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MASTER THESIS

WORKFORCE ASSIGNMENT IN A MULTI-WORKER MULTI-SIDED MIXED-MODEL ASSEMBLY LINE BALANCING PROBLEM

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ABSTRACT

WORKFORCE ASSIGNMENT IN A MULTI-WORKER MULTI-SIDED MIXED-MODEL ASSEMBLY LINE BALANCING PROBLEM

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In this thesis, workforce scheduling problem in a mixed model assembly line is studied in which precedence relations, qualification of workers, walking times between tasks and worker requirements are considered. The motivation of the study comes from a real life problem at MAN Türkiye A.Ş. Mixed integer linear programming formulations for minimization of number of actively used workers and minimization of makespan value are developed. However, since the problem is NP-Hard, a heuristic approach is introduced. The developed heuristic attempts to minimize the number of actively used workers first, and then to minimize the makespan value.

Keywords: Mixed model assembly lines, workforce scheduling

ÖZ

ÇOK İŞÇİLİ ÇOK TARAFLI KARIŞIK MONTAJ HATTI DENGELEME PROBLEMLERİNDE İŞGÜCÜ ATAMASI

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Bu tez kapsamında, karışık modelli montaj hatlarında işgücü çizelgelemesi çalışılmıştır. Söz konusu problemin karakteristiklerini, öndelik ilişkileri, işçi kalifikasyonları, işler arası yürüme zamanları ve çok işçi ile yapılması gereken işler oluşturmaktadır. Bu çalışmanın motivasyonu MAN Türkiye A.Ş.' de karşılaşıan bir gerçek hayat problemine dayanmaktadır. Bu probleme yönelik iki adet karışık tamsayılı doğrusal programlama formulasyonu yapılmıştır. Birincisi kullanılacak olan işçilerin sayısını en küçüklerken, ikincisi birincisinin sonucunu kullanarak işlerin arasındaki en büyük tamamlanma süresini küçültmektedir. Problemin NP-Zor olması dolayısıyla sezgisel bir yaklaşım geliştirilmiştir. Geliştirilen yaklaşım ilk olarak aktif olarak kullanılan işçilerin sayısını enküçüklemeye çalışırken, diğeri enküçüklenmiş işçi sayısını kullanarak işlerin arasındaki en büyük tamamlanma süresini en küçüklemeye çalışmaktadır.

Anahtar Kelimeler: Karışık modelli montaj hattı, işgücü çizelgeleme

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INTRODUCTION

By considering customer needs, firms produce products to survive in today's free market economy. This results in the existence of same type of products with different specifications. Especially, this situation occurs in automotive industry. While the firms from automotive industry produce differentiated products based on customer needs, their main concern is how they use their resources (workers, time, raw materials, etc.) efficiently. Therefore, their production line should be designed accordingly.

This thesis is motivated from a problem occurred in production line of MAN Türkiye A.Ş. that has been established in 1966. In 1985, truck and motor production plants were opened in Ankara. Since 1995, MAN Türkiye A.Ş. has been manufacturing busses where product families include travel buses, public transportation buses and middle distance buses. The products in the product family have many sub models with different options, leading to approximately twenty different bus types. The production method of these twenty different models is a good example for mixed model assembly line models defined in the literature. In the company, there are five cost centers corresponding to production. The production system of the company is assembly flow line with many workstations. There are approximately 110 workstations with 62 active workstations. The predefined operations are performed by the workers at these stations and the final product exists at the end of last station. The unique cycle time for each station is fixed. The operations that are assigned to the workstations have to be completed within the given cycle time. Because of large dimensions of workpieces, worker teams work simultaneously at different locations of workpiece at each workstation. Moreover, workforce management is difficult and complex in mixed model assembly lines under multi-worker situation. The problem studied in the scope of this thesis is not exactly pure mixed model assembly line balancing problem in mixed model assembly lines. MAN Türkiye A.Ş. has all its tasks assignments for each workstation in the line. However, as stated before, it manages the line with the manner of mixed model assembly lines. It means that at the beginning of each day, production mix and the model sequence are known. Moreover, because of the large size of a workpiece at each workstation, more than one worker is allowed to work simultaneously at each workstation. Therefore, the problem returns from static assembly line balancing problem to a scheduling problem solved for every period (cycle) for each workstation with properties of precedence relations between tasks, qualifications of workers for each tasks, multi-worker tasks and walking time with sequence dependent setups to first minimize number of actively used workers in resulting schedule, then to minimize makespan value of this resulting schedule.

