power setting. User might also put on a pot containing food that is already hot. The additional potential for a false negative, where sensor might mistaken pets, curtains or small children etc. for cook, can probably be eliminated using appropriate sensor data analysis algorithm.
- **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but no data
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, but no data
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will not operate when no signal from either motion or power level sensor is received
- **Safety system components might pose added risk to consumer:** None expected
- **Applicability across product types and product models:** Will need more development to apply to gas cooktops – specifically for the power level sensor. No patent found that specifically address this type of technology on gas cooktops, although it does not seem difficult to do.
- **Components/system availability:** Most parts are available off-the-shelf or have been manufactured in high volume at low cost
- **Installation:** No added effort beyond that for installing a conventional range
- **Serviceability:** Some training or new equipment is necessary for servicing the sensor

16. PREVENT UNATTENDED COOKING -- WARNING ONLY -- POWER LEVEL SENSOR + TIMER
    - **Effect on Cooking Process:** None, nothing affects burner operation
    - **Effect on Cooking Time:** None, nothing affects burner operation
    - **Effect of System on Consumer Behavior While Operating the Cooktop**: user needs to read manual to learn that to he/she needs to be present near the cooktop to either stop or avoid alarm actuation by occasionally turning the knob or pressing a reset button
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** User can easily verify system operation by setting the power level to high and see if the alarm will turn on after a pre-determined time has elapsed.
    - **Safety System Maintenance:** User maintenance procedure is the same as for conventional cooktops. Power level sensor will most likely located away from grease and food build-up under the cooktop surface.
    - **Cookware Applicability:** All cookware can be used with cooktop in any normal environment
    - **Range of Fire Incident Coverage (Based on existing fire data):** Probably will catch less than 40% of cooking fire incidents since it only warns user that burner has been on for a certain time. If user is far enough from the kitchen not to hear the alarm, then the system is useless.
    - **Percent of new product sales covered by this technology:** Will work fine with electric cooktops, but more development work needed for gas burner power sensor.
    - **The degree of mitigation of fires addressed:** Only gives warning of possible cooking fire pre-ignition condition
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, no special clean-up necessary if alarm works as intended: it alerts user to check on cooktop so fire should not occur.
    - **Effect of Actuation on the Safety System:** User has to reset manually to turn off alarm.
    - **Potential for False Actuation:** Potential for false negative, depending on the selection of power level threshold. Food/oil can still get really hot with lower power setting. Also user might put on a pot containing food that is already hot.
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks good, but not data. It is just a simple timer and alarm.
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks good, but not data. It is just a simple timer and alarm.

- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** *Cooktop will not work if no signal indicating heat source power level* is received
- **Safety system components might pose added risk to consumer:** Nothing expected
- **Applicability across product types and product models:** Will need more development for application to gas cooktops -- specifically of the power level sensor. No patents found that specifically address this type of technology on gas cooktops, although it does not seem difficult to do.
- **Components/system availability:** Most parts are available off-the-shelf or have been manufactured in high volume at low cost
- **Installation:** No added effort beyond that for installing a conventional range
- **Serviceability:** Some training or new equipment is necessary for servicing the sensor

