Supply and Services Canada / Approvisionnements et Services Canada

CLAIM FOR PROGRESS PAYMENT
RÉCLAMATION DE PAIEMENT PARTIEL

USE SUPPLEMENTARY CLAIM FORM DSS-MAS 1112 AS REQUIRED TO RECORD DETAIL
AU BESOIN, INSCRIRE LES DÉTAILS SUR LA FORMULE DE RÉCLAMATION SUPPLÉMENTAIRE DSS-MAS 1112

CONTRACTOR - ENTREPRENEUR	CLAIM NO. - N° DE LA RÉCLAMATION	DATE
Arjay Engineering ltd		MAR 3/91

ADDRESS - ADRESSE
2495 Haines Road, Mississauga, Ontario L4Y 1Y7

Development of Void Fraction meter, for measurement of gas hold up at high temperature and pressure.

FILE NO. - N° DU DOSSIER	SERIAL - SÉRIE	FF - FGMP/CF - CFMP	CONTRACT PRICE - PRIX DU CONTRAT
06SQ.23440-9-9155	23440-9-9155/01-SQ	234-131-000000-501202 -0433	$49,693.00 (Crown's Share: $37,270.00)

CONTRACTOR'S REPORT OF PROGRESS (IF MORE SPACE IS REQUIRED PLEASE USE SEPARATE SHEET)
COMPTE RENDU DES TRAVAUX PAR L'ENTREPRENEUR (SE SERVIR, AU BESOIN, D'UNE AUTRE FEUILLE)

The majority of time during the phase involved the testing of the probe at the University of Waterloo. Staff shortages and project interruptions slowed down the progress of testing. In November 1990, a meeting was held at the U of W to discuss test results. The figures were promising and showed high accuracy and repeatability. These results confirmed the project should continue into Task 5 (the final stage). Arjay is presently engaged in the sourcing and design of a probe for final tests at Canmet in Ottawa. The project is behind schedule by approximately 2 months, but is currently within budget (see attached reports).

PROGRESS REPORT

Development of Void Fraction Meter for Measuring of Gas Hold up at High Temperature and Pressure

SUBMISSION DATE: August 31, 1991.

SUMMARY

This report is further to our previous report which gave consideration to various material, for possible applications in a high temperature and high pressure environment. In this stage design considerations were carried out to determine different types of probes to run at room temperature and atmospheric pressure so as to attain maximum sensitivity for the detection of void fraction by capacitance change. This stage of development concentrated on different probe designs in an effort to obtain a design which would give sufficient capacitance change to ensure reliable and repeatable results, prior to proceeding with the high pressure, high temperature entry.

First, a single section of straight probe was built to insert into a cylindrical chamber with an air sparger at the bottom to pump air bubbles into the varsol liquid.

The changes in capacitance readings detected by the probe were quite insignificant even though different flowrates of air bubbles were tried.

A steel plate (size: 6" X 6") was made to be attached to the original single section straight probe. The theory behind the baffle plate was to increase the surface area of the probe, so as to increase the sensitivity for the detection of void fraction.

A three gallon pail was used instead of the cylindrical chamber in the second trial. The air sparger was used to pump bubbles into the varsol liquid.

The change in the capacitance readings when the air bubbles were pumped into the varsol liquid was about 0.7pF (picofarad).

Two different types of capacitance monitors are used in this experiment; Level-Lance Model 850 and the Arjay model 9054 Radio Frequency Capacitance Monitor. Both monitors detected the same change in capacitance readings (0.7pF).

It was learned the baffle plate would be an obtrusion during use, so further redesign was required. Also, it's size would not be able to fit into the Bubble Column Reactor. A 1" width drum probe was constructed for detection of void fraction. The drum is formed by a steel metal sheet soldered onto the straight rod. The Level-Lance Model 850 was used in this trial and changes in capacitance readings of about 0.7pF were recorded, when air bubbles were pumped into the varsol liquid.

Eventually, a 2" width drum probe was used. The same change in capacitance reading (0.7pF) was recorded.

The autoclave was then received from Canmet and used on further experiments.

After a meeting with Mr. Rick Reeves and Mr. Greg Reeves of Arjay Engineering Ltd., a new design of probe was suggested, as 0.7pF change in capacitance reading might not be sufficient for accurate void fraction measurement. A 1" width spiral probe formed by a steel metal strip was inserted into the autoclave chamber containing varsol liquid to detect changes in capacitance. The surface area of the probe was increased quite substantially, thus increasing the sensitivity of the capacitance monitor. Air bubbles were pumped into the autoclave unit by a single opening at the bottom.