In our study, two mixed integer linear programming model formulations are presented. First of them minimizes the total number of workers in the line, and the second one minimizes the makespan value by using the solution of first phase. Furthermore, for large sized problem instances, heuristic approaches are proposed since it is hard to get even a feasible solution in a reasonable time by feeding the proposed mathematical formulations to general solvers. Heuristic approaches are based on defined priority rules. Lack of any benchmark problem in the literature made us to generate them by considering real life data. The results of the experimental study indicate that our heuristic approach gives satisfactory results.

The organization of the study is as follows: Literature review of the problem considered is presented in Chapter 2. Chapter 3 includes problem definition and model formulation. In Chapter 4, our solution methodology is provided. Chapter 5 presents the experimental study and the results. In Chapter 6, the case study performed in MAN Türkiye A.Ş. is explained in detail. Finally, In Chapter 7, conclusion and discussions are presented.

CHAPTER I

In this chapter, a literature review for assembly line balancing, model sequencing and workforce scheduling is presented. In Section 2.1, detailed information about assembly line balancing and related works is given. In Section 2.2, model sequencing studies are introduced in detail. Section 2.3 covers workforce scheduling and works in the literature.

1. LITERATURE REVIEW

In this thesis, three basic different problems arising from assembly lines are considered: Assembly line balancing, model sequencing and workforce scheduling. These problems are integrated to each other as seen in Figure 1.

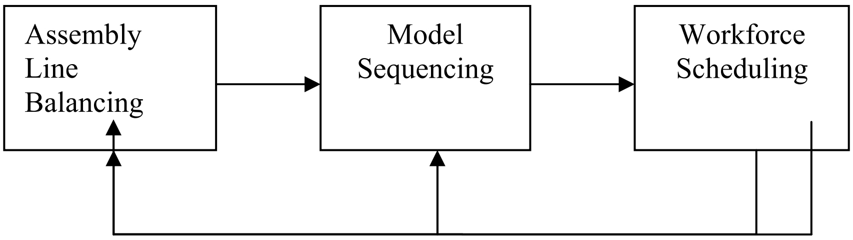

Figure 1 - Operational Planning of a Mixed Model Assembly Line

A classical assembly line balancing problem for assigning all tasks of each model to workstations taken as the first stage. Based on the output of the balancing, the model sequencing problem is solved as a second step. Depending on the sequencing results, line balancing could be reconfigured. At last, workforce should be scheduled on each workstation along with assembly lines. In the following sections, a detailed literature review for each basic problem is explained.

1.1 ASSEMBLY LINE BALANCING

Assembly line balancing problem can be described as a design problem of assignment of tasks to the workstations by considering several constraints such as a fixed cycle time and precedence relations between all tasks (Becker and Scholl, 2006). Assembly lines are the concern of many scientists since Henry Ford's study on single model assembly lines in 1915. Assembly lines are classified into many branches due to the developing technology and changes on the product specified by customers. The firms usually produce their goods based on the customer options. This results in that there is not only one type of product, but there are many variations of the main product due to the differentiated customer demands. Therefore, the firms need more different types of assembly line configurations than the traditional single one to stay competitive in the market. It can be said that single model assembly lines have been turned into a more flexible system, namely mixed model assembly lines. Mixed model assembly lines are concerned with production of variations of a small number of products on the same line. The production of the different variations needs assigning all of their tasks to the workstations in the line. It is much more difficult to balance mixed model assembly lines than simple assembly lines in terms of assigning different tasks of all product variations to the same workstations (Scholl, 1999).

In line manufacturing of similar products, the assembly line is arranged to decrease setup or change over times. Because of significant differences in assembly processes to realize this aim, they are produced in batches. These lines are called multi model assembly lines (Boysen et. al, 2007).

