Phlebotomy Workstation Redesign Project
Final Report: July 2000

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Overview

The following final report provides a summary of the Phlebotomy Workstation Redesign project. We would like to thank the State of Oregon and the Department of Business and Consumer Services in particular for making this project possible.

The overall structure of the report is as follows:

I. Presentation of Final Prototype
II. Review of Fundamental Features of the Design
III. Summary of Project Evaluation
IV. Evaluation of Results
V. Remaining Design Issues
VI. Summary of Project Activities for Entire Project
VII. Comments on the Worksite Redesign Grant Program.

I. Presentation of Final Prototype

Figures 1-3 depict the final aluminum prototypes installed at a new lab at the Mother Joseph Plaza (MJP) medical facility. These prototypes were installed at the beginning of April. This prototype consists of three main storage units, one end unit, two member chairs, and two draw stands (plus accessories). This represents the equipment for two full workstations and one dedicated wheel chair station. Figure 1 shows the overall storage unit. Figure 2 presents the end-unit that will complete the wheel-chair station. Figure 3 shows the workstation in use during a draw.

Figure 1. Overall Views of the Final Prototype at MJP

Note in Figure 1 the newly added bungee cords to hold the wastebaskets in place. This eliminates the possibility of patients kicking the wastebasket over onto the floor.

Figure 2. End-Unit at MJP

Figure 3. Workstation In Use at MJP

Figure 4 depicts several sizes of arm stabilizers that were built for the final prototype. The unit on the right was designed to be used for smaller children. The phlebotomists have discovered that the arm stabilizers are very helpful for restraining a small child's arm.

Figure 4. Multiple Sized Arm Stabilizers

II. Review of Fundamental Features of the Design

The following is a summary of the primary features of this workstation design.

Overall Concept

- Phlebotomist stands during the draw (with the option to sit occasionally and for drawing patients in wheel chairs)
- Member sits during the draw
- Smaller, moving draw surface with a fixed member chair (member is the reference)
- Member would extend arm to the side of body during the draw
- Member sits sideways (facing one of the partitions) during the draw

Draw Surface

- Draw surface is vertically adjustable by phlebotomist
- Draw surface is also adjustable horizontally
- Draw surface has a functional depth of 16” and has a convex circular shape on the phlebotomist side to allow the phlebotomist to access the member’s arm from multiple angles without increasing the reach distance.
- Draw surface has an overall size of approximately 18”x28”.
- Recessed areas on draw surface to prevent blood tubes from rolling off the table top.
- Movable accessory (arm stabilizer) to guard member’s hand and angle the arm.

Member Chair

- Member chair is vertically adjustable by the phlebotomist (e.g., foot pump)
- Member chair would be left in a higher position (seat height approximately 25”) for most members. The chair would only be lowered for members with difficulty sitting in the higher chair.
- Headrest integrated into backrest of chair.

Supplies

- Retain most supplies (e.g., one-days supply) built into a storage unit that also serves as a partition between workstations.
- Supply storage is flexible to allow for variations in needs and changes over time.
- Critical supplies are duplicated on the left and right hand sides of the workstation.
- Integrating supplies into partitions and/or draw surface minimizes member’s view of supplies and equipment.

II. Review of Fundamental Features of the Design (cont.)

Member Issues

- Member is protected from falling out of the chair by:
    - Having the member recline slightly in the chair during the draw
    - Supporting the member's feet with a foot rest
    - Having a moving work surface which can be pushed towards the member to hold them in the chair (or moved out of the way to access the patient)
    - Having a swivel lock option in member's chair
- Member storage is integrated into the partitions.
- A dedicated wheel chairs station is identical to a regular workstation (except without the patient chair). Phlebotomists are encouraged to sit while drawing wheel chair users.
- Use of a baby tray that attaches to the draw stand for drawing infants (still in development).

III. Summary of Project Evaluation

Table 1 is a summary of the evaluation results for the phlebotomy workstation redesign. Although long-term data will continue to be collected for one metric, the evaluation has revealed that the workstation produced positive results on all metrics. Based on these results, it would be reasonable to consider this new workstation a dramatic improvement over past designs and a huge success overall.

Table 1. Summary of the Results of the Project Evaluation

Metric	Result
1. Improve or maintain the ability to complete medically appropriate and safe blood draws.	• Satisfied all criteria. • Received an "A" rating on 92% (11 out of 12) of testable criteria.
2. Improve staff satisfaction and comfort.	• 91% of phlebotomist's satisfaction ratings were significantly improved for the new workstations.
3. Improve customer service and satisfaction.	• Many positive patient comments about the handrails and patient chair. • No negative patient comments reported.
4. Improve efficiency.	• Workstation at least supports current blood draw efficiency. • Workstation improves efficiency in many small ways and may produce measurable results after additional testing.
5. Reduce musculoskeletal risk factors.	• The final workstation was found to reduce the overall musculoskeletal risk rating from *Medium Risk* to *Low Risk*. • Reduced awkward wrist postures 73%. • Reduced awkward reaching by 87%. • Reduced awkward bending by 91%.
6. Reduce risk of accidents.	• Eliminated or significantly reduced 92% of identified accident risk factors. • Eliminated 46% of accident risk factors.
7. Reduce injuries and workers' compensation costs.	• Injury and workers' compensation data not available at this point. • No identified phlebotomist discomfort associated with the new workstations. • Tracking of this metric will continue.
8. Meet performance and functional requirements.	• Satisfied all criteria. • Received an "A" rating on 92% (57 out of 62) of testable criteria.

IV. Evaluation of Results

Our grant application specified metrics to be used in evaluating the effectiveness of the design. The following sections present the result of these evaluations.

The objectives with their expected metrics are listed below:

1. ***Improve or maintain the ability to complete medically appropriate and safe blood draws***. Objective 1 will be measured using operational metrics to be defined in the initial technical research.
2. ***Improve staff satisfaction and comfort***. Objective 2 will be measured using a validated survey instrument.
3. ***Improve customer service and satisfaction***. Objective 3 will be measured using customer phone surveys and on-site interviews, as well as wait time measurements.
4. ***Improve efficiency***. Objective 4 will be measured using time measures including average time for a blood draw, customer wait time in lobby, customer wait time in phlebotomy area, turn-around time for test results.
5. ***Reduce musculoskeletal risk factors***. Objective 5 will be measured using an ergonomic checklist, postural analysis, and upper-limb elemental task analysis. Predictive modeling will be used to assess the impacts of the potential solutions on musculoskeletal risk factors. Those factors include: the number of repetitive motions, the postures of the back, lower limbs and upper limbs, the type of grips, and the amount of force being exerted.
6. ***Reduce risk of accidents***. Objective 6 will be measured using cognitive task analysis and human error analysis methods.
7. ***Reduce injuries and workers' compensation costs***. Objective 7 will be measured using workers' compensation claims data.
8. ***Meet performance and functional requirements***. Objective 8 will be measured by comparing the resulting design to performance and functional requirements.

A. Objective 1. Improve or maintain the ability to complete medically appropriate and safe blood draws.

These criteria originate from our initial Phlebotomist Input Session conducted March 30, 1999. In addition, we reviewed the Phlebotomy Handbook (Garza and Becan-McBride, 1996) for additional criteria. The ratings of performance presented in Table 2 were completed by the ergonomist because the evaluations were based on concrete, observable characteristics of the workstation. The ratings were then reviewed and edited by the Design Team. The ratings were completed using an A-F grade scale, A being best, F being worst.

Table 2. Evaluation of the Ability to Complete Medically Appropriate and Safe Blood Draws

Criteria for Medically Effective and Consistent Blood Draws	Rating	How Does the Design Satisfy the Criteria?
Keep the arm stable throughout the blood draw process. This is the most important factor in an effective blood draw. Avoid any bumps, sudden movements, or changes in contraction in the member's arm muscles.	**B+**	Phlebotomists found the draw stand to be stable and safe to use for blood draws. A slight wiggle in the draw stand upright is the only criticism. While the wiggle does not seem to impact draw performance, it could increase risk of a problem if the table is bumped during the draw. If this is wiggle can be eliminated, the Rating would be "A". This rating also assumes that the draw stand base will continue to be adequately weighted to counteract any foreseeable tipping forces.
The arm should be almost straight. This straightens the vein and makes the skin more taut.	**A**	A mobile, height adjustable draw surface facilitates this.
Individual differences heavily influence arm postures needed to facilitate a draw. Therefore, flexibility in the workstation is important.	**A**	A mobile, height adjustable draw surface facilitates this.
Line up with vein running fore-aft in front of body.	**A**	A small, circular worksurface facilitates this.
The elbow should be supported throughout process.	**A**	The design permits this to be satisfied either while the elbow is on the draw surface or on the elbow wedge.
Phlebotomists draw "by feel", not by eye.	**A**	The design incorporates this need.
The forearm can be horizontal or angled down slightly.	**A**	Using the elbow wedge allows arm to be angle down slightly. If the elbow wedge is not used, the forearm is automatically horizontal.
Patients can squeeze an object or make a	**A**	The arm stabilizer is provided to give the

tight fist but should be advised to not squeeze repeatedly (this causes elevated potassium levels).		patient an object to squeeze.
Phlebotomists often use their fingers to "anchor" the vein (hold the vein in place to keep it from moving or rolling).	**A**	The design incorporates this need.
The needle angle with respect to the surface of the skin should be approximately 15 degrees.	**A**	The mobile, height adjustable draw surface facilitates the correct needle angle.
The patient's arm should be as low as possible (for patient comfort) while maintaining as open an arm angle as possible for the blood draw.	**A**	The mobile, height adjustable draw surface allows the correct arm posture.
Resting the arm on a padded surface is helpful for the patient's comfort.	**A**	A padded wedge is available for use at the workstation.

B. Objective 2. Improve staff satisfaction and comfort.

Table 3 presents the results of the Staff Satisfaction Survey. The baseline survey was collected from 19 phlebotomists at three different labs in June of 1999. The final survey was collected from five phlebotomists with substantial experience using the prototype workstation. In all cases, phlebotomist rated statements on a 5-point scale, where 5 indicates, "strongly agree", and 1 indicates, "strongly disagree". The table presents the average scores for each question and the results of a two-tailed T-test conducted for each question. This T-test was used to determine if there were significant differences between the baseline scores and final scores (at the 0.05 level of confidence).

A review of Table 3 indicates that the phlebotomists gave the new workstation significantly higher satisfaction ratings on the vast majority of questions. Out of 50 questions, **41 questions (82%) scored significantly higher for the new workstation**, 4 questions (8%) did not score significantly higher, and 5 questions (10%) did not have adequate data to test. Of those questions that did not score significantly higher, the majority of these involved

- Draw scenarios that the phlebotomist was not able to experience in order to evaluate the station properly.
- Defects in the current prototype that are in the process of being fixed.

Table 3. Results of the Staff Satisfaction Survey (1-5 Scale)

Category	Issue/Situation	Avg. Baseline Rating	Avg. New Rating	T-Test Result (p value)	T-Test Finding (p<0.05)
Overall	Overall, this workstation is effective, efficient, and well designed	2.32	4.40	0.00004	**Significant Improvement**
	The workstation is comfortable and convenient for me	2.16	4.20	0.00193	**Significant Improvement**
	The workstation seems to be comfortable and convenient for members	2.63	4.40	0.00020	**Significant Improvement**
Supplies/ Equipment	Location of supplies is effective (overall) Also for specific items:	2.79	4.80	0.00001	**Significant Improvement**
	• Primary sharps container	2.94	4.80	0.00005	**Significant Improvement**
	• Sharps container for butterfly needles and syringes	2.94	4.60	0.00036	**Significant Improvement**
	• Gloves	3.22	4.80	0.00009	**Significant Improvement**
	• Needles	3.28	4.80	0.00013	**Significant**

					Improvement
	• Tourniquets	3.28	4.40	0.04544	**Significant Improvement**
	• Tubes	2.89	4.80	0.00001	**Significant Improvement**
	• Sink	2.83	5.00	0.00000	**Significant Improvement**
	• Computer	2.65	4.00	0.12630	Not Significant**
Work-station	• Overall amount of workspace is adequate	2.58	4.60	0.00006	**Significant Improvement**
	• Work surface is at the right height for drawing	2.53	4.60	0.00005	**Significant Improvement**
	• Work surface is at the right height for writing	3.05	4.20	0.03540	**Significant Improvement**
	• Work surface is wide enough (left to right)	2.37	4.60	0.00003	**Significant Improvement**
	• Work surface is the correct depth (fore-aft)	2.94	4.20	0.02578	**Significant Improvement**
	• Workstation prevents tubes from falling on the floor	2.00	4.60	0.00001	**Significant Improvement**
	• Leg room adequate for members	2.95	4.60	0.00068	**Significant Improvement**
	• Space around the workstation adequate for traffic flow	3.00	4.40	0.02068	**Significant Improvement**
Chairs	• Members can get in and out of chairs easily	2.68	3.80	0.08990	Not Significant*
	• Chairs are stable	3.47	4.60	0.00632	**Significant Improvement**
	• Chairs are at the right height for members	3.11	4.60	0.00083	**Significant Improvement**
	• Chairs do not have to be moved	3.00	4.80	0.00007	**Significant Improvement**
	• Chairs are easy to move	1.59	N/A		N/A***
	• Chairs are comfortable for members	3.22	4.60	0.00144	**Significant Improvement**
Phleb-otomists	Workstation is effective for a variety of sized staff. Specifically for:	2.33	4.50	0.00035	**Significant Improvement**
	• Tall staff	2.21	4.50	0.00020	**Significant Improvement**
	• Short staff	2.75	4.67	0.00491	**Significant**