17. **PREVENT FOOD IGNITION IN PAN -- ELEC. SIGNAL PROCESSING, SELECT MODE OR T -- T SENSOR CONTACTS POT**
    - **Effect on Cooking Process:** All cooking processes possible as long as maximum temperature setting is high enough for high temperature cooking (searing)
    - **Effect on Cooking Time:** Likely to affect cooking time by less than 10%
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User needs to read the manual to understand how to use the new mode-select control knob or buttons
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Need special equipment or specialist help to verify system operability
    - **Safety System Maintenance:** Need additional procedures, in particular cleaning the temperature sensor of grease or food particulate build-up
    - **Cookware Applicability:** Some cookware materials or shapes could compromise safety system performance. *(e.g. glass/ceramic ware, cookware with concave bottom)*
    - **Range of Fire Incident Coverage (Based on existing fire data):** Likely will address more than 40% of fire incidents, since it prevents pre-ignition conditions from occurring during most cooking processes
    - **Percent of new product sales covered by this technology:** Multiple designs applicable to gas and solid or coil electric element cooktops.
    - **The degree of mitigation of fires addressed:** Will prevent fires from occurring
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, no adjustment or cleanup necessary after safety system actuation, since it prevents fire from ever occurring
    - **Effect of Actuation on the Safety System:** Since cooktop will continuously manipulate heat to keep foodstuff at proper temperature, no reset is necessary after each actuation
    - **Potential for False Actuation:** Potential for false negative if temperature sensor and cooking vessel do not have good contact due to surface dirt or misalignment
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic, but no data. Sensor is unprotected
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data. Sensor is out in the open and has high likelihood of being impacted by cookware
    - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Depends on the algorithm selected. On some systems, where cooking modes need to be selected, cooktop will still work even though the safety system is not on/operating . On others, cooktop will not work since user has to input required temperature setting when turning on the control knob.
    - **Safety system components might pose added risk to consumer:** None expected
    - **Applicability across product types and product models:** Can work for all models of one product type
    - **Components/system availability:** Most parts are new parts that need to be developed and manufactured
    - **Installation:** No different from conventional range
    - **Serviceability:** Current staff will need some training and/or new equipment to test/service the sensor

18. **PREVENT FOOD IGNITION IN PAN -- ELEC. SIGNAL PROCESSING, SELECT MODE OR T -- NON-CONTACT T SENSOR**
    - **Effect on Cooking Process:** All cooking processes possible as long as maximum temperature setting is high enough for high temperature cooking (searing)
    - **Effect on Cooking Time:** Likely to affect cooking time by less than 10%
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User needs to read the manual to use the new mode-select control knob or buttons
    - **Limits availability or efficacy of marketed cooktop features:** None

- **Ease of System Verification:** Need special equipment or specialist help to verify system operability
- **Safety System Maintenance:** Need additional procedures, including cleaning the temperature sensor of grease or food particulate build-up
- **Cookware Applicability:** Need special cookware (with known emissivity) for system to work properly
- **Range of Fire Incident Coverage (Based on existing fire data):** Likely will address more than 40% of fire incident since it prevents pre-ignition conditions from occurring for most of the cooking process
- **Percent of new product sales covered by this technology:** Can be installed on any new cooktop though more work needs to be done for gas-fired cooktops to ensure that radiation from the flame will not be mistaken for pot high temperature.
- **The degree of mitigation of fires addressed:** Prevents fire from occurring
- **Effect of Safety System on Cooktop Performance After Actuation of System:** None, fire should never even occur
- **Effect of Actuation on the Safety System:** None, no cleaning or adjustment is necessary when safety system actuates
- **Potential for False Actuation:** Potential for false negative, if sensor is dirty and does not register the true cooking pot temperature
- **Can Operate Over product life w/o failure (safety factor of 2):** No data, looks problematic – sensor window might get soiled with grease and food and might require replacement. Some models require sensor to move up and down from cooktop surface; mechanism might get soiled and jammed.
- **Can operate within reasonably foreseeable misuse conditions (durability):** No data, looks good. *Sensor is located away from pot traffic during cooking. Chance of impact with cooking pot/pan is minimal*
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop can still operate even though the safety system might not be working (e.g. Bosch's model on the market becomes a conventional cooktop when system is not working).
- **Safety system components might pose added risk to consumer:** None expected
- ***Applicability across product types and product models:*** *Can work on all models of the same type*
- **Components/system availability:** Most parts need development
- **Installation:** No different than for conventional cooktops
- **Serviceability:** Needs new training and some new equipment

