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EG&G Idaho, Inc.

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INTERIM REPORT

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ACKNOWLEDGEMENT

The fundamental principle behind the new stagnation properties option was suggested and amplified by O. J. Demuth. The author would like to recognize and thank him for his contribution to the success of this development.

SUMMARY

The stagnation properties option in RELAP4/MOD6 was completely reviewed, from theoretical foundation to code application. The result of this investigation was the identification of a fundamental mismatch between the essentially homogeneous, equilibrium-based, RELAP4 code and the nonhomogeneous and/or nonequilibrium critical flow models imposed on the code. By continuously monitoring fluid Mach numbers and adjusting flow areas such that sonic velocity was never exceeded, the mismatch could be accommodated. This approach was implemented, found to work correctly, and will be incorporated into the MOD7 version of the code.

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I. INTRODUCTION & BACKGROUND

1. RATIONALE & ORIGINAL INCORPORATION

Depressurization of any system is dependent upon the rate of mass depletion. The time in which a vessel or system can be emptied is, therefore, determined by the rate of fluid flow through breaks or openings in the structure. Critical flow governs the rate at which fluid will be discharged from a system during most of a depressurization and, consequently, it largely controls the time of blowdown.

The RELAP4 computer code makes the determination of when fluid choking will occur by comparing two coincident flow rate calculations and selecting the minimum. The first of these computations is the calculation of a junction flow estimate from an iterative solution of the following linearized expression^[1], derived from the momentum equation:

$$W_{est} = W + (\Delta P - F) \frac{\Delta t g_c}{I} \quad (1)$$

where

- F = lumped parameter accounting for junction friction and momentum changes,
- g_c = gravitational constant,
- I = junction inertia,
- ΔP = junction pressure differential,
- Δt = time step size,
- W = junction flow rate,
- W_{est} = new junction flow rate estimate.

The second flow rate estimate is obtained from the critical flow tables in the RELAP4 code for the critical flow model selected, and the upstream-volume pressure and enthalpy. These two flow rate estimates are compared each time step and the flow is assumed choked when the estimate from the critical flow tables is less than the inertial estimate from the momentum equation.

The critical flow tables in the RELAP4 code were originally developed and inserted into the code with stagnation pressure and enthalpy as the independent variables^[2]. Since stagnation properties were not available in the code, however, the tables were used with the static properties mentioned above. This utilization of the tables was an obvious error, which produced choked flow rates generally lower than would theoretically be predicted. To correct this misapplication, a stagnation properties subroutine and associated coding were prepared^[3,4] and inserted into RELAP4/005, Update 32^[5]. Checkout of the routine continued, minor corrections and limitations were added, and this stagnation properties option became fully operational in RELAP4/E, Update 50 (see Reference 5).

2. OBSERVED IRREGULARITIES

Even before the stagnation properties option became fully operational some anomalies were observed. Fluid Mach numbers much greater than unity could occur in the volumes upstream of a choked junction, necessitating the imposition of a test to check and limit volume Mach number to one. This artificial limitation of volume fluid velocity to the critical value, though compatible with RELAP4 requirements, caused the calculation or attempted calculation of lower flow rates with the stagnation properties option than without, Figures 1 and 2, a result that was patently wrong.

The results displayed in Figure 1 were obtained from a simple system that was initially in the two-phase state. Essentially all problems of interest, however, originate from subcooled initial conditions. Here an additional problem was encountered with the stagnation properties option. Extremely oscillatory behavior was exhibited during flashing of the subcooled liquid, Figure 2, accompanied by an unacceptable increase in code execution time.

These problems with the stagnation properties option were recognized almost immediately and preliminary studies initiated to determine their cause and devise a solution. A number of approaches were investigated without notable success^[6]. Therefore, appropriate warning messages were placed in the code^[7], the option was removed from the list of

those recommended for general usage^[8], and approximate methods to circumvent the absence of stagnation properties in the code were investigated and promulgated^[9,10], pending final solution of the problem.

II. APPROACH AND SOLUTION

1. PROBLEM ORIGIN AND SOLUTION PHILOSOPHY

An extensive study of the stagnation properties problem was undertaken by O. J. Demuth in 1976-1977. The results of this study, largely unpublished, revealed that the difficulties with the option were not associated with the stagnation properties subroutine, as previously supposed, but were due to a fundamental incompatibility between the nonhomogeneous and/or nonequilibrium critical flow models (e.g., Henry-Fauske, Moody) and the essentially homogeneous, equilibrium, RELAP4 code.