					Improvement
	• Heavy staff	2.58	4.67	0.00496	**Significant Improvement**
	• Pregnant staff	2.39	4.50	0.09411	Not Significant**
	• Right-handers	2.79	4.50	0.00183	**Significant Improvement**
	• Left-handers	2.76	4.00	0.15279	**Significant Improvement**
Members	Workstation is effective for drawing a variety of patients. Specifically for:	2.63	4.50	0.08980	Data not available
	• Tall members	2.89	4.60	0.00027	**Significant Improvement**
	• Short members	2.63	4.60	0.00007	**Significant Improvement**
	• Heavy members	2.63	4.75	0.00011	**Significant Improvement**
	• Babies	2.63	N/A		Data Not Available**
	• Small children in parent's lap	2.68	4.50	0.11321	Data Not Available**
	• Children sitting by themselves	2.42	4.00	0.00000	**Significant Improvement**
	• Wheelchair users	2.74	3.67	0.40417	**Significant Improvement**
	• Members who are frightened/ tense	2.79	3.75	0.01915	**Significant Improvement**
	• Members who faint	2.47	3.50	0.02699	**Significant Improvement**
	• Members who must partially remove shirt	1.79	3.50	0.00223	**Significant Improvement**
	• Pregnant members	2.89	4.50	0.14298	Data Not Available**
	• Helps the member feel at ease/ minimizes stress	2.68	3.80	0.03663	**Significant Improvement**
Members Cont.	• Drawing from both arms	2.68	4.60	0.00013	**Significant Improvement**
	• Drawing from the hand	3.11	4.40	0.02697	**Significant Improvement**
	• Drawing blood from the finger	3.00	4.00	0.21606	Not Significant**
	• Drawing blood from other locations (e.g., upper arm)	2.94	4.20	0.02447	**Significant Improvement**

* Not significant result based primarily on defects in the current prototype that are in the process of being fixed.
** “Not significant” result based primarily on lack of opportunity to test this particular draw situation.
*** N/A in this case means that the chair is bolted down. Therefore, there is no need for the chair to be easy to move.

In support of the satisfaction ratings, the following baseline staff comments were collected regarding various existing workstations.

Skyline Lab Phlebotomist Comments

- Because I am tall it makes it hard to draw and gives me a back ache
- Workstation is too low have to bend over to far and always asking the patient to move closer
- Poorly organized. These workstations each differ enough to make a too confusing. It is too low for drawing and has a "crowded-in" feeling.
- Workstations have a fixed height and depth and are at the wrong height and depth. It's a back killer.
- Supplies are below the counter, have to stoop. Hard on back.
- Chairs are not adjustable.
- Only complaint counter is too deep. Too much space between the patient and eye. I have to lean over too much. Bad wheelchair access.
- Middle workstation is too narrow.
- Tubes roll away from the wheelchair access table.
- A lot of patients have difficulty moving chairs close to counter.
- We need somewhere comfortable for our wheelchair patients.
- Leaning over aggregates a neck and back injury

Beaverton Lab Phlebotomist Comments

- If I wear shoes with a steel it is more comfortable. If I don't, it's too high.
- Patients have difficulty getting in and out of draw station. The chairs are too big and they hit their knees on it as they get in.
- There isn't adequate legroom for patients. It's too shallow. The patient' s knees are touching the station but their upper body isn't close enough.
- The workstation is too small, too cramped for employees, no room for babies.
- Need a bigger drawing area. Too many patients here.
- We are constantly bumping into one another has with pass-through, turnaround, etc.
- The chairs are not user-friendly. They need to adjusting all the time and are not comfortable for the patients. Patients can fall out of the chairs. We have had 2-3 older patients fall out of chairs.
- The dividers between stations have minimal confidentiality and patients have complained that they feel like cattle in a stall.
- The workstation is too tall for shorter phlebotomists. Patients have problems getting in and out of the stations, especially elderly patients.
- The workstation does not prevent tubes from falling on the floor.

- The bed is too high to put it patient that has fainted.

North Lancaster Lab Phlebotomist Comments

- I can get close to the patient. I don't have to bend forward too much
- What I like least about this workstation is the angle of the draw that is hard on the wrist, arm and back due to twisting.
- There is no privacy between workstations for patients.
- Two out of the three stations are difficult to draw from both arms.
- Not enough room for tubes.
- Tubes are in and okay place.
- Some older and heavier people aren't able to move all the way back in the seat consequently making it harder to draw.
- Not enough room. Bad the angle. Not enough room for garbage. Too low. Get rid of it
- There is room to the left but there is no room to the right.
- No room to fit a child sitting in a parent's lap.
- It is easy for patients to get in and out of the workstation
- I don't like drawing blood from the side and having to reach over and get to us to use.
- The right side is against the wall, no space to draw.
- I'm short so the gloves are a bit hard to reach.
- Easy access to blood drawing equipment.
- Possible to pinch patient's hand in drawer.
- Supplies are hard to get, have to bend down have to move members hand out of the way.
- When drawing from the patients left arm, there is no place to put tubes without reaching over under the patients arm.
- Have to reach across body to access sharp container.
- Patients must up to the seat before they can sit down.
- Would like to draw more from the side of the patient. Must access the patient head-on.

In comparison, the following are staff comments collected from phlebotomists that have used the new prototype workstation.

New Workstation Phlebotomist Comments

- The new stations work great!
- I like how all the supplies are at arms reach and at your fingertips. You don't have to search or reach very far for any one thing.
- The recessed trays are great for preventing tubes from falling on the floor.
- Easy for member to get in and out of chair. Positioning is easier also. User-friendly. Patient-friendly.
- Patients really like the handrails.
- I like the adjustable workstation. It means less bending and reaching.
- I like having access to sharps with both hands within arms reach
- Supplies out of reach for patients (patients can't access supplies).

- The built-in sharps container for butterflies and syringes is wonderful because you do not need to run around carrying exposed needles.

The following are phlebotomist comments on remaining issues. All of these issues will be addressed this year.

- It is inconvenient to lock and unlock all three wheels to move table.
- Footrest needs to be moved back to make it easier for the patient to get in the chair.
- The draw table is too high for wheelchair users.
- Patient's chair hits table when the patient is getting out of the chair. This tends to mark up the draw table.

C. Objective 3. Improve customer service and satisfaction.

There presently has not been a sufficient volume of testing of these workstations in order to warrant a Kaiser Permanente customer phone survey to date. Since Kaiser Permanente Labs have discontinued regular phone surveys for the time being, it is not expected that a phone survey will be feasible. However, Kaiser Permanente does routinely track patient complaints and will continue to do so for these new workstations.

Numerous patient complaints of the pre-existing workstations have been identified. These complaints include the following:

- Clutter on the workstation.
- Uncleanliness (e.g., reusing used gauze).
- Difficulty getting in and out of chairs.
- Falling out of chairs after fainting.

A number of informal patient comments of the new workstation were solicited during the testing of prototypes and during the final assessment. The most common patient comment on the workstations was that they liked the handrails. Patients also commented positively on the large wide chair that seemed very secure to them. Patients also liked the footrest on the chair and indicated that they thought getting in and out of the chair was fairly easy. The following patient comment basically sums up patient comments on the new workstation, "I think this new station is a very neat and comfortable." To our knowledge, we have received no negative comments on the workstation from patients.

During the testing of the new workstation, we did have one patient faint. According to the phlebotomists on the scene, the patient remained safely in the chair. Therefore, the workstation successfully passed this important test. Once several improvements are implemented to the chair (strengthening the backrest and adding a headrest), the chair will be even more effective for protecting fainting patients.

D. Objective 4. Improve efficiency.

The time measurements could find no significant differences in average draw times between the final prototypes and baseline measures. Average draw times still run approximately two minutes for both baseline and prototype workstations. This is

partially due to the fact that the workstation redesign generally did not change the actual blood draw tasks, it changed the workstation used for those tasks. For instance, by improving the location of the supplies, the amount of time required to reach for those supplies was only slightly reduced.

While draw times were not reduced, the efficiency of the workstation was improved in other ways. For example, by organizing and standardizing the workstation, this helps phlebotomists quickly change from workstation to workstation and from lab to lab.

Some opportunities for increasing efficiency at the workstation were examined and rejected during the design process. For example, finding the edge of tape on a tape role is a time-consuming activity. During the design, we investigated outfitting the workstation with tape dispensers. However, we found that many phlebotomists disliked tape dispensers. For example, they generally preferred to hold the entire tape roll in their hand. Also, we were unable to find an appropriate tape dispenser that would fit in the workstation. Therefore, after much effort, we abandoned the tape dispenser idea. We provided a location in the design for phlebotomists to neatly hang a roll of tape.

One of the major ways in which the efficiency of the workstation was improved was by streamlining of the movement of supplies travel at the workstation. In traditional workstation designs, supply and trash storage were generally inefficiently located. This encouraged phlebotomists to place supplies on the worksurface before and after use. The major problem with this is that it creates a cluttered and unsanitary appearance for the patient. The new workstation was designed so that supplies travel directly from storage to use to disposal. This not only helps create a more clean appearance, it helps the phlebotomist to work more efficiently. For example, it takes less time to dispose of something directly after use than it does to place it on the workstation and then later pick it up and dispose of it. However, the phlebotomist must employ this technique while working. Therefore, training is an important component of this change. While this change has not produced any measurable reductions in draw time to date, this may be the result of lower volume use of the workstations. It might be possible to measure improvements in efficiency once these workstations have been installed at a high-volume lab. In any case, we do not expect that the increase in efficiency will be dramatic. Nevertheless, we consider it a success that the workstation does not in any way compromise the efficiency of the blood draw task and certainly improves efficiency in several intangible ways.

E. Objective 5. Reduce musculoskeletal risk factors.

The analyses of musculoskeletal risk factors were completed for both the baseline workstation (Mt. Talbert Lab) and the final prototype workstation (MJP Lab). Mt. Talbert was selected as the baseline because it was representative of the types of problems that occurred with the existing workstations. Other existing labs were included in the assessment of the baseline in order to ensure there were no major differences from the Mount Talbert lab. Video was collected in each case during task performance. The analysis for the final prototype assumes that the phlebotomist is using the recommended techniques for task performance and workstation use.

The Ergonomics Checklist Assessment is a brief analysis method for determining the overall level of musculoskeletal risk factors. A checklist was completed for both the baseline and final prototype videotapes. Table 4 presents the checklist results by body region for the baseline and the final prototype. The Overall Score equals the highest Body Region Score. Risk ratings are determined by the following scale: High=10+, Med=5-9, and Low=0-4. The circled scores indicated the highest score for that task.

Table 4. Checklist Results

Task	Hands/ Wrists/Arms	Shoulder/ Neck	Back/Torso	Legs/Feet	Head/Eyes
Baseline	5	5	4	5	3
Mt. Talbert Lab	**Medium**	**Medium**	**Low**	**Medium**	**Low**
Final Prototype	4	2	1	1	3
MJP Lab	**Low**	**Low**	**Low**	**Low**	**Low**

Note: The circles indicate those body regions with the highest individual risk rating.

The checklist results indicate a Medium Risk for the baseline measurements due to risk factors in the hands/wrists/arms, shoulder/neck, and the legs/feet. The final prototype was found to reduce the overall risk rating to Low Risk.

Two detailed musculoskeletal analysis methods were employed: Postural Analysis and Upper-Limb Elemental Task Analysis. Both of the analysis methods are based on review of videotape and documentation of awkward postures/movements that occur at each task step. The Postural Analysis focuses on continuous postures while the Elemental Task Analysis focuses on repetitive movements. Table 5 compares the postural and elemental task analysis results for both the baseline and final prototype workstations.

Table 5. Impact of New Workstation on Specific Musculoskeletal Risk Factors

Risk Factor Quantified	Max. Rec. Level	Baseline Measures	Final Prototype Measures
Stressful Wrist Motions Per Hour	1000/hr. max.*	L: 180/hr. R: 202/hr.	L: 180/hr. R: 147/hr.
Repeated Pinch Grips Per Hour	2000/hr. max.*	L: 1135/hr.	L: 1163/hr.