19. **PREVENT FOOD IGNITION IN PAN -- ELEC. SIGNAL PROCESSING, AUTO-ACTIVATION -- T SENSOR CONTACTS POT**
    - **Effect on Cooking Process:** High temperature cooking (searing) is negatively affected
    - **Effect on Cooking Time:** Probably affects cooking time by less than 10%
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** None, since user will not even be aware that safety system is actuating
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Service technician needed to verify system operation.
    - **Safety System Maintenance:** System maintenance requires few additional procedures, including cleaning of the temperature sensor regularly of grease or food build-up
    - **Cookware Applicability:** Some cookware materials or shapes could compromise safety system performance. (e.g. glass/ceramic ware, cookware with concave bottom)
    - **Range of Fire Incident Coverage (Based on existing fire data):** Will address more than 40% of cooking fire incidents since it will avoid the occurrence of overheated foodstuff or cookware
    - **Percent of new product sales covered by this technology:** Multiple designs applicable for gas and solid or coil electric element cooktops. **The degree of mitigation of fires addressed:** Will prevent cooking fires from occurring
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, no adjustment or clean-up necessary after safety system actuation since it prevents fire from ever occurring
    - **Effect of Actuation on the Safety System:** None, system will actuate and reset automatically.
    - **Potential for False Actuation:** Potential for false negative if temperature sensor and cooking vessel do not have good contact due to surface dirt or misalignment
    - ***Can Operate Over product life w/o failure (safety factor of 2):*** *Looks problematic, but no data. Sensor* is unprotected
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data. Sensor is out in the open and has high likelihood of being impacted by cookware
    - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop will still work even though the safety system is not on/operating

- **Safety system components might pose added risk to consumer:** None expected
- **Applicability across product types and product models:** Can work for all models of one product type
- **Components/system availability:** Most parts are new parts that need to be developed and manufactured
- **Installation:** No different than for conventional range
- **Serviceability:** Current staff need some training and/or new equipment to test/service the sensor

20. PREVENT FOOD IGNITION IN PAN -- ELEC. SIGNAL PROCESSING, AUTO-ACTIVATION -- NON-CONTACT T SENSOR
    - **Effect on Cooking Process:** Will affect quality of high temperature cooking such as searing
    - **Effect on Cooking Time:** Might affect cooking time by less than 10%
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** None, cook will not notice that system is actuating
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Need specialist help or special equipment
    - **Safety System Maintenance:** User maintenance requires few additional procedures, in particular cleaning the temperature sensor regularly of grease or food build-up
    - **Cookware Applicability:** Need special cookware (of known emissivity) for system to work properly
    - **Range of Fire Incident Coverage (Based on existing fire data):** Likely will address more than 40% of fire incidents since it prevents pre-ignition conditions from occurring for most cooking processes
    - **Percent of new product sales covered by this technology:** Can be installed on any new cooktop, though more work needs to be done for gas-fired cooktops to ensure that radiation from the flame will not be mistaken for high pot temperature.
    - **The degree of mitigation of fires addressed:** Prevents cooking fire from occurring
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, system will prevent fire from occurring. Therefore, no additional cleaning or adjustment is necessary after each actuation
    - **Effect of Actuation on the Safety System:** None, system automatically resets itself.
    - **Potential for False Actuation:** Potential for false negative, if sensor is dirty or illegal cookware with unknown emissivity is used.
    - **Can Operate Over product life w/o failure (safety factor of 2):** No data, looks problematic – sensor window might get soiled with grease and food and require replacement. Some models require sensor to move up and down from cooktop surface; mechanism might get soiled and jammed.
    - **Can operate within reasonably foreseeable misuse conditions (durability):** No data, looks good. Sensor is located away from pot traffic during cooking. Chance of impact with cooking pot/pan is minimal
    - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop might still be able to work even though safety system is off
    - **Safety system components might pose added risk to consumer:** None expected
    - **Applicability across product types and product models:** Can work on all models of the same type
    - **Components/system availability:** Most parts need development
    - **Installation:** No different than for conventional cooktop
    - **Serviceability:** Technician will need new training and some new equipment

21. PREVENT FOOD IGNITION IN PAN -- NO SIGNAL PROCESSING, MECHANICAL ACTUATION
    - **Effect on Cooking Process:** High temperature cooking (searing) will be negatively affected
    - **Effect on Cooking Time:** Most likely will affect cooking time by more than 10 percent. Most mechanical actuation devices (bimetal strip or expansible liquid sensors) will react more slowly to temperature fluctuations, which might cause system to delay the on/off cycle time and thus prolong cooking time.
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** None, since cooktop will either constantly manipulate heat source to maintain temperature settings selected, or maintain a limiting high temperature automatically regardless of the heat setting selected
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Need service technician to verify system operation.
    - **Safety System Maintenance:** System maintenance requires few additional procedures, in particular cleaning the temperature sensor regularly of grease or food build-up
    - **Cookware Applicability:** Some cookware materials or shapes could compromise safety system performance since the sensor will need to be in contact to the cooking vessel (e.g. glass/ceramic ware, cookware with concave bottom)