When a junction choked during a transient, these critical flow models prescribed a new junction flow rate in excess of the upstream-volume flow rate that produced the stagnation conditions supplied to the critical flow model. (In future discussion, the word volume used alone will refer to a volume upstream from a choked or potentially choked junction). The higher junction flow rate, in turn, caused a higher volume flow rate, higher stagnation pressure, an even higher junction flow rate, until the critical flow tables indicated a higher flow than the momentum equation and the junction unchoked. But by this time the volume fluid was highly supersonic and in an accelerating mode so that a point was quickly reached where stagnation pressure exceeded steam table dimensions and the code failed. Arbitrarily limiting volume velocity to the homogeneous, equilibrium, critical value for purposes of stagnation properties calculation, however, either caused radical flow rate oscillations at the subcooled-saturated transition point, Figure 2, as fully explained in Reference 6, or, in the two-phase region, the readjustment within the code mentioned earlier. In effect, the volume was "pumped down" until its artificial stagnation conditions produced a junction critical flow rate compatible with the volume flow rate. The result of this adjustment was the calculation of critical flows, using stagnation properties, that were lower than those calculated by entering the critical flow tables with static conditions, Figure 1.

Since the RELAP4 code could not calculate a homogeneous, equilibrium, volume flow sufficiently high to match the nonhomogeneous, nonequilibrium, critical flow rate being demanded of it, some method had to be found to alleviate this inequality. Limiting volume fluid velocity alone had been seen to be no solution. If the critical flow models in the code were to remain unchanged, then some method of passing the required junction critical flow through the volume had to be devised. This, then, was the approach to the solution of the stagnation properties problem. Methods would be examined to allow a volume to pass a higher-than-homogeneous-equilibrium flow rate while at the same time preserving all other aspects of the system under consideration.

2. OPTIONS AND SELECTION

Two possible avenues of approach to the above scheme were identified; modify conditions within the volume or modify the volume itself. The critical mass flow equation

$$W = \frac{Aa}{v} \quad (2)$$

where

- A = volume flow area,
- a = homogeneous, equilibrium, critical velocity,
- W = critical mass flow rate,
- v = volume specific volume,

will calculate a homogeneous, equilibrium, critical mass flow rate as it is defined above. When a higher mass flow rate must be passed and the critical velocity is limited by the volume state, then either the volume flow area must be increased or the volume specific volume must be decreased. Since specific volume is linked directly to all other volume conditions, including sonic velocity, the simpler approach appeared to be to arbitrarily modify volume flow area, while maintaining system volume, such that the fluid Mach number would never exceed unity.

3. IMPLEMENTATION

Effecting the proposed solution proved to be a task of considerable magnitude, dependent almost entirely upon empirical methods to determine both the basis of volume flow-area modification and the proper placement of this modification in the RELAP4 calculational stream.

Flow area variation required a factor with which to multiply current volume flow area to obtain a new value each time step. During construction of this factor, the necessity for two of them soon became apparent, as the proper factor in the subcooled regime was inadequate in the two-phase region and vice versa. Thus, immediately after calculation of stagnation properties each time step, two volume critical flow rates were determined. The first was based upon mass flux from the homogeneous, equilibrium, critical flow tables at volume stagnation conditions while the second was calculated from volume local critical velocity. Two factors were then derived from the ratio of actual average volume flow rate to these volume critical flow rates. The factor based upon volume critical flow rate from the critical flow tables was largest in the subcooled regime and was applied there, while that based upon volume critical flow rate from local conditions was largest in the two-phase region and was utilized there. In effect, these factors were two Mach numbers which, when multiplied by current volume flow area, would ensure that the volume Mach number would never exceed unity, regardless of junction flow demand.

This computation worked well except during the subcooled-to-saturated transition, when extreme instability was again observed because of the discontinuous nature of local sonic velocity at that point^[11]. A linear transition between the two volume-area multiplication factors was finally devised such that the transit from subcooled multiplication factor to two-phase multiplication factor was completed at two percent quality. This effectively eliminated all problems that had been encountered during fluid transition and allowed a smooth mass flow calculation during the entire transient.