		R: 1052/hr.	R: 1025/hr.
% of Awkward Wrist Movements/ Postures (> 10° bend)	33% of time max.*	L: 14% **R: 41%**	L: 14% R: 11%
% of Awkward Shoulder Movements/ Postures (> 30° Away From Body)	33% of time max.*	L: 8% **R: 30%**	L: 4% R: 4%
% of Awkward Back Movements/ Postures (> 10° Bend From Vertical)	33% of time max.*	**33%**	3%
Overall Risk Determination**		**Medium Risk**	**Low Risk**

Note: L refers to left-hand, R refers to the right-hand

* The guidelines here were adapted from the ANSI Z-365 draft standard checklist, Hammer (1934), and Kilbom and Persson (1988).

** The overall risk determination was made as follows. High Risk was determined if one or more risk factors clearly exceeded the maximum recommended guideline. Medium Risk was determined if one or more risk factors exceed the guideline marginally. Otherwise, a Low Risk was determined.

The results of the detailed musculoskeletal analysis indicate the following. For the original workstations, the proportion of the time in which the task involved awkward wrist, shoulder and back postures/movements either exceeded or was close to exceeding the maximum recommended level of 33% of the task time (41%, 30% and 33%, respectively). This was due primarily to the awkward postures occurring during the drawn itself. The final prototype workstation was found to dramatically reduce the amount of time in awkward postures (11%, 4%, and 3%, respectively). This corresponds to reducing awkward wrist postures by 73%, reducing awkward reaching by 87%, and reducing awkward bending by 91%. This occurred primarily because of the highly adjustable draw surface and elbow wedge that allows the phlebotomist to draw blood in the best possible position.

Both the Stressful Wrist Motions per Hour and Repeated Pinch Grips per Hour were significantly below the recommended maximum levels for both the baseline and the final prototypes. Further, the final prototypes did not have a significant impact on these measures.

Risk factors for musculoskeletal injury (presented in Table 6) were developed based on the original analysis of the data collected at the labs in March 1999. Specifically, the risk factors were identified primarily through observation and analysis of task performance.

The evaluations of performance were completed by the ergonomist because the evaluation was based on concrete, observable characteristics of the workstation. The evaluations were reviewed and edited by the Design Team.

Table 6. Evaluation of Success at Reducing Musculoskeletal Risk Factors

Risk Factors	How Does the Design Address the Risk Factors?
Prolonged awkward wrist posture while drawing blood (holding vacutainer	Improved wrist position by: • Providing angled wedges to support member arm at an angle

adapter)	• Providing training that encourages phlebotomists to maintain straight wrists during the draw. • Reducing reach distance • Providing a height adjustable draw surface
Awkward and repetitive wrist movements while picking up and placing items from the work surface	Reduced awkward wrist movements by providing angled wedges to support member arm at an angle. This effectively lowers the worksurface and improves wrist positions while picking and placing tubes.
Awkward and repetitive wrist movements while inserting and removing tubes from holder	Improved wrist position by: • Providing angled wedges to support member arm at an angle • Providing training that encourages phlebotomists to maintain straight wrists during the draw. • Reducing reach distance • Providing a height adjustable draw surface
Reaching/bending while placing/tying tourniquet	Reduced reaching/bending by: • Providing a small, curved draw surface that allows access from all sides. • Making it possible to position the draw surface with respect to the patient. • Providing a height adjustable draw surface • Angled wedge brings the elbow a bit closer
Reaching/bending while sticking/ drawing blood	Reduced reaching/bending by: • Providing a small, curved draw surface that allows access from all sides. • Making it possible to position the draw surface with respect to the patient. • Providing a height adjustable draw surface • Angled wedge brings the elbow a bit closer
Reaching/bending for supplies	Reduced reaching/bending by: • Storing supplies above the work surface. • Providing a flexible storage system to allow the most frequently used items to be stored so as to require the least reaching. • Providing critical supplies on both the left and right hand side of the workstation.
Twisting of the lower back Drawing on side work surfaces (at Salem/N. Lancaster)	• Small, curved draw surface allows direct access to the vein from any direction and with either patient arm.
Static Muscular Fatigue in Legs and Back	Reduced static muscular fatigue in legs by: • Building a footrest into the draw stand to allow the phlebotomist to elevate one foot while working.

	• Provided high quality anti-fatigue mats • Designed the workstation to allow the phlebotomist to sit occasionally while drawing blood if desired.

F. Objective 6. Reduce risk of accidents.

The risk factor scenarios for accidents (presented in Table 7) were developed based on the original analysis of data collected at the labs in March 1999. Specifically, the scenarios were identified through structured interviews with phlebotomists and management as well as through human error analyses of task performance.

The ratings of performance were completed by the ergonomist because the evaluation was based on concrete, observable characteristics of the workstation. The ratings were then reviewed and edited by the Design Team. The ratings were completed using an A-F grade scale, A being best, F being worst.

Table 7. Evaluation of Success at Reducing Needle Stick Risk Factors

Risk Factor Scenario	Rating	How Does the Design Address the Risk Factors?
Phlebotomists reach across his/her body to dispose of a needle. This is caused by the sharps container being only on one side of the workstation.	**A**	**Risk factor eliminated** by providing redundant sharps containers on both sides of workstation.
Patient faints while being drawn. Phlebotomist tries to grab for the patient to keep them from falling.	**A**	**Risk factor significantly reduced** Member is protected from falling out of the chair by: • Having the member recline slightly in the chair during the draw. • Supporting the member's feet with a footrest. • Having a moving work surface that can be push towards the member to hold them in the chair (or move the work surface out of the way). • Swivel lock option in member's chair.
Sharps containers shared between two adjacent workstations. Both phlebotomists can attempt to dispose of needles in the same container at once.	**A**	**Risk factor eliminated** Sharps containers are isolated at each workstation. No sharps containers are shared between workstations. A special curved divider was designed to prevent any needle sticks occurring between

		two adjacent phlebotomists.
Tubes rolling off counter onto floor due to lack of containment.	**A**	**Risk factor significantly reduced** This risk factor was substantially eliminated by providing large redundant tube containment trays on the draw surface and on the adjacent writing worksurface.
Child accesses sharps container.	**A**	**Risk factor significantly reduced** Sharps containers are positioned so as to be difficult to access by patients, particularly children. The sharps containers are also clearly and appropriately labeled and visible.
Sharps container not tied down (can tip over).	**A**	**Risk factor eliminated** All sharps containers are secured to the workstation. The risk of a sharps container being inadvertently tipped over has been substantially eliminated.
Sharps container is too close to member's side. Dispose of needles too close to members.	**A**	**Risk factor significantly reduced** Sharps containers are positioned so as to be difficult to access by patients, particularly children. The sharps containers are also clearly and appropriately labeled and visible.
Child interferes with blood draw of parent.	**A**	**Risk factor significantly reduced** Since the member sits on a raised chair.
Carrying a butterfly needle or syringe across the aisle to a large sharps container on the back counter.	**A**	**Risk factor eliminated** This risk factor was eliminated by integrating a large 5 qt. sharps container into the main workstation. This allows the phlebotomist to dispose of all needle types without having to leave the workstation.
Congestion in work area. Many phlebotomists working together. Increased risk of being bumped.	**B**	**Risk factor slightly reduced** By providing larger workstations, the likelihood of phlebotomists running into each other is reduced. Otherwise, this scenario was not address specifically within the scope of this project
Restricted space in workstation (narrow width of workstation).	**A**	**Risk factor eliminated** This workstation design provides adequate space for both the patient and the phlebotomist.
A tube malfunctions during the draw. The phlebotomist reaches below the	**A**	**Risk factor eliminated** by providing storage for emergency

worksurface to find an additional tube. In the process of fumbling for a tube, they take their eye off the needle and risk a needle stick.		tubes (and all tube supplies) above the draw surface. This allows the tubes to be easily visible and accessible.
Member's arm raises suddenly before the needle is disposed.	**A**	**Risk factor significantly reduced** Arm stabilizer helps to stabilize the patient's arm during and after the draw. This is particularly helpful for children.

G. Objective 7. Reduce injuries and workers' compensation costs.

There has presently not been enough testing in order to determine the impact of the station redesign on workers' compensation claims data. Kaiser Permanente will continue to track workers' compensation claims data and will report to Oregon-OSHA the impact to this objective in 18 months from the date of this report.

Phlebotomist discomfort data was collected for the baseline measurements at the beginning of the project. Phlebotomists were asked to rate the severity and frequency of discomfort for multiple body region by circling the most appropriate response (as shown in Table 8 below). They were asked to circle "None" if they had no discomfort in a body region. For the purposes of presentation of the data, the severity and frequency ratings were mapped onto a 3-point scale (3 indicates both severe and daily, 1 indicates both mild and monthly, etc.)

Table 8. Discomfort Data Results

Body Region	No Discomfort	Severity			Frequency		
• Hands/Wrists/Arms	None	Mild	Moderate	Severe	Monthly	Weekly	Daily
• Shoulders/Neck	None	Mild	Moderate	Severe	Monthly	Weekly	Daily
• Back/Torso	None	Mild	Moderate	Severe	Monthly	Weekly	Daily
• Legs/Feet	None	Mild	Moderate	Severe	Monthly	Weekly	Daily
• Head/Eyes	None	Mild	Moderate	Severe	Monthly	Weekly	Daily

Figure 5 presents the results of this analysis.

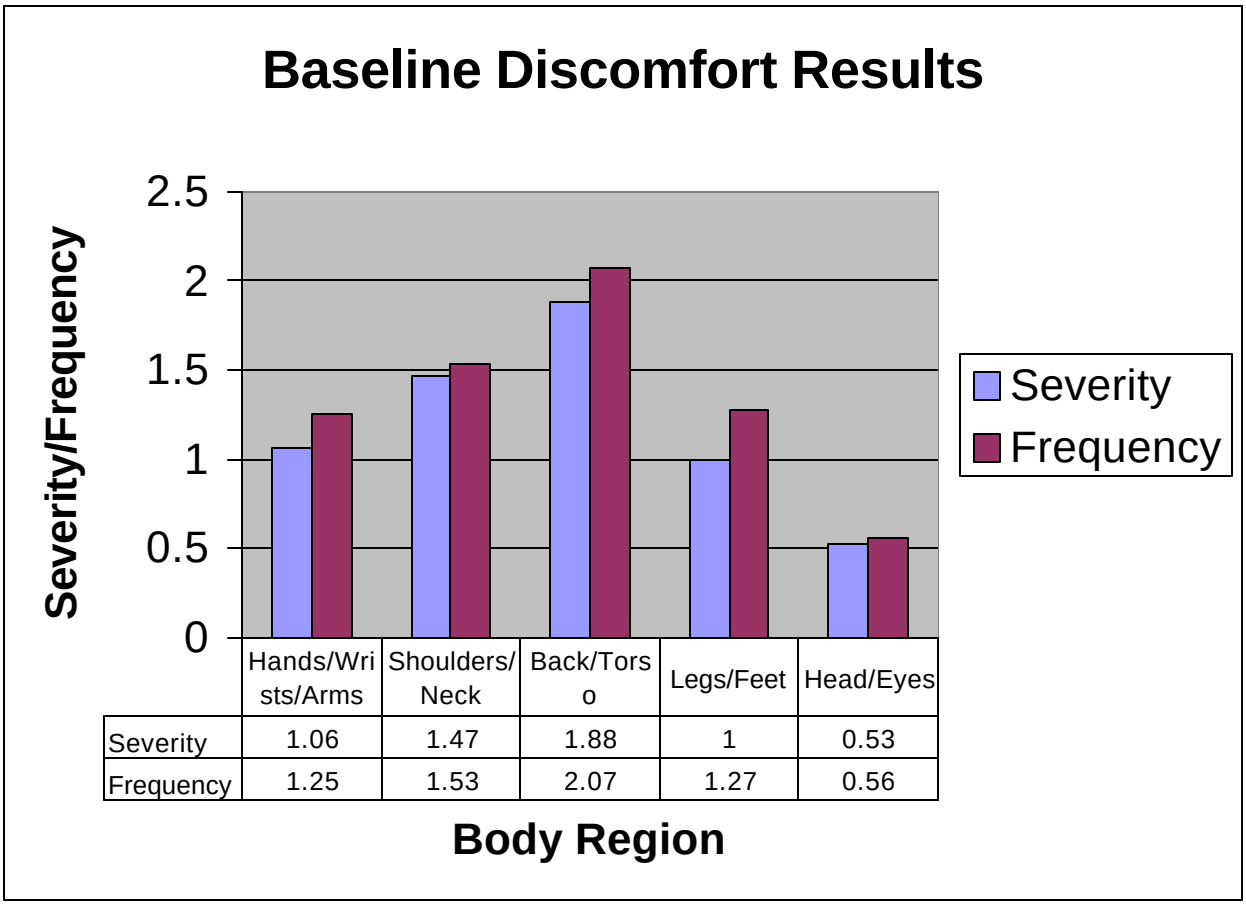


Figure 5. Baseline Discomfort Rating Results

Figure 5 shows that the back/torso was rated highest for discomfort, followed by the shoulders and neck.

An identical survey was completed for the four phlebotomists with experience using the new workstations. This survey identified no discomfort and no phlebotomist has reported any discomfort to date associated with using the new workstations. Nevertheless, this metric will continue to be tracked.