It was also suggested that in this experiment, a table be produced so the changes in capacitance could be measured against air flowrate (ft3/hr) and time (minutes).

The results were quite favourable, a capacitance reading of 0.9pF was obtained at an air flowrate of 70ft3/hr with a 1" spiral probe. With the 2" spiral probe, the maximum change in capacitance is 2.4pF at 70ft3/hr of air flow.

The capacitance does not change much over time, therefore it is not time-dependent.

The change of 2.4pF is considered sufficient for reliability and justifies proceeding to the next stage of development.

The next stage will be to proceed with a high temperature and high pressure entry fitting, and to incorporate a dual feature in the electronics where the spiral probe will detect the capacitance and the support rod will detect the level.

Simon Chien,P.Eng.

CAPACITANCE MONITOR

1" SPIRAL PROBE SPAN: 10 - 25 pF

AIR FLOW (FT3/HR)	TIME (MIN)	METER READING (%)	PICOFARAD (pF)
0	-	50	-
20	0	48	0.3
	10	48	0.3
	20	48	0.3
	30	48	0.3
40	0	47	0.45
	10	46	0.60
	20	46	0.60
	30	46	0.60
50	0	45	0.75
	10	45	0.75
	20	45	0.75
	30	45	0.75
70	0	44	0.90
	10	44	0.90
	20	44	0.90
	30	44	0.90

CAPACITANCE MONITOR

2" SPIRAL PROBE SPAN: 10 - 25 pF

AIR FLOW (FT3/HR)	TIME (MIN)	METER READING (%)	PICOFARAD (pF)
0	-	50	-
20	0	46	0.60
	10	46	0.60
	20	46	0.60
	30	46	0.60
30	0	44	0.90
	10	44	0.90
	20	44	0.90
	30	42	1.20
40	0	40	1.50
	10	38	1.80
	20	38	1.80
	30	38	1.80
50	0	36	2.10
	10	36	2.10
	20	36	2.10
	30	36	2.10
70	0	34	2.40
	10	34	2.40
	20	34	2.40
	30	34	2.40

TIME ALLOCATION REPORT

Engineering Services by Simón Chien

April 2, 1991 — 4.5 Hours

- Test run using varsol, pumping with air
- Built another steel pipe to run the test.

May 7, 1991 — 3 Hours

- Built a baffle plate for void fraction research.

May 21, 1991 — 3.5 Hours

- Built baffle plate probe.
- Testing varsol with air bubbles. Change in capacitance 0.7pF (with Level Lance).

June 7, 1991 — 3.5 Hours

- Testing baffle plate probe using 9054 RF Capacitance monitor. Change in capacitance 0.7pF.

June 24, 1991 — 7.5 hours

- Built circular probe, so that bubbles could flow through easier.
- Capacitance change 0.7pF.

July 11, 1991 — 3 Hours

- Meeting to discuss using autoclave as test chamber for spiral probe.
- Disassemble the autoclave.

July 18, 1991 — 4 Hours

- built 1" width spiral probe.

CONTINUED...PAGE 2.

July 22, 1991	5 Hours
	- Testing 1" wide spiral probe in the autoclave chamber.
	- Data obtained shows a maximum change in capacitance of 0.9pF at air flowrate of 70ft3/hr.
July 29, 1991	3 Hours
	- Built a 2" width spiral probe.
July 30, 1991	2 Hours
	- Finish 2" width spiral probe.
July 31, 1991	4 Hours
	- Testing the 2" spiral probe in autoclave chamber.
August 1, 1991	3 Hours
	- Testing the 2" spiral probe in autoclave chamber.
August 7, 1991	4 Hours
	- Testing the 2" spiral probe in autoclave chamber.
	- Capacitance changes of 2.4pF were found at a flowrate of 70ft3/hr.
August 15, 1991	6 Hours
	- Report preparation by review of data.

Total: 56 Hours

TIME ALLOCATION REPORT

Service by Personnel Exclusive of Simon Chien

April 20, 1991	Rick Reeves - Engineering - 2 Hours
	Greg Reeves - Engineering - 2 Hours
	Status Meeting.
July 11, 1991	Rick Reeves - Engineering - 1 Hour
	Greg Reeves - Engineering - 1 Hour
	Meeting with Simon
August 22, 1991	Ann Harrison - Administration - 6 Hours (Secretarial, Report Preparation, etc.)