Although the volume-area multiplication factor was calculated immediately after the call to the stagnation properties subroutine, its application at that point was unsatisfactory. The pertinent RELAP4 transient hydraulic logic steps for a typical choked-junction volume are as follows:

- (1) Select new time step size.
- (2) Obtain new junction flow rate estimate.
- (3) Calculate new junction flow rate, new volume mass, and new volume internal energy through simultaneous solution of continuity, energy, and momentum equations.
- (4) Compute new volume average flow rate.
- (5) Acquire remaining volume state variables.
- (6) Edit, if required.
- (7) Go back to Step 1.

Volume Mach number and flow area multiplication factor were determined in Step 2, before the new junction flow rate estimate was finalized. The factor was applied, however, between Steps 4 and 5, so that the new volume and junction flow rates had been established and the new volume velocity head would reflect the increased/decreased volume flow area. Then, when the remaining volume state variables, including static pressure, were calculated, they would also mirror the change in volume flow area and feed the change back into the next volume-flow-area multiplication factor computation. Insertion of the volume-flow-area multiplication process at other points in the calculational stream was attempted during model development but without success, extreme flow instability being the usual result.

Changing volume flow area while maintaining system volume did not affect other system calculations with the exception of volume-wall frictional loss, and that only partially. Volume length and diameter were not altered and, hence, the volume L/D ratio was unchanged. Since initial or non-modified volume flow area was not maintained in the mass flux calculation to determine Reynolds number, however, this mass flux number would be too low, Reynolds number too low, and volume frictional loss somewhat too high, all other things being equal. As this error would only occur in volumes upstream or directly associated with critical junctions, which volumes are usually small, the error involved would generally be one of very low order and did not appear to greatly affect system calculations. This irregularity will be reviewed at a later date, however, to determine if the code should be changed to reflect a somewhat lower frictional loss.

As implied in the preceeding discussion, volume stagnation properties will be used to enter the critical flow tables to acquire the downstream junction choked flow rate. The more correct stagnation conditions would be those at the junction itself. However, difficulties with flow instability were again encountered during model development when junction stagnation properties were used. Since there was some question of the correct method of determining junction stagnation conditions, use of these properties was postponed until this problem could be studied in detail. The error introduced by using volume stagnation properties was relatively small and could be accommodated at this time.

III. THEORETICAL/ANALYTICAL VERIFICATION

The results shown in Figures 1 and 2 came from a very simple steady-state system model. It consisted of an infinite reservoir connected to an infinite containment by a 100 foot pipe, 10 square feet in cross-section. This pipe was divided into two nodes 50 feet in length, so that the RELAP4 code rendition of this system was a straight-forward four-volume model. The containment was at atmospheric conditions, while the reservoir remained at a pressure of 1400 pounds per square inch absolute and a temperature of 440 degrees Fahrenheit for subcooled investigations, Figure 2, and at the same pressure and a quality of eight percent for saturated studies, Figure 1.

This steady-state system was chosen deliberately to provide easy theoretical verification of the new stagnation properties option. In the subcooled regime, a multi-iterative technique could be used to calculate steady-state conditions independently of the RELAP4 code. The only assumption required was incompressibility which, with the fluid completely in the liquid phase, was quite satisfactory. The results of this computation are compared with the RELAP4 code solution of the same problem, using the Henry-Fauske critical flow model, in Figure 3 as regards break mass flow, and in Figure 4 as regards break-volume stagnation pressure. The observed differences are probably caused by the incorrect frictional losses in the code, discussed earlier, and the use of junction stagnation properties in the theoretical solution.

Another analytical verification of the new stagnation properties option could be accomplished with the RELAP4 code itself. By ignoring the momentum flux or velocity head terms in the momentum equation in the code, volume static pressure becomes a reasonable facsimile of stagnation pressure (only slightly higher), particularly in the simple steady-state system selected above. This was done and the results are compared with those using the stagnation properties option in Figure 5. Again, the comparison is very good and the new stagnation properties option appears to be functioning correctly.

It is interesting to note the difference in steady-state flow rate shown in Figure 5 with that in Figure 2. The vastly different flow rates give a graphic indication of the error introduced by entering the critical flow tables with static rather than stagnation properties.