H. Objective 8. Meet performance and functional requirements.

The Design Objectives (i.e., performance and functional requirements) were developed by the Design Team during April and May 1999. The ratings of performance (presented in Table 9) were completed by the ergonomist because the evaluation was based on concrete, observable characteristics of the workstation. The ratings were then reviewed and edited by the Design Team. The ratings were completed using an A-F grade scale, A being best, F being worst.

Table 9. Evaluation of Success at Meeting Design Requirements

Category	Final Rating	Phlebotomy Workstation Design Objectives
Supplies/ Equipment	**A**	***Critical Supply/Equipment Storage.*** Critical supplies/equipment that must be accessed during the draw or during an emergency (e.g., sharps containers, gauze and emergency tubes, tape, tourniquets) should be stored in a reliable location and should be easy to access during the draw.
	A	***Eliminate Crossing the Body.*** Critical supplies/equipment should be stored on both sides of the phlebotomist (or should be easily moveable from one side to the other between patients). The phlebotomist should never have to cross their body in order to dispose of sharps. The phlebotomist should never have to cross their body to access supplies (particularly while a needle is exposed or in the patient's arm).
	A	***General Supply Storage.*** General supplies/equipment (used throughout the day) should be stored so as to be easily accessible to the workstation in order to maximize efficiency (prevent time being wasted while retrieving supplies).
	A (depends on phlebotomist behavior)	***Minimize Redundant Transfers.*** All supplies should be positioned in order to minimize unnecessary repositioning tasks (i.e., staging supplies temporarily).
	A	***Protection of Supplies/Equipment***. Supplies and sharps containers should be inaccessible to members (particularly children).
	A	***Supply Cleanliness***. Supplies should be protected from contamination (e.g., sneezing, coughing, or brushing arm or clothes against)
	A	***Flexibility of Storage.*** The supply storage should be flexible (supplies should be rearrangable based on changes in equipment/supply needs overtime).
	A	***Tube Containment.*** There should be a place to temporarily store and contain tubes that is a reliable location and is easy to access during the draw. Tubes should be safely contained throughout the draw process. The risk of tubes falling on the floor should be eliminated or reduced to an insignificant level
	A	***Tourniquet Storage.*** Tourniquets should be stored within easy reach (and should be easy to store and access).
	A	***Glove Storage.*** All three sizes of gloves needed by personnel during blood draws should be stored so as to prevent time being wasted searching for gloves.
	A	***Separation of Clean and Soiled Materials.*** Clean supplies should be stored separately from soiled or contaminated materials (e.g., used sharps, gauze,

		and wipes). Care should be taken to avoid contaminating clean supplies or having clean supplies fall into sharps containers or trash.
	A	***Non-Sharps Trash Storage.*** The non-sharps wastebasket should be within easy reach during the draw process. It should be easy to throw trash into the wastebasket. The risk of missing the basket and having trash fall on the ground should be minimized.
	A	***Disposal of All Sharps.*** All sharps (regular, butterfly, and syringes) should be disposed of at the workstation (i.e., without having to leave the workstation).
	A	***Sharps Containers.*** Sharps container should be secured to the workstation. The risk of overturning the sharps container should be eliminated or reduced to an insignificant level.
Work-station	**A** **(depends on phlebotomist behavior)**	***Appearance to Member.*** Supplies should be stored so as to create a neat and clean appearance for the workstation. The amount of supplies visible to the member should be minimized. Supplies should be stored in specific locations whenever possible. Workstation design should discourage placing supplies/equipment loosely on the draw surface whenever possible.
	A	***Cleanability.*** The workstation should be easy to clean. All storage locations should be easy to remove and clean. Inside corners and seams should be avoided where possible (replaced by fillets and smooth transitions). Surfaces should be resistant to becoming contaminated (e.g., cracking or absorbing fluids).
	A **(assuming changes to baby tray and chair)**	***Durability.*** Surfaces and structures should be resistant to cracking, breakage, and other damage over time.
	A **(design being used for all retrofits)**	***Footprint.*** The overall size of each workstation should be minimized. It would be desirable (though not required) for the workstation to usable as retrofits within existing labs.
	A	***Trip Hazards.*** There should be no objects in aisle ways or work areas (such as trash receptacles) that could interfere with movement or create a trip hazard.
	A **(depends on phlebotomist behavior)**	***Minimize Bending.*** Bending should be eliminated or minimized while performing phlebotomy tasks. This particularly applies while accessing supplies and while performing the draw.
	A **(depends on phlebotomist behavior)**	***Minimize Reaching.*** Reaching should be eliminated or minimized while performing phlebotomy tasks. This particularly applies while accessing supplies and while performing the draw.
	A **(depends on phlebotomist behavior)**	***Minimize Wrist Movements.*** Awkward wrist movements and postures should be eliminated or minimized while performing phlebotomy tasks. This particularly applies while accessing supplies and while performing the draw.
	A **(depends on phlebotomist behavior)**	***Minimize Hand Forces.*** Hand and fingertip forces should be minimized while performing phlebotomy tasks. This particularly applies while accessing supplies and while performing the draw.
	A **(assuming chairs/stools provided)**	***Minimize Standing Fatigue.*** Fatigue from standing by the phlebotomist should be minimized. This can be accomplished via floor coverings, anti-

		fatigue mats, shoe insoles, foot rests, periodic sitting, etc.).
	A	***Prevent Exposure to Hard Edges.*** Exposed hard or sharp edges on the workstation should be eliminated or minimized. (e.g., the edges of draw surface should be rounded, particularly on the member's side)
	A- **(potential head knocker)**	***Prevent Contusions.*** There should be no features of the workstation that the member or the phlebotomist might bump into (e.g., prevent head and knee knockers).
	A	***Prevent Hooks.*** There should be no features of the workstation that could snag/hook the member's or the phlebotomist's clothing.
	A	***Member Leg Clearance.*** The member should have adequate leg clearance at the workstation.
	A **(assuming current draw stand)**	***Phlebotomist Toe Clearance.*** The phlebotomist should have adequate toe clearance at the workstation.
	A **(assuming unified wheel locking)**	***Ease of Adjustment.*** All workstation adjustments should be easily operated in a short period of time.
	A	***Draw Either Arm.*** The workstation should allow the phlebotomist to easily draw from either member's arm.
	A	***Phlebotomist Sitting vs. Standing.*** It is preferable if the phlebotomist stands for the majority of draws. However, it is desirable if the phlebotomist can sit occasionally. It is not recommended for the phlebotomist to always sit while drawing.
	A	***Writing Worksurface Height.*** Writing worksurfaces should (preferably) allow the phlebotomist to write in an upright posture (without having to bend the back and neck excessively)
	A	***Member-Phlebotomist Interaction.*** The workstation should facilitate an effective interaction between the phlebotomist and the member that provides excellent member service and efficiency.
	A	***Workstation Boundaries.*** It is preferable that each workstation be discreet and separate from other draw stations. Particularly, there should be no sharing of sharps containers and no common worksurfaces that are used for placing tubes and paperwork prior to tubes being labeled.
	A	***Labeling Tubes.*** The workstation should allow tubes to be labeled in the presence of the member.
	A	***Proximity of Labels.*** The labels should be able to be placed at the draw surface during the draw so that the phlebotomist can double check the tubes needed.
	A **(depends on phlebotomist behavior)**	***Minimize Mixing Paper Work.*** The risk of paperwork, labels, and tubes from two or more different members being switched or misplaced should be eliminated or reduced to an insignificant level.
	A	***Design for Majority of Population.*** The workstation design should accommodate a minimum of 90% of the phlebotomist and patient population is size and weight.
Draw Surface	**B+** **(with slight wiggle,**	***Forearm Support Stability.*** The member's forearm should be completely supported during the draw. The member's arm (i.e., draw surface) should

	A if wiggle eliminated)	remain firm and stable during the blood draw. The risk of the draw surface moving during the draw should be eliminated or reduced to an insignificant level.
	A (assuming use of angle wedge)	***Forearm Support Inclination.*** The workstation should allow the member's forearm to be placed in a horizontal orientation, sloped down (e.g., using a wedge), or sloped up in rare cases. A sloped down arm may help to improve wrist and arm postures during the draw.
	A	***Draw Surface Depth.*** The draw surface should be of minimum depth while supporting a variety of patient forearm lengths. The member's hand should not come in contact with the phlebotomist's body.
	A	***Access to Member's Arm.*** The phlebotomist should be able to have equal access to the member's arm from various angles (i.e., in-line with arm and off to each side of the arm. In other words, the reach distance should be the same for different positions of the vein. This allows the phlebotomist to line-up with the vein to more effectively draw blood.
	A (assuming adequate lighting at future labs)	***Lighting.*** Adequate lighting should be provided for drawing tasks. The highest light levels should be directed at the member's arm. Glare should be minimized on the draw surface, on supplies, and the member's arm.
Member Issues	**A- (seat pan is a bit deep, no armrests)**	***Member Chair: Ingress/Egress.*** Members should be able to enter and leave the workstation without difficulty. The risk of tripping and falling should be eliminated or reduced to an insignificant level.
	A	***Member Chair: Movement.*** Member chairs should not have to be moved or should be easy to move.
	A (A+ if headrest added successfully)	***Protecting Fainting Patients.*** Members who faint should remain in the chair and should be protected against falling. The risk of the member falling out of the chair or hitting against anything should be eliminated or reduced to an insignificant level.
	A	***Member Privacy.*** The member should have privacy while being drawn.
	A	***Sense of Openness.*** The workstation should balance privacy with a sense of openness. The workstation should not be so enclosed so as to contribute to a sense of claustrophobia.
	A	***Providing Diversions for Member.*** There should be space available at right angles to the draw surface for cartoons or pictures to be posted to give the member something else to concentrate on during the draw. The space should allow materials to be easily replaced and should be easy to clean.
	A	***Phlebotomist Access to Adjacent Stations.*** Phlebotomists can see members at adjacent stations while performing a blood draw.
	A	***Member Storage: Presence and Size.*** There should be adequate storage at the workstation for the member's belongings, including: paperwork, membership cards, purses, diaper bags, canes, coats, and hats.
	A	***Member Storage: Accessibility.*** The storage should be designed to allow the member to place and retrieve items easily without having to bend or reach.
	A- (belongings can be forgotten on member	***Member Storage: Preventing Lost Items.*** The storage should be designed to minimize the risk of a member forgetting any of their belongings. It is preferable if the member is able to keep belongings in view during the draw

	shelf in corner)	process. It is also preferable if the member storage is dedicated to the workstation to reduce the risk of the belongings being mixed-up and confused.
Special Needs	**A**	***Multiple Phlebotomists.*** There should be adequate space for another phlebotomist to assist the primary phlebotomists for certain draws (e.g., uncooperative patients).
	A	***Integration of Computers.*** The workstation should include consideration of where a data input computer would be located in the work area. Consideration should be given to how the computer would be integrated into the workstation for those labs that combine reception and drawing functions.
	A- **(assuming vertical upright lowered)**	***Wheelchair Draws.*** Provision should be made for drawing wheelchair users either at the primary workstation (preferably) or at a separate workstation
	A	***Traffic Flow around Wheelchairs.*** Draws from persons in wheelchairs do not interfere with traffic flow in the area.
	A	***Drawing Small Children.*** Provisions should be made for drawing small children in parent's laps and small children sitting by themselves
	A **(assuming member chair reinforced)**	***Drawing Large Persons.*** Provisions should be made for drawing very large persons at the primary workstation (preferably) or at a separate workstation.
	A	***Drawing Pregnant Women.*** Provisions should be made for drawing pregnant women.
	Untested to Date	***Drawing Infants.*** Provisions should be made for drawing infants either at the primary workstation (preferably) or at a separate workstation.
	A	***Drawing Infants: Padding.*** Area for drawing infants should be padded for the comfort of the infant
	Untested to Date	***Drawing Infants: Preventing Falls.*** Area for drawing infants has raised sides to prevent infant from rolling off.

V. Remaining Design Issues

A. Draw Stand

The current wheels on the draw stand are time consuming to lock and unlock. This will be a problem for high-volume labs. We are planning to implement an integrated wheel locking system. However, implementation looks to be several months away.

We received the new production uprights and they appear to function well. The only drawback is that there is more wiggle in the new production uprights then was present on the previous prototypes. We have asked the vendor to see if anything can be done to reduce the wiggle.

To make this draw stand function correctly for wheelchair users, it will be necessary to modify the base of the draw stand to lower the vertical upright by 2" or more. This occurs because the vertical up rights we're using our two inches longer than we want but we have been unable to find a quick and inexpensive way to make them shorter. This reality must also be considered in the design of integrated wheel locking systems.

We decided to integrate a rubber bumper into the edge of the draw surface. This will help to prevent damage to the draw surface banging from into the storage units as well as the metal handles on the sides of the member chair.

Additional weight should be added to the base in order to minimize risk of tipping the stand over. The current weight of the base is adequate but some additional weight is recommended to increase security.