November 27, 1991

Supply & Services Canada
Canmet, ERL
555 Booth Street
Ottawa, Ontaric
K1A 0G1

Attention: Charlene Hogan

Reference: Void Fraction Project 06SQ.23440-9-9155

Dear Charlene:

Further to your request, the following is an overview of the instrumentation that has been used to monitor the Void Fraction Probes.

This report will be included with our next Project Submission.

Should you have any questions or concerns, please do not hesitate to contact me.

Yours truly,

Greg Reeves

GR/alh

Encl: void fraction report

ARJAY ENGINEERING LTD.
2495 Haines Road, Mississauga, Ontario, Canada L4Y 1Y7
(416) 277-4541
telex 06-961368 (Can-Am)

Void Fraction Instrumentation Details

File No. 06SQ.23440-9-9155

The Void Fraction probe operates on the principle of capacitance change within the auto clave which is proportional to the amount of entrained gases in the fluid. An increase in gas holdup results a decrease in capacitance.

Arjay Engineering Ltd is a manufacturer of capacitance instrumentation for industrial use and has adapted its existing technology to monitor the void fraction capacitance testing.

A number of models were used to determine the instrument best suited to this experimentation. The Arjay Model 9054 unit has been selected as the unit of choice because of it's diagnostics abilities, radio frequency technology, specific accuracy at low capacitance spans, and micro controller capabilities which provides programing flexibility.

There are three distinct physical components of the 9054 capacitance system:

1. The probe, which is the primary investigation of this project and of which is covered in detail as part of the main report.

2. The pulse card, which is mounted at the head of the probe assembly. The card converts the capacitance of the probe into a digital pulse which is transmitted to the main control unit for signal processing. By converting this signal immediately at the probe head, minimal interference to capacitance readings allows for optimum accuracy. The signal can be transmitted along 2 wires up to one kilometer away with little to no effect on the operation of the unit.

3. The 9054 controller, which is located remote from the process. This is a micro-processor unit which has been specifically programmed for level monitoring applications. A keypad and LCD display interface allow the unit to be calibrated into usable signals and measurements. For instance, the unit will convert the digital pulse into a reading in feet or % volume. A digital to analog converter card provides a 4-20mA signal for calibrated span which can then be used for recording, etc. An RS-232 interface allows the unit to link directly with computers for further processing and diagnostics.

Continued...Page 2.

Following herewith, is the 9054 user manual for start-up of a typical level application. The level probe for this project would use this manual verbatim. The Void Fraction probe for this project would follow the same calibration but assuming empty tank refers tc total gas holdup, or no fluid. A full vessel refers to no gas holdup or complete fluid.

Refer to manual in Section 9

PROGRESS REPORT

Development of Void Fraction Meter for Measuring of Gas Hold up at High Temperature and Pressure

SUBMISSION DATE: March 31, 1992

CONTRACT: 06SQ-23440-9-9155
Canmet Project Contacts: C M Hogan

Dr. Agarwol

This progress report updates developments of the Void Fraction Meter from the previous report submitted on August 31, 1991.

After experimentation results from the last report, it was determined that the actual working model should be designed and constructed to operate within the autoclave supplied by Canmet.

Design considerations were given to the findings of process development work with particular attention to:

1) the sizing restrictions of the autoclave

2) the high temperature and pressure of the vessel

3) the desired information from the sensing devices

1. Once the autoclave was received and inspected it became evident that there are significant restrictions to flexibility of probe design. The internal mixer, temperature probe, sparger and required void fraction probe all influenced the final design of the probe. There was very little room to maximize a sensor size for increased sensitivity. earlier experiments proved that a spiral sensor design would increase the needed capacitance change for desired results but installation of the unit with appropriate supports would be difficult.

2. Also, the constrictive nature of the autoclave and the actual desired readings negate the use of a multi-section probe for this portion of the project. As such, the final assembly will provide two capacitance readings. One will give a direct reading of the actual fluid level within the vessel and the second (spiral) probe will provide a capacitance value of the void fraction at a point directly above the mixer blades.