IV. ANALYTICAL/EXPERIMENTAL VERIFICATION

1. BE/EM Study

Many of the studies conducted since the old stagnation properties option was proven unsuitable have simulated stagnation conditions by the technique discussed above, where the momentum flux terms in the RELAP4 momentum equation were ignored. This was done in the BE/EM study (Reference 10) and it is useful to compare their results with those using the new stagnation properties option.

Rather than execute the entire BE/EM model problem, the vessel side break components, from inlet annulus to containment, were simulated in a small model designated Mini-BE/EM. The validity of this model can be confirmed from Figure 6, where the cold leg break mass flow rates from both system and component models are compared under identical conditions. Figure 7 illustrates the same parameter, break mass flow, but this time using the new stagnation properties option with the Mini-BE/EM model. The comparison is excellent, remembering, as shown in Figure 5, that ignoring the momentum flux terms produced a slightly higher static pressure than the stagnation properties option yielded stagnation pressure and, hence, a very slightly higher flow rate. Nonetheless, these flow rates are essentially identical and indicate that correct critical flow can now be obtained directly, without special modeling considerations.

The extremely oscillatory mass flow exhibited by the Mini-BE/EM system about four seconds into the transient illustrates a problem with the Henry-Fauske/Homogeneous Equilibrium critical flow model, a problem that has always existed but is greatly exaggerated when using stagnation properties.

The sequence of events during a transient may be envisaged by reference to Figure 8, a partial plot of the relevant critical flow tables in the RELAP4 code, showing the transition between the Henry-Fauske and the Homogeneous Equilibrium critical flow models. The plot

in Figure 8 can be considered as frozen in time at the point when the break-volume pressure is 1000 pounds per square inch and the quality is such that the Henry-Fauske and transition mass-flux traces intersect. Now, when the enthalpy and/or quality increases only a small amount, at constant pressure, the mass-flux drop is precipitous. The situation, however, is even more unfortunate in that the pressure is not constant but is also declining. Thus, during a transient, all the traces in Figure 8 are slowly dropping and the mass-flux decrement at transition can be very large.

Problems with this critical flow model have never been particularly serious until the advent of a correctly functioning stagnation properties option. During a transient, fluid in the volume upstream from a break flashes almost immediately. If stagnation properties are not being utilized, the break flow chokes very quickly at a rather moderate value and, helped by a slowly increasing static quality, the critical mass flux transitions between the two critical flow models with only minor oscillation (Curve 1, Figure 9). When the stagnation properties option is operative, however, the character of the blowdown is quite different. Break-volume fluid again flashes almost immediately but the stagnation state remains subcooled. The break flow chokes at a much higher rate and tends to stabilize at that point, since stagnation pressure and enthalpy do not change initially as rapidly as their static counterparts. Then, as the volume evacuates, the stagnation state drops to saturation and passes very quickly into significant quality, effectively halving the break flow almost instantaneously. Because of the partially stabilized flow in the system, however, the break volume is pressurized by the incoming fluid, subcools, and the oscillatory pattern is established (Curve 2, Figure 9).

To test this hypothesis, a mass-flux multiplier or "dial" of 1.80 was appended to the Homogeneous Equilibrium critical flow model. This effectively raised that model's mass-flux trace to approximately intersect the Henry-Fauske trace near the saturation point, Figure 8, thereby decreasing the gap between the two models at transition. Results from this modification are plotted as Curve 3, Figure 9, and show a marked

decrease in oscillatory behavior, a clear indication that critical flow model transition is the source of the mass-flow instability shown by the Mini-BE/EM system in Figure 7. Further corroboration of this fact was furnished by exercising the Mini-BE/EM system with the Homogeneous Equilibrium critical flow model alone, utilizing a mass-flux multiplier of 1.20. No instability was noted at any time during the transient.

2. SEMISCALE TEST S-02-4

So far all verification of the new stagnation properties option has been against theoretical and analytical standards. There may also be some interest in how use of this option compared against experimental data. Therefore data from Semiscale Test S-02-4^[12,13,14] were selected to rate the actual functioning of this option. Several parameters were available for comparison but cold leg break flow was selected as being of most interest. The Homogeneous Equilibrium and Henry-Fauske critical flow models were arbitrarily chosen for use with a very finely noded (nine volume) model of this break nozzle. Spool Piece 23, the section of piping just upstream of the nozzle, was modeled as a time-dependent volume using the experimental data recorded there after processing as suggested by Hall^[15]. These volume conditions then became the driving mechanism for the blowdown simulation and allowed an analytical/experimental data comparison without the necessity of executing the entire Semiscale system model. Figures 10 and 11 present the results, respectively, both with the stagnation properties option operative and without it. The excellent agreement of the Homogeneous Equilibrium critical-flow-model/stagnation-properties-option combination with the data in Figure 10 is immediately apparent. The less favorable comparison of the Henry-Fauske model with the data, Figure 11, is also evident.