B. Member Chair

We are planning to integrate a headrest into the chair to allow fainted patients to remain in the chair comfortably. This will eliminate the need, in many cases, to transfer a fainted patient to a recliner or bed. We are also planning to reinforce the backrest to prevent the backrest from suddenly breaking and collapsing. Once these changes are made they will be retrofitted at the existing labs with the new workstations.

C. Storage Units

There are no remaining issues that have been identified with the storage units. Several minor changes have been made to the engineering drawings that will be reflected in future versions.

D. Baby Tray

We continue to plan a baby tray attached to the draw stand. This tray will have wider Velcro straps repositioned to allow a tighter fit. We are also planning on making the tray

out of a more durable material. The current material is too brittle and has broken in the past.

E. Arm Stabilizer

The latest arm stabilizer prototypes functioned effectively overall. We tested three models of various lengths. We are planning on retaining the version that is 20" long because this version works best for adults and wheel chair users. A smaller version (14”) will be used for drawing small children.

The plastic tube serving as the handle grip is currently 1.75" in diameter. According to the print, the diameter should be 1.25". The tube and pin that holds it in place should both move freely through the holes in the sides of the arm stabilizer. The pin that is used to hold the tube should be modified to match the drawing and allow the tube to be removed easily for cleaning. We plan to further detail the drawing to specify these requirements.

F. Other Workstation Issues

We are planning to ensure new labs have appropriate-adjustable stools to allow phlebotomists to sit while drawing if necessary.

G. Training Issues

We have discovered that there are still gaps in the effectiveness of the phlebotomists training. During the final assessment, we found that phlebotomists did not always follow training guidelines. For instance:

- phlebotomists often didn't adjust the height and the position of the drawn stand to minimize reaching and bending.
- they sometimes reached across their bodies unnecessarily to access supplies.
- they used gloves in the high location rather than storing them lower on the left storage unit.

We agreed to implement a follow-up procedure with phlebotomists. Following the training and after a specified period of time, the trainer will conduct one or more follow-ups with each phlebotomist to make sure all workstation use guidelines are being practiced. If there are any deviations from the guidelines, the trainer will review these with the phlebotomist in a constructive way and encourage adherence to the guidelines.

VI. Summary of Project Activities for Entire Project, January 1999 – June 2000

January-February 1999 (Pre-Project Activities):
- Created a Design Team made up of representatives from Regional and National EHS, Regional and National Facilities, Regional Lab (including phlebotomist representation), and the consultant.
- Developed our schedule of activities.
- Established monthly meetings for the Design Team.

March 1999 Activities:
- Completed official project launch.
- Completed literature searches.
- Developed plan for conducting the research and including phlebotomists and other stakeholders in the design.
- Selected Kaiser Permanente labs to include in the on-site research.
- Conducted on-site research at labs (March 11-12).
- Completed ergonomics and human factors analyses.
- Conducted 1st Phlebotomist Input Session (March 30).

April 1999 Activities:
- Developed preliminary Design Objectives (i.e., Design Requirements).
- Conduct brainstorming meeting with Design Team (April 6).
- Conceptual and preliminary design.
- Built cardboard models of design concepts.
- Compiled baseline data.

May 1999 Activities:
- Competed Conceptual Design Review (May 3), Presented cardboard prototypes to Design Team.
- Built new cardboard models based on feedback.
- Completed Phlebotomist Input Session (May 18, presented revised cardboard prototypes to phlebotomists).

June 1999 Activities:
- Constructed workstation models for the June 17 Review Meeting.
- Conducted the Detailed Design Review Meeting (1st meeting at Kaiser Theatre Building), June 17 (discussed latest workstation concepts, reviewed design requirements, evaluated latest models, obtained phlebotomist inputs, made major design decisions).
- Initiated engineering design.

July 1999 Activities:
- Conducted a meeting with the sharps container supplier, July 1, regarding sharps disposal.

- Performed additional engineering design.
- Modified existing models to add the 5-qt. sharps container and reduce reach to supplies.
- Conducted Design Review Meeting, July 6 (discussed syringe/butterfly disposal and obtained additional phlebotomist inputs on design, evaluated new medical chair).
- Visited potential storage unit manufacturer, July 15.
- Modified existing models to address issues (such as providing adequate patient toe clearance).
- Obtained additional phlebotomist inputs, July 27.
- Visited Sunnyside Medical Center, July 28, to attempt to identify existing technologies for the draw stand.

August 1999 Activities:
- Constructed new model for August 9 meeting.
- Design Review Meeting, August 9 (focused on sharps container visibility, protecting phlebotomist arm from needle sticks while reaching to supplies on the right side of the storage unit, tourniquet storage, and tube staging).
- Constructed models, August 20 (develop flexible storage design, evaluate salon chair and overbed table concept).
- Performed detailed engineering design.

September 1999 Activities:
- Completed engineering drawings for the storage unit.
- Completed engineering revisions.
- Ordered two models of patient chairs for evaluation.
- Conducted research into the engineering of the draw-stand.
- Prepared for the ICOH presentation.

October 1999 Activities:
- Attended the ICOH conference in Montreal. Made a presentation on the phlebotomy workstation project (October 1).
- Finalized engineering drawings.
- Designed a special end-station storage unit.
- Built corrugated storage unit models of the latest engineering drawings.

November 1999 Activities:
- Conducted Phlebotomist Input Session to have phlebotomists evaluate the latest design (November 3).
- Conducted discussions with Design Team to make decisions based on phlebotomist inputs.
- Selected a patient chair for the workstation and ordered chairs for the January testing.
- Reviewed shop drawings with the manufacturer. Implemented engineering revisions based on phlebotomist inputs and findings of the evaluation.
- Redesigned the support structure for the draw-stand.
- Revised shop drawings.

- Initiated build of aluminum prototypes of storage units.
- Worked on technical difficulties with the draw-stand vertical adjustment mechanism.

December 1999 Activities:
- Manufactured the interim aluminum prototypes.
- Received an additional patient chair.

January 2000 Activities:
- Received interim aluminum prototype workstations at Mt. Scott lab (sent them back for revisions to fix manufacturing errors).
- Installed and tested the modified prototype workstations with the design team.
- Conducted testing of workstations with various phlebotomists (completing surveys).

February 2000 Activities:
- Continued to modify and refine the locking wheels on the draw stand
- Completed revisions to engineering drawings for final aluminum prototypes.
- Conducted preliminary training of some phlebotomists at Mt. Scott lab.

March 2000 Activities:
- Established training certification program for redesigned phlebotomy workstations.
- Conducted training with Phlebotomist Trainers and the phlebotomists at Mt. Scott (March 15).
- Research unified wheel locks for draw stand.

April 2000 Activities:
- Installed final prototypes for new lab at Mother Joseph Plaza (MJP).
- Developed temporary solution (individual wheel-locking) for draw stand.
- Presented project (April 4) to Washington State Chapter of Association of Occupational Health Professionals (Oregon Chapter of AOHP in process of being formed).
- Tested prototypes at Mt. Scott and MJP.

May 2000 Activities:
- Tested prototypes at Mt. Scott and MJP.
- Conducted meeting with the Professional Focus Group to propose this station as a Kaiser Permanente National Standard.
- Research unified wheel locks for draw stand.
- Reexamine baby tray design.
- Address problems with vertical uprights on draw stand failing.

June 2000 Activities:
- Conducted meetings to discuss unresolved issues (baby tray, unified wheel locking of draw stand).
- Research unified wheel locks for draw stand.
- Modified engineering drawings

- Obtained and installed functional vertical uprights.
- Received half storage unit, new inserts and new arm stabilizers for MJP.
- Completed final assessment at Mt. Scott and MJP.
- Completed draft final report.
- Conducted meeting with Design Team to review Final Report.
- Finalized draft report.

VII. Comments on the Worksite Redesign Grant Program

Kaiser Permanente and the Arthur D. Little organization would like to thank OR-OSHA for providing the funding and opportunity to work on a project that improves worker comfort and safety. The team working on this project appreciated the guidance and support provided by the OR-OSHA liaison, Sharon Dey. We felt that the application for the grant and the ongoing process were reasonably straightforward. Some issues we did encounter, however, included the need to switch some of the monies from specified categories to others. In addition, as the project progressed, we found there were times when additional services and products were needed which we had not planned for. An example, was the need for increased industrial design time when a prototype or product did not meet our needs. When we faced this, we were fortunate that Kaiser Permanente could fund many of the adjustments. It would be ideal to create some type of system that would allow the grant program to assist with these unknown issues and adjustments.

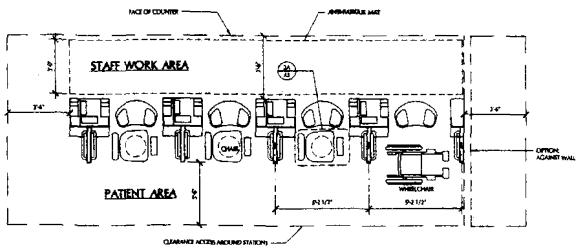
Overall, the entire team felt this project was very successful and we were grateful for the grant and assistance from OR-OSHA. Thank you again, we feel our contribution to worker safety and comfort has been a very positive experience.

Kaiser Phlebotomy Stations & Draw Tables

CONSULTANTS

PETERSEN KOLBERG AND ASSOCIATES, P.C.
Architect *(503) 682-0413*

DRAWING INDEX



1/T1 Typical Station Lay-out
SCALE : 3/8" = 1'-0"

KAISER PERMANENTE
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500 NE MULTNOMAH ST.
12TH FLOOR
PORTLAND, OR 97232-2099

Revisions
No. | Revisions | By | Date | Appr.

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pka ARCHITECTS
Petersen Kolberg & Assocs, P.C.
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6969 SW Hampton St., Portland OR. 97223
Tel. (503) 968-6800 Fax (503) 968-6860

Stamp

Key Plan

Project Architect Approval:

Architect/Engineer Of Record:

Facility

Project
Kaiser
Project #990902C

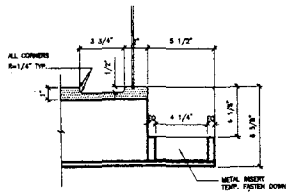
Sheet Title
Title Sheet

File Name : 990902C-Title Sheet

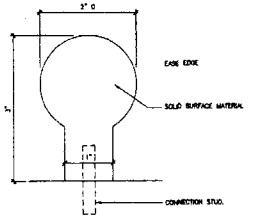
Scale 1/4"= 1'-0"
Drawn By Team H.
Checked By
Issue Date 7/31/2000

Permit No.

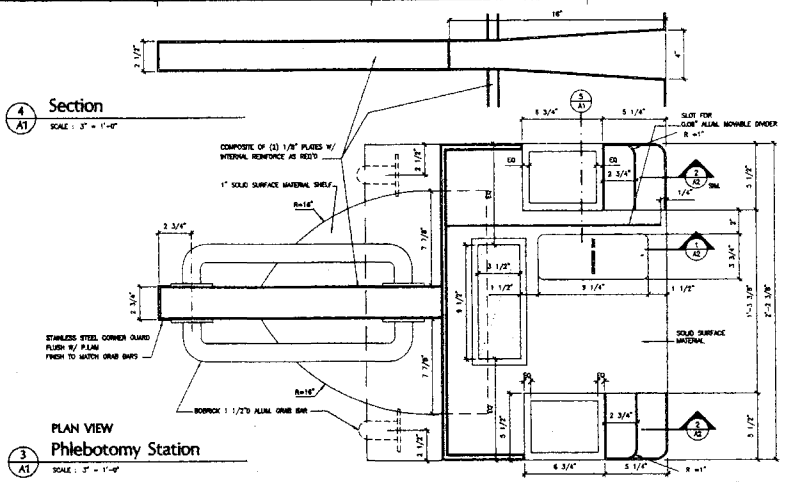
Sheet
T1
Of Sheets



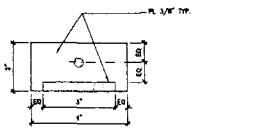
5 / A1 Section
SCALE : 3" = 1'-0"



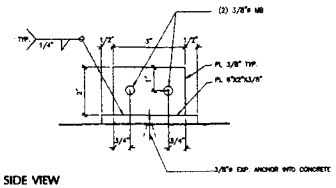
8 / A1 Coat Hook
FULL SCALE



4 / A1 Section
SCALE : 3" = 1'-0"

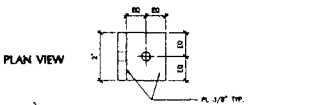


PLAN VIEW

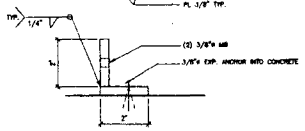


SIDE VIEW

6 / A1 Steel Connector
SCALE : 6" = 1'-0"