- **Range of Fire Incident Coverage (Based on existing fire data):** Will address more than 40% of cooking fire incidents since it will avoid the occurrence of overheated foodstuff or cookware
- **Percent of new product sales covered by this technology:** Will be difficult to apply on smooth top cooktops (Ceran) so will probably cover between 40-90% of new product sales
- **The degree of mitigation of fires addressed:** Prevents cooking fire
- **Effect of Safety System on Cooktop Performance After Actuation of System:** None, no adjustment or cleanup necessary after safety system actuation, since it prevents fire from ever occurring
- **Effect of Actuation on the Safety System:** Since cooktop will continuously manipulate heat to keep foodstuff at proper temperature, no reset is necessary after each actuation
- **Potential for False Actuation:** Potential for false negative if temperature sensor and cooking vessel do not have good contact due to surface dirt or misalignment
- **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic, but no data. Sensor is unprotected
- **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data. Sensor is out in the open and have high likelihood to be impacted by cookware
- **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Depends on the mechanical design; some cooktops can still work when safety system is off. On other designs, cooktop cannot be turned on when the sensor is broken.
- **Safety system components might pose added risk to consumer:** None expected
- **Applicability across product types and product models:** Can work for all models of one product type, except on smooth top cooktops (Ceran)
- **Components/system availability:** Most parts are new parts that need to be developed and manufactured
- **Installation:** No different than for conventional ranges
- **Serviceability:** Current staff needs some training and/or new equipment to test/service the sensor

22. PREVENT BOIL DRY/SPILL OVER -- T SENSOR
    - **Effect on Cooking Process:** Will not affect any cooking process since user needs to select boil-mode for system to actuate
    - **Effect on Cooking Time:** Will not affect cooking time since user needs to select boil-mode for system to actuate and this only actuates after boiling is detected. For other cooking processes, no manipulation is imposed on the heat source therefore, no change in cooking time.
    - **Effect of System on Consumer Behavior While Operating the Cooktop:** User will intuitively figure out how to use cooktop. System controls include knob setting or button specifically for boiling
    - **Limits availability or efficacy of marketed cooktop features:** None
    - **Ease of System Verification:** Service technician needed to verify system operation.
    - **Safety System Maintenance:** System maintenance involves few additional procedures, specifically cleaning the temperature sensor regularly of grease or food build-up
    - **Cookware Applicability:** Some cookware materials or shapes could compromise safety system performance since the sensor will need to be in contact with the cooking vessel (e.g. glass/ceramic ware, cookware with concave bottom)
    - **Range of Fire Incident Coverage (Based on existing fire data):** Will address less than 40% of cooking fire incidents since it only address fires arising due to boil dry condition.
    - **Percent of new product sales covered by this technology:** Will be difficult to apply to smooth top cooktops (Ceran) so will probably cover between 40-90% of new product sales
    - **The degree of mitigation of fires addressed:** Prevents only boil-dry incidents.
    - **Effect of Safety System on Cooktop Performance After Actuation of System:** None, cooktop is performing normally as the system actuates continuously.
    - **Effect of Actuation on the Safety System:** None, system resets automatically whenever boil mode is selected
    - **Potential for False Actuation:** Potential for false negative if temperature sensor and cooking vessel do not have good contact due to surface dirt or misalignment
    - **Can Operate Over product life w/o failure (safety factor of 2):** Looks problematic, but no data. Sensor is unprotected
    - **Can operate within reasonably foreseeable misuse conditions (durability):** Looks problematic, but no data. Sensor is out in the open and has high likelihood of being impacted by cookware
    - **Safety system's effect on cooktop's conformity with current safety standards (UL/ANSI) Need to fail safe (cooking system shut-down):** Cooktop might still work if safety system is off
    - **Safety system components might pose added risk to consumer:** None expected

- **Applicability across product types and product models:** Can work for all models of one product type, except Ceran™ cooktop
- **Components/system availability:** Most parts are new parts that need to be developed and manufactured
- **Installation:** No different than for conventional range
- **Serviceability:** Current staff needs some training and/or new equipment to test/service the sensor

Most of the oil ignition tests described in the experimental section of this report were carried out with unused oil. It is known that during cooking, the concentration of free fatty acids in the oil increases and that this increase is associated with a drop in the ignition temperature of the oil. Therefore it is important to consider whether the temperature thresholds discussed in section 4 are appropriate for used oil as well as fresh oil.