Note the significant flow-rate differences with and without the stagnation properties option, one more indication of the error introduced by entering the critical flow tables with static conditions. Another difficulty in using these conditions in the critical flow tables is that the level of error is dependent upon volume size, as static conditions depend upon volume average velocity and this is a direct function of

volume flow area. When modeling in the most finely noded manner, all flow losses can be easily accounted for up to the break and the stagnation pressure calculated in the upstream volume should be correct. When a coarser nodalization is used and the upstream volumes are modeled correctly (all flow losses up to the break accounted for in the upstream junctions) the same stagnation pressure and, consequently, break flow rate should be calculated, Figure 12. This is not the case when static properties are used in the critical flow tables, as the smaller-volume, finely-noded, model will have a lower static pressure in the break volume and a lower break flow rate, which pressure and flow rate will rise as the noding is coarsened and volume size increased. This fact is illustrated in Figure 13, which should be compared to Figure 12 to point up the noding independence when using the stagnation properties option.

V. CODE EXECUTION TIME

During development and verification of the stagnation properties option, a reasonable amount of information became available that related to code execution time with and without the option operative. Since this knowledge is directly related to the usefulness of the option, a timing summary from representative system models is included in Table I.

Even a cursory examination of this table will show that no clear trend is discernable. Generally speaking, however, some execution time increase with the stagnation properties option should be expected. Experience, borne out by the timing results in Table I, indicates that the following criteria probably apply:

- (1) The longer the time that the system remains in the subcooled state, the greater will be the execution time increment with the stagnation properties option.
- (2) The finer the noding or, in other words, the smaller the absolute size of the system components, the greater will be the execution time increase.
- (3) Very generally, though not shown specifically in Table I, the higher the critical flow rate, the faster the blowdown, the greater the pressure change per volume per time step, the smaller the required time step, and the longer the code execution time. Since utilization of the stagnation properties option gives rise to higher critical flow rates than using static properties, the execution time increment with this option, for the same critical flow model, will usually be increased. Also, since the more nonhomogeneous and/or nonequilibrium critical flow models (Henry-Fauske, for instance) generate higher critical flow rates, their use tends to be interconnected with the above phenomena to further extend the execution time increment.

System size and complexity, somewhat unexpectedly, seemed to have little relation to additional code execution time with the stagnation properties option. Thus, there appears to be no way to positively predict the computer execution time increment with this option for any particular system model.

VI. CONCLUSIONS AND RECOMMENDATIONS

The conclusion is reasonably clear that the new stagnation properties option should be incorporated into the RELAP4 code. Its utilization with the available critical flow models provides better results without the need for special modeling requirements, either as regards noding arrangements or system modification.

Development of the new stagnation properties option was completed with RELAP4/MOD6, Update 3, and verification and additional checkout with RELAP4/MOD7, Update 67. In line with the above recommendation to incorporate the option into the RELAP4 code, the stagnation properties update was brought into conformity with RELAP4/MOD7, Update 76, and the update cards delivered to G. L. Singer on December 12, 1978. Use of the new option is essentially transparent, that is, there are no procedural changes in implementation other than ensuring that the current water-packing "fix", which is required, has not been turned off.

In addition to the recommendation to include the stagnation properties option, several other recommendations, not necessarily in order of importance, should also be considered.

- (1) At present, stagnation properties will be used in the code as an option. After a period of checkout and use, this option should be changed to the default method for critical flow determination.
- (2) The excellent agreement found between Semiscale Test S-02-4 data and the Homogeneous Equilibrium critical flow model with stagnation properties and without dials, Figure 10, should be pursued with the other critical flow models and, possibly, with other experimental data. Quite probably new recommendations for critical flow model usage would come from such a study.