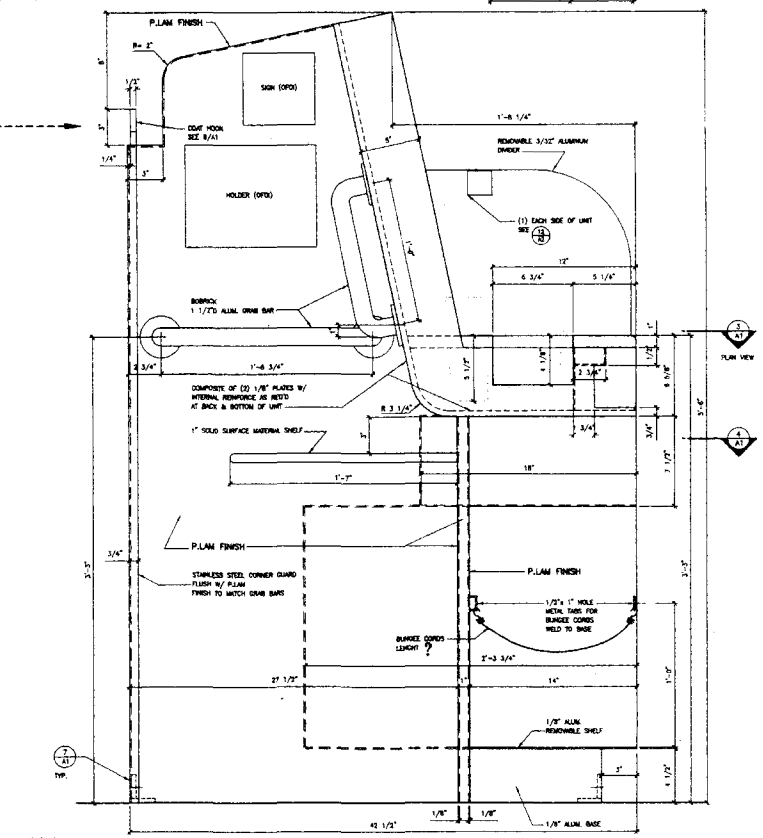


PLAN VIEW



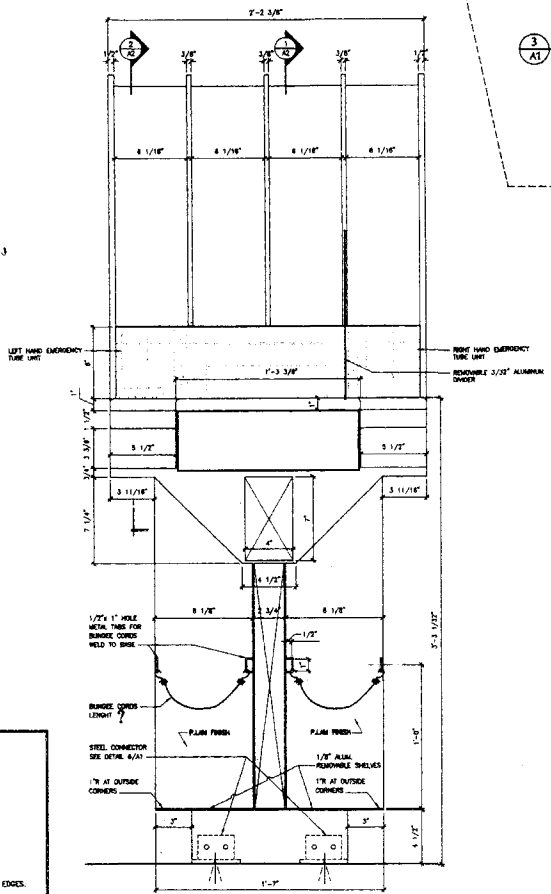
SIDE VIEW

7 / A1 Steel Connector
SCALE : 6" = 1'-0"



PLAN VIEW

3 / A1 Phlebotomy Station
SCALE : 3" = 1'-0"



1 / A1 Phlebotomy Station
SCALE : 3" = 1'-0"
FRONT VIEW
ALL PARTS ALUMINUM UNLESS NOTED.

2 / A1 Phlebotomy Station
SCALE : 3" = 1'-0"
SIDE VIEW

Notes :

1 - ALL ALUM. & STEEL EXPOSED TO VIEW SHALL BE FACTORY POWDER COAT PAINTED (RAL7004 COLOR.
2 - ALL ALUMINUM SHALL BE 3/32" (0.09") THICK UNLESS OTHERWISE NOTED.
3 - PROVIDE SHOP DRAWINGS FOR REVIEW PRIOR TO ANY WORK.
4 - VERIFY ALL DIMENSIONS AND CONTACT ARCHITECT OF ANY DISCREPANCIES PRIOR TO ANY WORK.
5 - SOLID SURFACE MATERIAL SHALL BE CORIAN EVEREST (ONLY WHERE INDICATED) SUBMIT SAMPLES FOR REVIEW.
6 - ALL PLASTIC SHALL BE 1/8" THICK UNLESS OTHERWISE NOTED. COLOR AS SELECTED BY ARCHITECT. SUBMIT SAMPLES FOR REVIEW.
7 - ALL WELDINGS SHALL BE CONTINUOUS, SMOOTH & ROUNDED. NO SHARP EDGES.
8 - ALL METAL, PLASTIC & SOLID SURFACE SHALL BE SMOOTH & ROUNDED W/ NO SHARP EDGES.
9 - P.LAM FINISH : FORMICA NATURAL CANVAS 7022-58 (ONLY WHERE INDICATED).

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

IF THIS SHEET IS NOT 30"x42", IT IS A REDUCED PRINT - SCALE ACCORDINGLY

KAISER PERMANENTE
NATIONAL FACILITIES SERVICES
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12TH FLOOR
PORTLAND, OR 97232-2099

Revisions

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Stamp

Key Plan

Project Architect Approval

Architect/Engineer Of Record

Facility
KAISER PERMANENTE

Project
Phlebotomy Station & Draw Table
Project #990902C

Sheet Title
PHLEBOTOMY STATION DETAILS
File Name : 990902C-PHLEBO-A1

Fac No.	Bldg No.	Floor Loc.	Section
Scale	3"=1'-0"		
Drawn By	Team H.	Permit No.	
Checked By		Sheet	A1
Issue Date	7/31/2000	of 8 Sheets	

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

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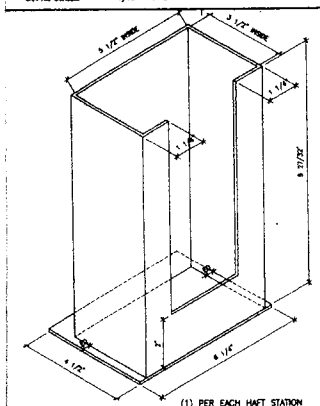
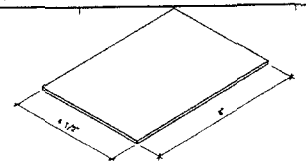
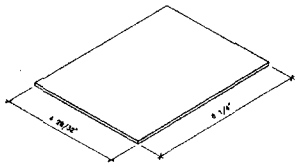


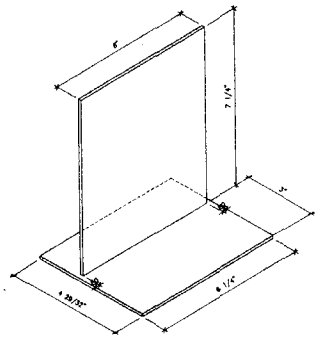
3 A2 **Insert A** (1) PER EACH HAFT STATION (3) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



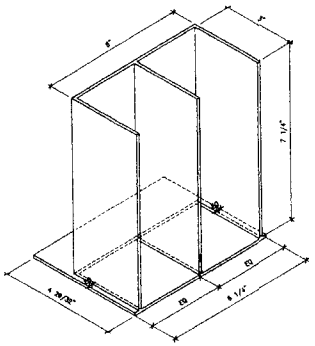
5 A2 **Insert C** (1) PER EACH HAFT STATION (4) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



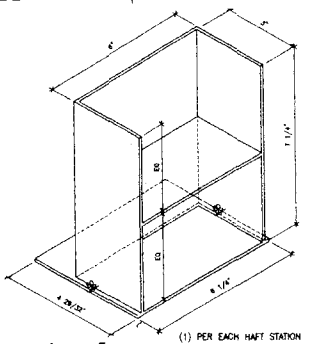
4 A2 **Insert B** (1) PER EACH HAFT STATION (4) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



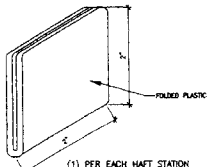
6 A2 **Insert D** (1) PER EACH HAFT STATION (4) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



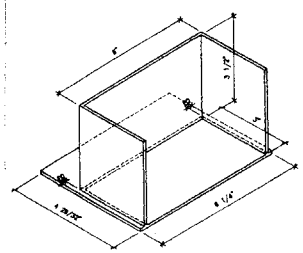
7 A2 **Insert E** (1) PER EACH HAFT STATION (2) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



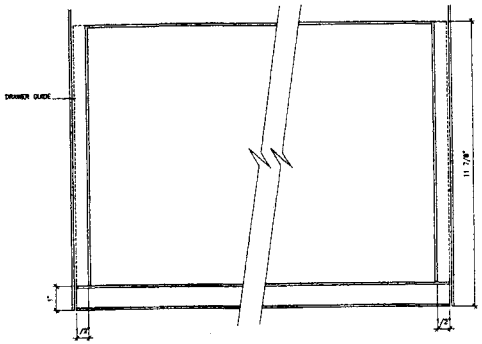
8 A2 **Insert F** (1) PER EACH HAFT STATION (2) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)



12 A2 **Plastic Slot** (1) PER EACH HAFT STATION (2) PER EACH PHLEBOTOMY STATION
SCALE : 1" = 1'-0" (Made of Clear Plastic)

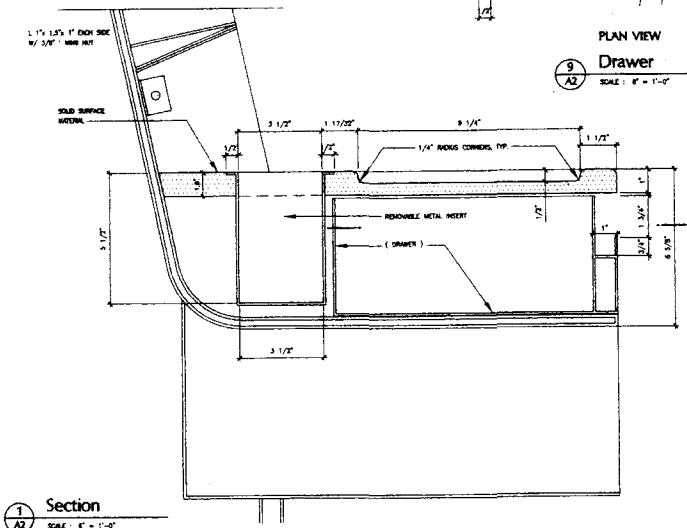


10 A2 **Insert G** (1) PER EACH HAFT STATION (4) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)

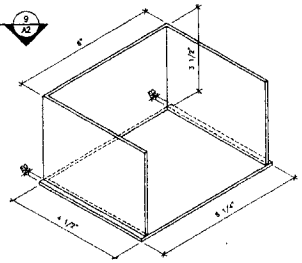


PLAN VIEW

9 A2 **Drawer**
SCALE : 6" = 1'-0"



1 A2 **Section**
SCALE : 6" = 1'-0"



11 A2 **Insert H** (1) PER EACH HAFT STATION (4) PER EACH PHLEBOTOMY STATION
SCALE : 6" = 1'-0" (Made of Plastic)

2 A2 **Section**
SCALE : 6" = 1'-0"

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Stamp

Key Plan

Project Architect Approval:

Architect/Engineer Of Record:

Facility: KAISER PERMANENTE

Project: Phlebotomy Station & Draw Table
Project #990902C

Sheet Title: PHLEBOTOMY STATION DETAILS & INSERTS
File Name : 990902C-PHLEBO-A2

Fac. No.	Bldg. No.	Floor Loc.	Section
Scale: 6"=1'-0"			
Drawn By: Team H.		Permit No.	
Checked By:		Sheet: A2	
Issue Date: 7/31/2000		OF 8 Sheets	

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

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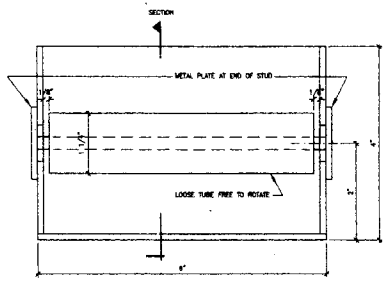
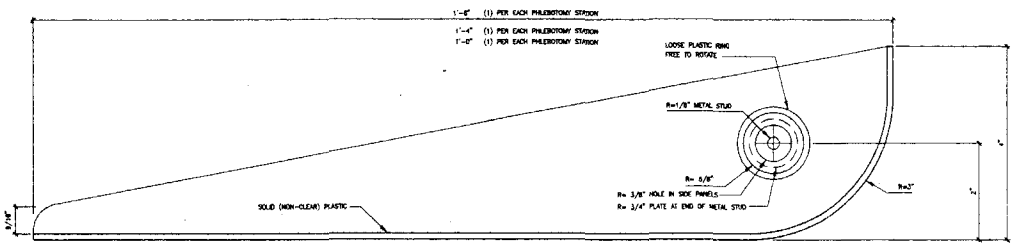