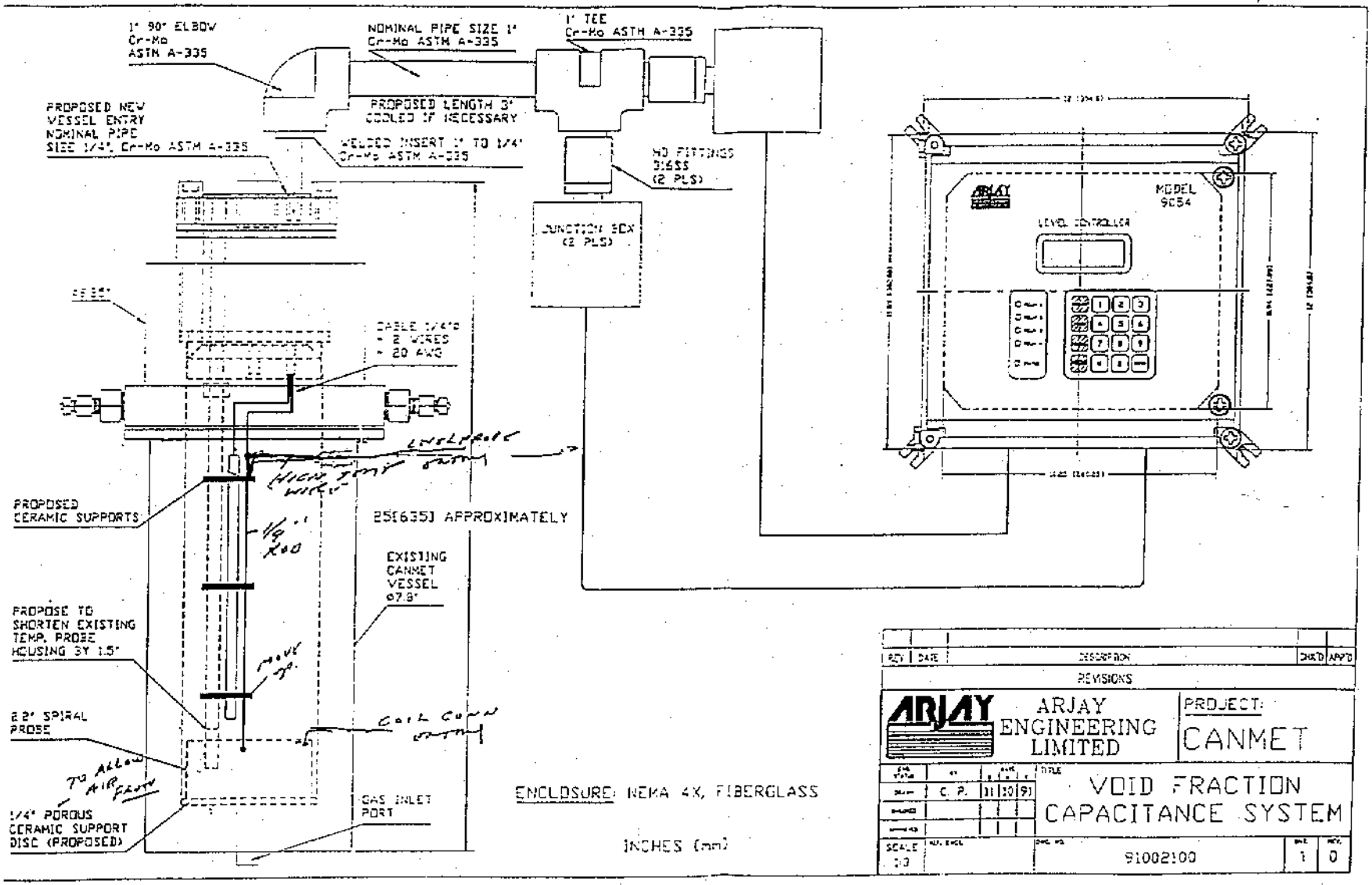
3. An extension pipe leading away from the vessel will reduce the temperature at the fitting which carries the sensor wires into the outside atmosphere. This will allow the use of insulating polymers within the fitting which in turn provide the high pressure rating required for the vessel. The prototype design was considered and drafted for review by Canmet in October, 1991. Comments were received from Canmet regarding sizing and supports and revisions were made to the drawing and re-submitted to Canmet in January, 1992 (see attached letter and drawing Appendix 1 and 2 respectively).

It has now been agreed through conversations between Charlene Hogan of Canmet and Arjay Engineering Ltd, that the sensing device should be constructed per the latest drawing (rev.1,1/42).

Once this has been constructed it will be forwarded to the Canmet lab in Ottawa for further testing in the auto clave. Modifications to the design may be required to enhance further requirements.

It is expected that the sensor assembly will be ready for shipment to Canmet in June /July of 1992.