- (3) The extremely oscillatory flow-rate behavior encountered during transition between the Henry-Fauske and the Homogeneous Equilibrium critical flow models with Mini-BE/EM, Figure 7, should be eliminated. Some investigation into its cause has already been accomplished and the underlying problem has been identified, but minimum verification has been performed. Additional study should be scheduled to complete this inquiry and a permanent remedy then selected and incorporated into the RELAP4 code.
- (4) The Henry-Fauske critical flow model is presently incorporated into the RELAP4 code in two distinct tables, one for the subcooled regime and a second for the saturated region. In addition, these tables are not entirely symmetrical and, under certain transient conditions with the stagnation properties option, the crossover between the two can lead to serious instability. Significant effort has already been expended in reviewing and recalculating these tables with the view of combining them into one table, such as that for the Homogeneous Equilibrium model. This project should be completed.

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Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

HF/HEM CRITICAL FLOW MODEL
TRANSITION CONFIGURATION

Fig. 8

Fig. 9

Fig. 10

30

Fig. 11

Fig. 12

Fig. 13

TABLE I
TIMING SUMMARY

MODEL	TRANSIENT TIME (sec)	EXECUTION				INCREMENT EXECUTION		CRITICAL FLOW MODEL*
		TIME (sec)		TIME STEPS		TIME	TIME STEPS	
		W/O STAGP	W/STAGP	W/O STAGP	W/STAGP			
4-Vol Steady-State								
Subcooled	5	24.78	30.86	1531	1644	+24.5%	+7.4%	HF
Saturated	5	6.79	8.05	350	374	+18.6%	+6.9%	HF
4-Vol Transient	10	15.03	13.85	934	740	-7.9%	-20.8%	HEM
Semiscale Cold Leg								
9-Volume	5	254.79	1363.55	12157	48109	+435.2%	+295.7%	HF
	5	202.04	564.50	9676	20781	+179.4%	+114.8%	HEM
7-Volume	5	170.95	467.30	8753	19751	+173.4%	+125.6%	HEM
33 Mini-BE/EM	5	46.48	49.55	2702	2628	+6.6%	-2.7%	HF/HEM
Trojan**	20	111.81	133.98	1779	1971	+19.8%	+10.8%	HF/HEM

* HF Henry-Fauske
 HEM Homogeneous Equilibrium
 HF/HEM Henry-Fauske/Homogeneous Equilibrium (Parabolic Transition)

** Minimum Node Model, Modified for stagnation properties by:
 (1) Reinstating momentum equation momentum flux terms.
 (2) Reducing pump-side break piping to nominal size.
 (3) Adding vessel-side break piping.

REPORT DATE: DECEMBER

P DIST CODE WB 2100

<-----CURRENT MONTH----->				L	S	COST ELEMENT <-----YEAR TO DATE----->										
<LABOR HRS--><DOLLARS-->		E	WBS	T	PERF	<-----LABOR HRS--><DOLLARS-->		ANNUAL OUTSTG								
ACT	BUD	ACTUAL	BUDGET	V	NUMBER	A	ORG	<-----DESCRIPTION----->	CD	DESC	ACT	BUD	ACTUAL	BUDGET	BUDGET	COMMIT
14		.3	.0					4700 MANUFACTURING	G	LABOR	14		.3	.0	.0	.0
13		.3	.0					6100 LOFT EXPERIMENTAL PROG	G	LABOR	65		1.4	.0	.0	.0
652		14.6	.0						G	LABOR	1070		24.8	.0	.0	.0
		.0	.0					0000 PERF ORG FOR NON LABOR	N	MES			.0	.0	.0	86.5
		8.3	.0					2100 SEMISCALE	N	MES			94.8	.0	.0	259.6
		8.3	.0						N	MES			94.8	.0	.0	346.0
		.6	.0					1400 MATERIAL	P	OTHER			.6	.0	.0	.0
		.3	.0					2100 SEMISCALE	P	OTHER			.1	.0	.0	.0
		.0	.0					4700 MANUFACTURING	P	OTHER			1.3	.0	.0	.0
		.7	.0						P	OTHER			2.0	.0	.0	.0
		.4	.0					9500 ACCOUNTING USE ONLY	R	STD			.4	.0	.0	.0
		.4	.0						R	STD			.4	.0	.0	.0
652		24.0	.0								1070		122.0	.0	.0	346.0
14639	12579	453.0	434.5								40512	36490	1362.0	1,275.3	6,135.2	484.5