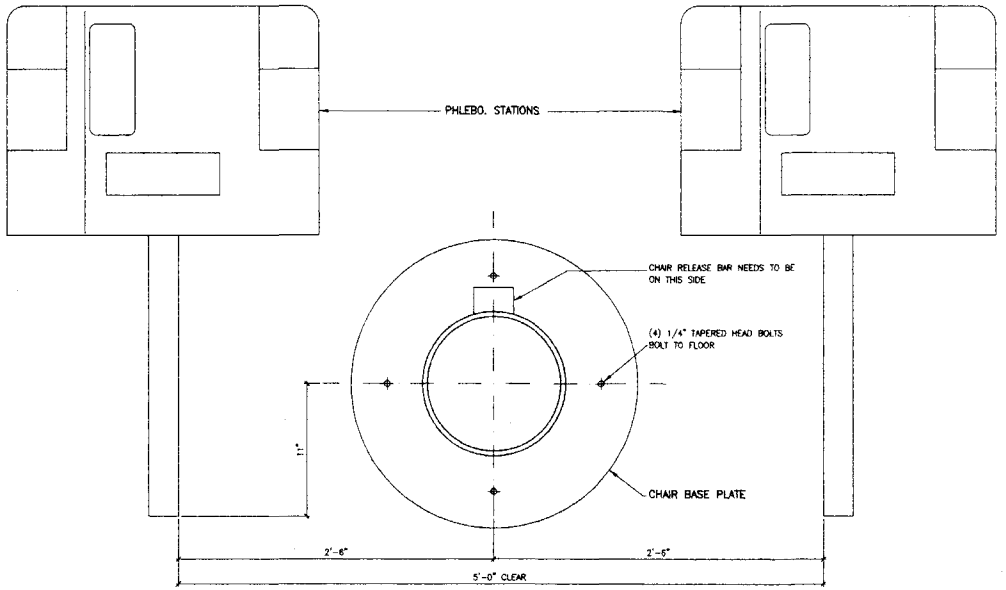
FRONT VIEW



SECTION

(Made of Plastic)

1/A3 **A.P.D.** (1) PER PHLEBOTOMY UNIT
FULL SCALE



2/A3 **Typical Plan Layout**
SCALE : 3/4" = 1'-0"

KAISER PERMANENTE

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Revisions

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Facility
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Project
Phlebotomy Station & Drew Table
Project #990902C

Sheet Title
Phlebotomy Station Details & Chair
File Name : 990902C-Phlebo-A3

File No.	Bldg No.	Floor Level	Section
Scale: FULL SCALE			
Drawn By: Sam H.		Permit No.	
Checked By		Sheet: A3	
Issue Date: 7/31/2000		OF 8 Sheets	

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

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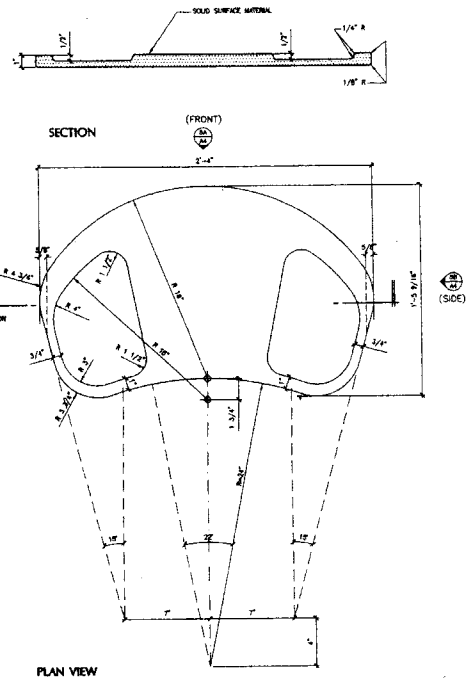
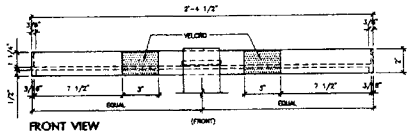
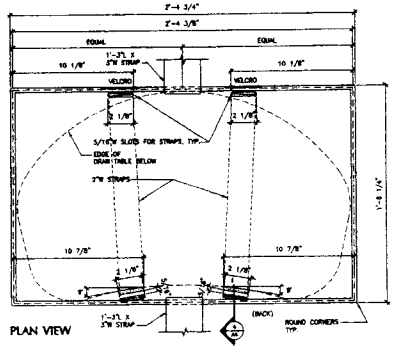
NOTE: BASE IS UNDER REVISION



1/A1 Draw Table
SCALE : 3" = 1'-0"



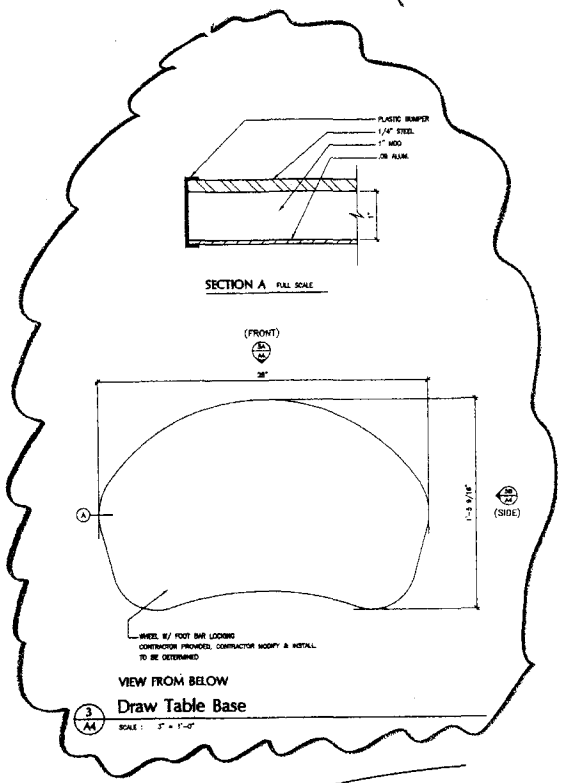
FRONT VIEW



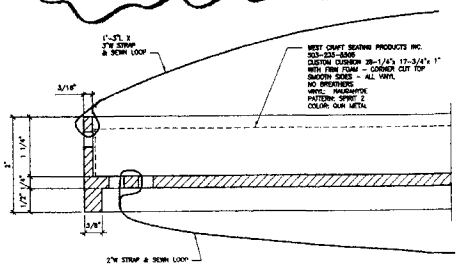
PLAN VIEW

2/A1 Baby Table
SCALE : 3" = 1'-0"

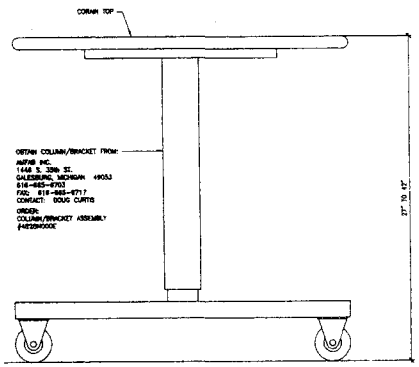
(1) PER EACH FULL SIZE PHLEBOTOMY STATION
(Made of clear Polycarbonite)



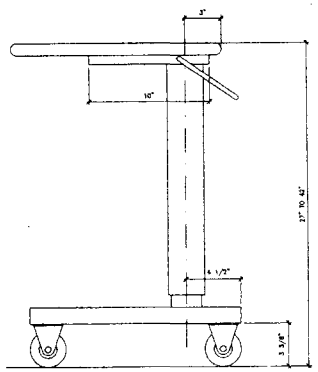
3/A1 Draw Table Base
SCALE : 3" = 1'-0"



4/A1 Section
FULL SCALE



A - FRONT ELEVATION



B - SIDE ELEVATION

5/A1 Draw Table Elevations
SCALE : 3" = 1'-0"

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Project
Phlebotomy Station & Draw Table
Project #990902C

Sheet Title
Phlebotomy Station Draw Table
File Name : 990902C-PHLEBO-A4

Per. No.	Bldg No.	Plan Loc.	Station
Scale	3"=1'-0"		
Drawn By	Team M.	Permit No.	
Checked By		Sheet	A4
Issue Date	7/31/2000	of 8 Sheets	

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

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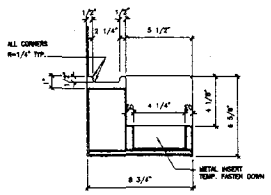
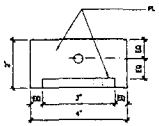
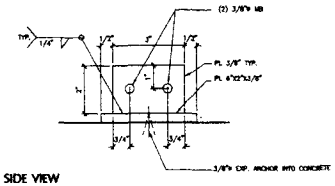


5 / A6 Section
SCALE : 3" = 1'-0"

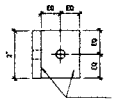


PLAN VIEW

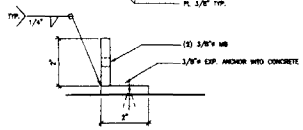


SIDE VIEW

6 / A6 Steel Connector
SCALE : 6" = 1'-0"

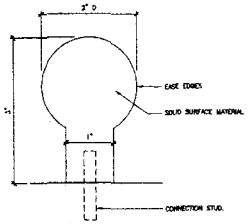


PLAN VIEW

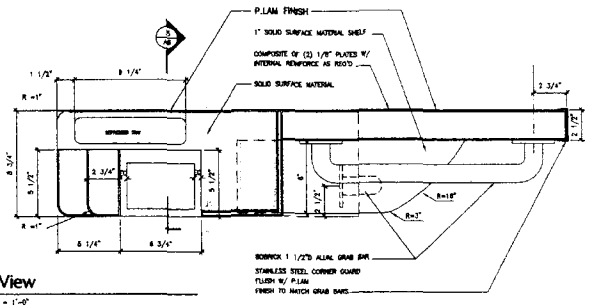


SIDE VIEW

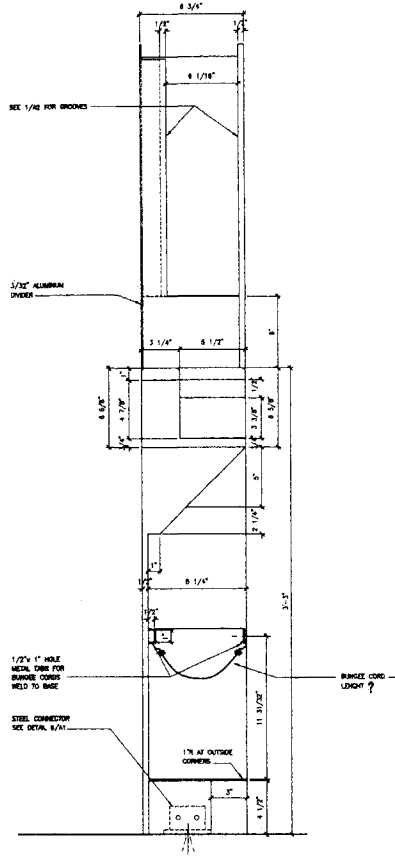
7 / A6 Steel Connector
SCALE : 6" = 1'-0"



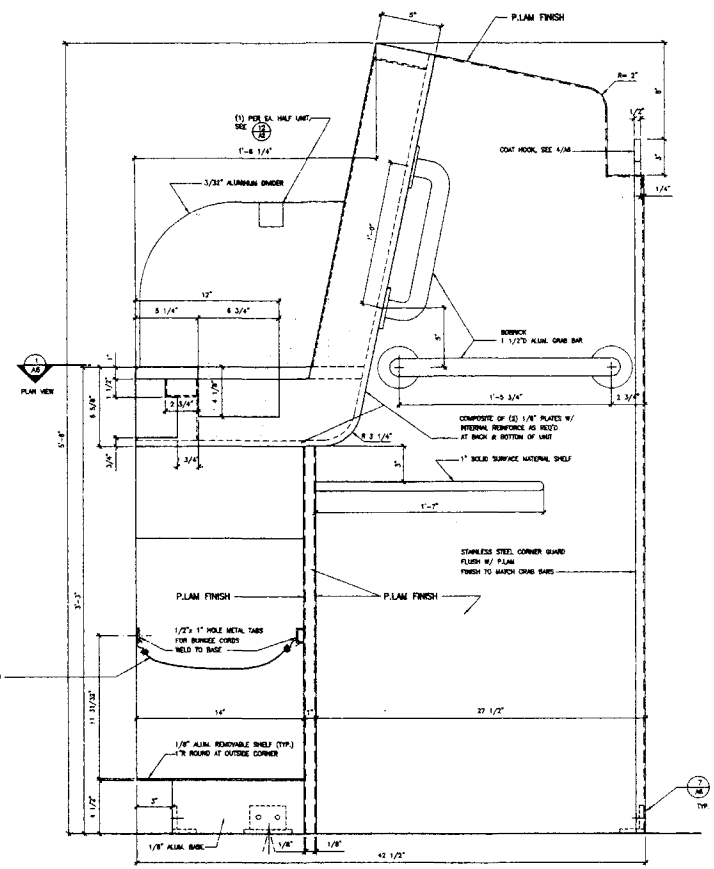
4 / A6 Coat Hook
FULL SCALE



1 / A6 Plan View
SCALE : 3" = 1'-0"



FRONT VIEW
3 / A6 Phlebotomy Station
SCALE : 3" = 1'-0"
ALL PARTS ALUMINUM UNLESS NOTED.