C. Hyon



REV	DATE	DESCRIPTION	CHK'D	APP'D

REVISIONS

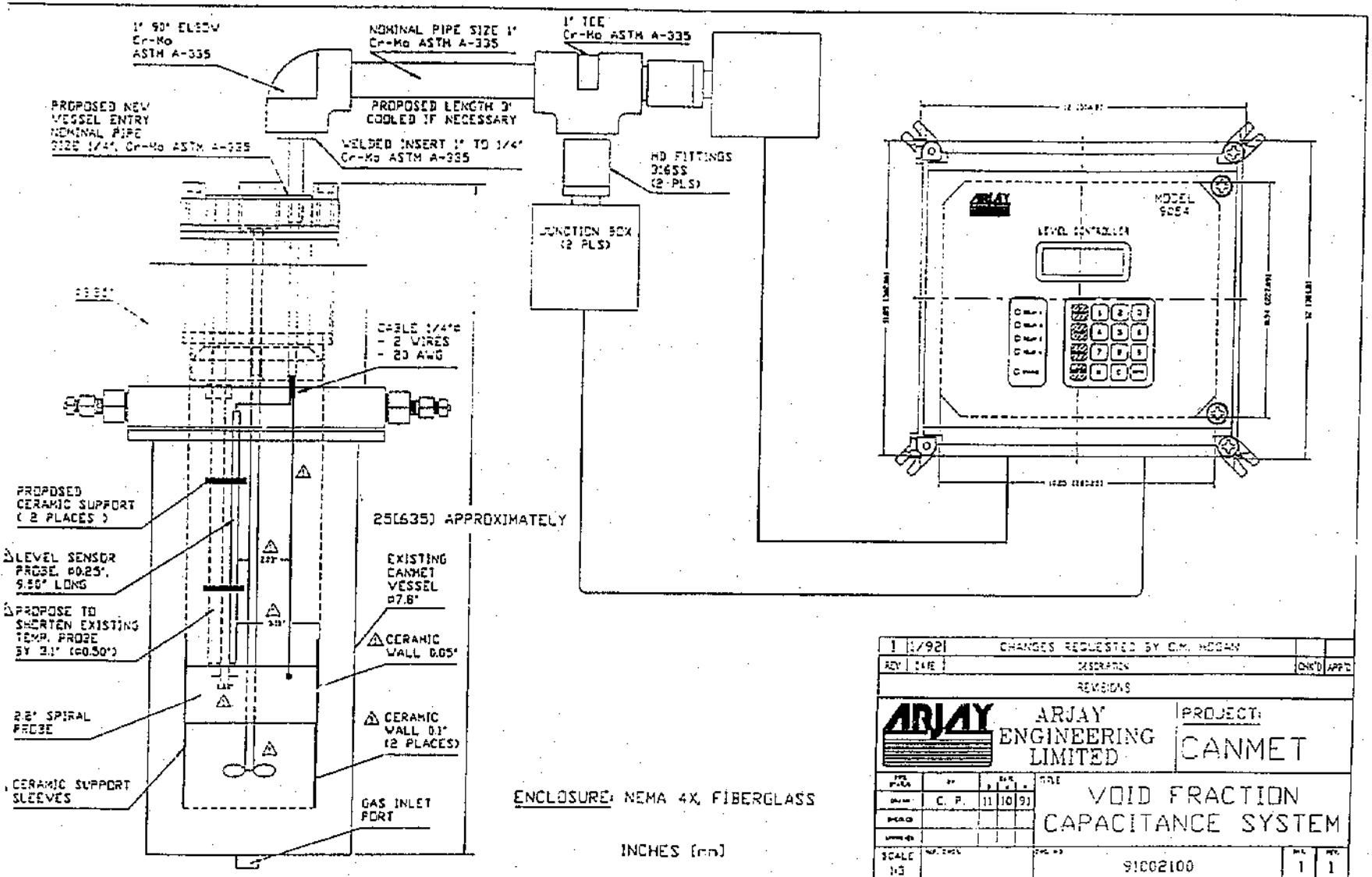
ARJAY ENGINEERING LIMITED

PROJECT: CANMET

TITLE: VOID FRACTION CAPACITANCE SYSTEM

DRAWN	C. P.	11/10/91	
CHECKED			
APPROVED			

SCALE: 1:3 | DWG. NO. 91002100 | SHT. 1 | REV. 0



REV	DATE	DESCRIPTION	CHK'D	APP'D
1	1/92	CHANGES REQUESTED BY C.M. MORAN		

REVISIONS

ARJAY ENGINEERING LIMITED

PROJECT: CANMET

TITLE: VOID FRACTION CAPACITANCE SYSTEM

BY	DATE
C. P.	11 10 91

SCALE: NS

DWG. NO. 91002100

REV. 1

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