The graph below shows the change in smoke, flash and fire (ignition) points of oil with increasing free fatty acid (FFA) content. Typical FFA concentrations for unused frying oil are between 0.05 and 0.08% or less [Reference: Bailey's Industrial Oil and Fat Products, Volume 1, page 214]. From the graph, it can be seen that the FFA concentration must rise to around 2% before any significant change in ignition temperature occurs.

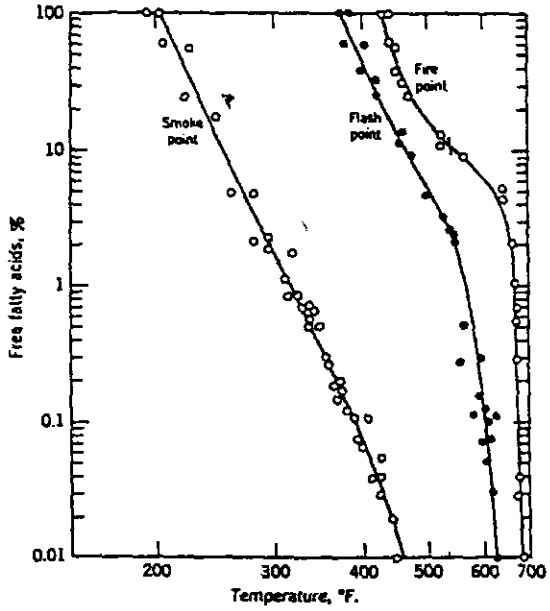


Figure G1: Smoke, fire and flash points of miscellaneous crude and refined fats and oils, as functions of the content of free fatty acids. [from: Bailey's Industrial Oil and Fat Products, Volume 1, page 212].

Data is available in the literature relating time at temperature of cooking oil to the increase in free fatty acid content in the oil. For example, for canola oil held at 190C (374F), and used to fry batches of french fries for four minutes three times every eight hours:

	0 hrs	32 hrs	64hrs
FFA, %	0.01	0.46	0.96

[Reference: U.S. Patent 6,201,145 *Non-hydrogenated canola oil for food applications,* Fan;Zhegong; Assigned to Cargill Inc.]

For partially hydrogenated soybean oil (commonly used for commercial frying), held at 360F for 15hrs and used to fry pork and chicken continuously, the final FFA content was 0.69%. This oil was considered to be unacceptable for further use.
[Reference: U.S. Patent 6,187,355 *Recovery of used frying oils,* Akoh, te al. Assigned to the Georgia Research Foundation, Inc.]

In addition, the USDA requires that meat and poultry products including such products as corn dogs and pork rinds be fried in oil containing no more that 2% FFA.
[Reference: Libra Technologies Inc., 101 Liberty St., Metuchen, NJ 08840]

The tests described above relate to commercial frying situations, in which the level of oil use is significantly more severe than would be experienced in the home. They indicate that even with heavy commercial levels of oil reuse, the increase in FFA content is not sufficient to significantly lower the ignition temperature of the oil.

In order to verify these data, ADL carried out ignition tests on used oil. In these tests, approximately 750ml of canola oil was heated to 360F or above and used to fry ten batches of frozen french fries. In between each batch, the oil temperature was allowed to drop to around 300F. After the tenth batch, three 100ml samples of the used oil were then heated until ignition in a stainless steel frying pan. The resulting oil ignition temperatures, and the ignition temperatures for unused oil from the earlier tests are given in the table below.

Test conditions			Ignition temperature
Oil type	**Pan type**	**Range**	**(F)**
used	stainless steel	Rinnai	700, 730, 735
fresh	stainless steel	Rinnai	750
fresh	cast iron	Rinnai	730
fresh	aluminum	Rinnai	680
fresh	stainless steel	electric	760
fresh	cast iron	electric	740
fresh	aluminum	electric	760

These test results are consistent with the findings in the literature and show that the ignition temperatures in the used oil tests lay within the range of ignition temperatures noted for fresh oil.