SIDE VIEW
2 / A6 Phlebotomy Station
SCALE :3" = 1'-0"

Notes :

1 - ALL ALUM. & STEEL EXPOSED TO VIEW SHALL BE FACTORY POWDER COAT PAINTED FRAL7004 COLOR.
2 - ALL ALUMINUM SHALL BE 3/32" (0.08") THICK UNLESS OTHERWISE NOTED.
3 - PROVIDE SHOP DRAWINGS FOR REVIEW PRIOR TO ANY WORK.
4 - VERIFY ALL DIMENSIONS AND CONTACT ARCHITECT OF ANY DISCREPANCIES PRIOR TO ANY WORK.
5 - SOLID SURFACE MATERIAL SHALL BE CORIAN EVEREST (ONLY WHERE INDICATED) SUBMIT SAMPLES FOR REVIEW.
6 - ALL PLASTIC SHALL BE 1/8" THICK UNLESS OTHERWISE NOTED. COLOR AS SELECTED BY ARCHITECT. SUBMIT SAMPLES FOR REVIEW.
7 - ALL WELDINGS SHALL BE CONTINUOUS, SMOOTH & ROUNDED. NO SHARP EDGES.
8 - ALL METAL, PLASTIC & SOLID SURFACE SHALL BE SMOOTH & ROUNDED W/ NO SHARP EDGES.
9 - P.LAM FINISH : FORMICA NATURAL CANVAS 7022-58 (ONLY WHERE INDICATED).

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Revisions

No.	Revisions	By	Date	Appr.

Architect

PETERSEN KOLBERG & ASSOCIATES ARCHITECTS

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Stamp

Key Plan

Project Architect Approval:

Architect/Engineer Of Record:

Facility
KAISER PERMANENTE

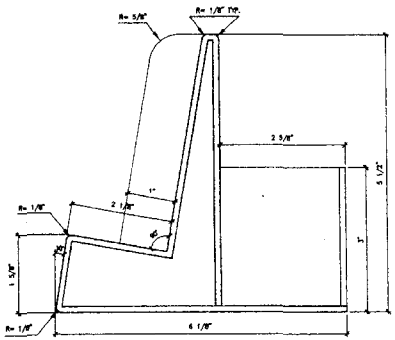
Project
Phlebotomy Station - End Unit
Project #990902

Sheet Title
Phlebotomy End Half Unit & Details

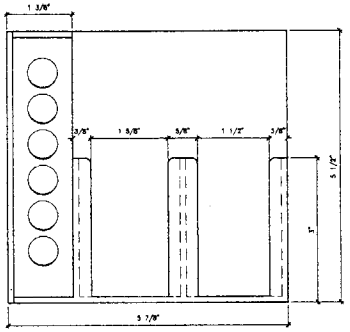
File Name : 990902C-PHLEB0-A6

Fac No.	Bldg No.	Floor Level	Section

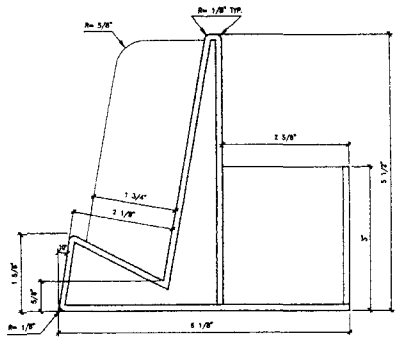
Scale 3"=1'-0"
Drawn By Susan H.
Checked By
Issue Date 7/31/2000
Permit No.
Sheet A6
of 8 Sheets



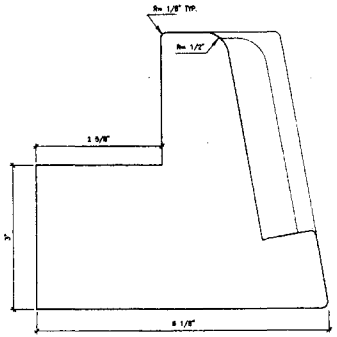
A Section A
FULL SCALE



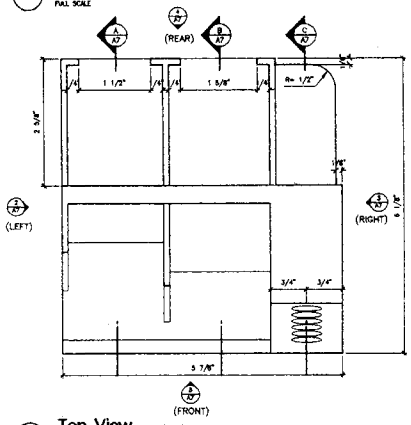
4 Rear View
FULL SCALE



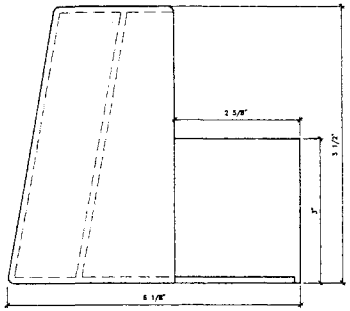
B Section B
FULL SCALE



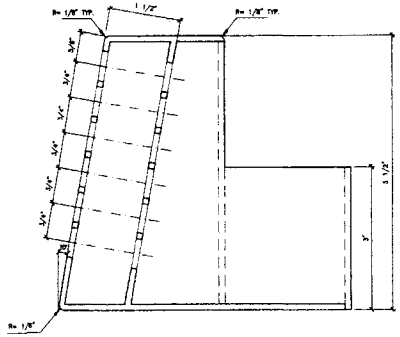
2 Left View
FULL SCALE



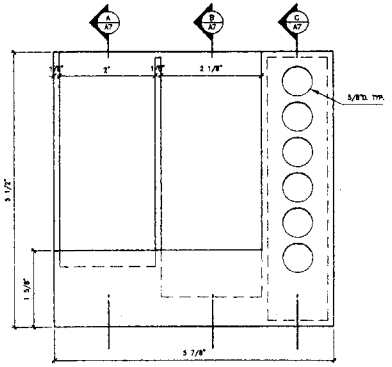
1 Top View
FULL SCALE



3 Right View
FULL SCALE



C Section C
FULL SCALE



5 Front View
FULL SCALE

(1) LEFT HAND UNIT PER EACH PHLEBO. STATION.

THIS UNIT WILL BE CONSTRUCTED FROM 1/8" CLEAR ACRYLIC

KAISER PERMANENTE

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500 NE MULTNOMAH ST.
12TH FLOOR
PORTLAND, OR 97232-2099

Revisions

No.	Revisions	By	Date	Appr.

Architect

ARCHITECTS
Petersen Kolberg & Assocs, P.C.
AIA Architects / Planners
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Stamp

Key Plan

Project Architect Approval:

Architect/Engineer Of Record:

Facility
KAISER PERMANENTE

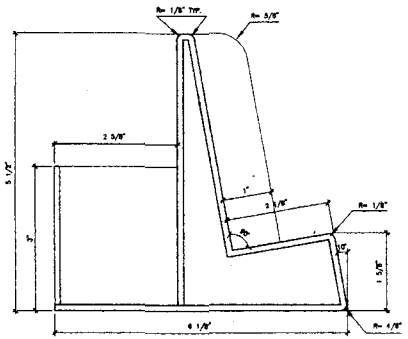
Project
Left Hand Unit
Project #990902C

Sheet Title
Tube & Wipe Details
File Name : 990902C-Phlebo-A7

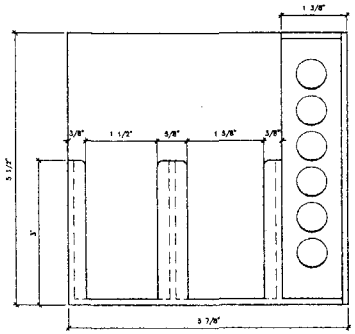
Fac. No.	Bldg. No. / Floor Level / Section
Scale	FULL SCALE
Drawn By	Tuan H.
Checked By	
Issue Date	7/31/2000
Permit No.	
Sheet	A7
	of 8 Sheets

GRAPHIC SCALES: 1/16" = 1'-0" | 1/8" = 1'-0" | 1/4" = 1'-0" | 1/2" = 1'-0" | 3/4" = 1'-0" | 1" = 1'-0" | 1-1/2" = 1'-0" | 3" = 1'-0"

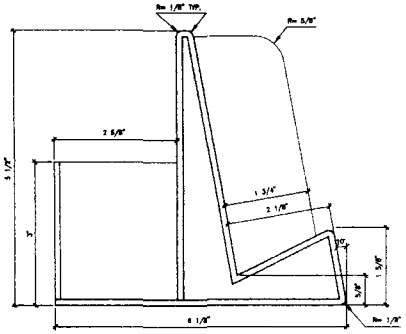
IF THIS SHEET IS NOT 30"x42", IT IS A REDUCED PRINT - SCALE ACCORDINGLY



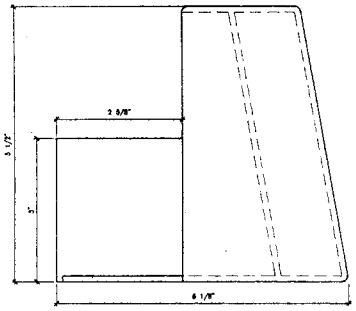
A Section A
FULL SCALE



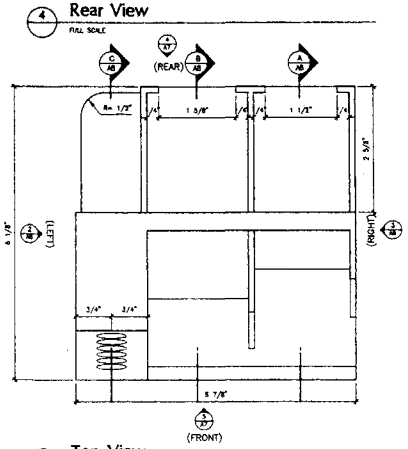
4 Rear View
FULL SCALE



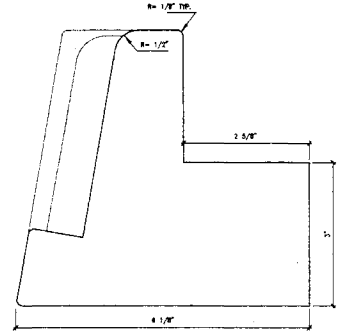
B Section B
FULL SCALE



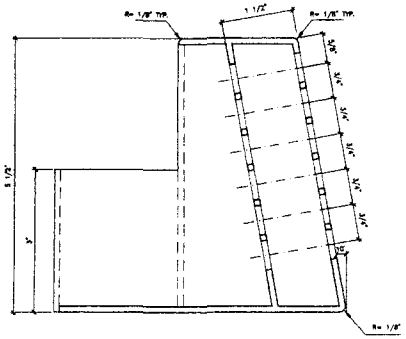
2 Left View
FULL SCALE



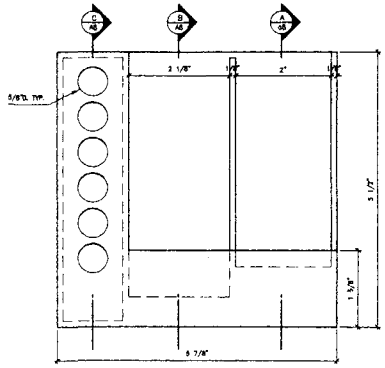
1 Top View
FULL SCALE



3 Right View
FULL SCALE



C Section C
FULL SCALE



5 Front View
FULL SCALE

(1) RIGHT HAND UNIT PER EACH PHLEBO. STATION.
(1) RIGHT HAND UNIT PER EACH HALF STATION.

THIS UNIT WILL BE CONSTRUCTED FROM 1/8" CLEAR ACRYLIC

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Revisions

No.	Revisions	By	Date	Appr.

Architect

PCA ARCHITECTS

Petersen Kolberg & Assocs, P.C.
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Stamp

Key Plan

Project Architect Approval:

Architect/Engineer Of Record:

Facility: KAISER PERMANENTE

Project: Right Hand Unit
Project #990902C

Sheet Title: Tube & Wipe Details
File Name : 990902C-Phlebo-A8

Fac. No.	Bldg. No.	Floor Lev.	Section

Scale: FULL SCALE
Drawn By: MAS
Checked By:
Issue Date: 7/31/2000
Permit No.
Sheet: A8
OF 8 Sheets