To the best of our knowledge the design of assembly lines was first applied by Henry Ford in 1915. However, the first mathematical model was presented by Salveson (1955) for balancing single model assembly lines. Later on, single model assembly lines have been of the interest of many academicians and practioners, thus extensive research has been induced. Then, the change of production paradigm towards a customer needs based production has created new research area, on the design of mixed model assembly lines. Mixed model assembly line balancing problems were studied first by Thomopoulus (1967). Mixed model assembly line balancing problems are harder than the single model assembly line balancing problems, because variations of the main model may require different station times in each workstation (Becker and Scholl, 2006). Requirement of different station times in each workstation results in idle time or work overloads. Therefore, all tasks of various products in the line are assigned to workstations as well, by smoothening overall work load. This is called as horizontal balancing (Merengo et.al, 1999). Mixed model assembly line balancing problems have the same basic assumptions that of single model assembly line balancing problems: deterministic task times, assignment restrictions such as precedence constraints, equipment restrictions, fixed cycle time that is all workstations on the assembly line have same time restriction (Baybars, 1986).

To model and solve the mixed model assembly line balancing problems, two different approaches are used. Basic idea of the first approach is that although there are differences between different product models, there are many similarities, since they usually belong to the same product family. Based on this idea, joint precedence diagram is constructed by considering the precedence diagrams of each model variations (Thomopoulus, 1970). Using joint precedence diagram, the mixed model balancing problem is transformed. The second approach states that although the mixed model balancing problem can be represented as a single model problem by means of the joint precedence diagram, processing time of each model at each station is different for each model yielding work overload and hence idle times (Becker and Scholl, 2006). Therefore, smoothing the work overload is a vital issue for the mixed model assembly assembly lines (Emde, 2009). Thomopoulus (1970) and Buckhin et.al (2002) have presented different objective functions for their purpose.

Assembly line balancing problems are known as NP-Hard. Therefore, effective algorithms have been developed to get near optimal solutions in a reasonable time. As an example, Pastor et.al (2002) use tabu search, Vilarinho and Simaria (2002) use simulated annualing, Karabatı and Sayın (2003) use priority rule based heuristics, Kim et.al (2000b) use genetic algorithm. Altemier et.al. (2009) mention about a Decision Support System which does not perform all tasks assignment, just a reconfiguration of assignment of tasks to the stations.

In the case of large size of products such as buses, yatches, etc. that are produced on the assembly lines, there are parallel workplaces (zones) in the product at which more than one worker can work simultaneously (Akagi et al., 1983). Bartholdi (1993) defines two sided (left side and right side) assembly lines. In two sided assembly lines, tasks are grouped according to their location requirements (left side and right side). In the light of these studies, multiple worker assignment to a workstation has been an issue to reduce the number of workstations. Study on two sided assembly lines was done by Özcan and Toklu (2009). Then, Özcan (2010) considered stochastic nature of two sided assembly lines. Moreover, Özcan and Toklu (2010) studided two sided assembly linesd with sequence dependent setup times. And, to the best of our knowledge recent study on two sided assembly lines were made by Özcan et.al (2010). For more than two sided assembly lines, Becker and Scholl (2009) have considered the final assembly of automobile by splitting the automobile to five zones named as workplaces. In the study of Dimitriadis (2006), a single model assembly line allowing more than one worker work at each workstation and a heuristic method is proposed for minimizing the number of workstations in the line. Another study for grouping workers in mixed model assembly lines is due to Çevikcan (2009) suggesting a mathematical model for setting up the worker teams in each station, and a heuristic solution method. Kellegöz (2010) has handled the balancing problem of single model assembly lines with parallel multi-manned workstations, and they proposed a branch and bound algorithm for finding their optimal solutions.

Mixed model assembly lines are used by the firms to maintain its competitive power in daily production environment. Therefore, there is a need to solve these types of problems better by using realistic approaches.

1.2 MODEL SEQUENCING LITERATURE

Determining production sequence of model variations in mixed model lines an important decision should be made. The work overloads are eliminated by utility workers (Boysen et al., 2009), who are highly qualified workers that can handle each type of job (Scholl, 1999).

1.3 WORKFORCE SCHEDULING LITERATURE

According to Figure 1, after assembly line balancing problem is solved (design) and the model sequence (tactical) is determined, the last (operational) decision for mixed model assembly lines is to "schedule" the workers or worker teams. A feasible schedule is the assignment of tasks to workers at different zones of a workstation so that precedence relationships and restrictions (cycle time) are not violated. We should note that each model on a certain station in the previous cycle is transferred to the next workstation in the current cycle. In this way, tasks are performed while the workpiece moves along the line. It makes the problem more complicated if constraints about worker qualifications, walking times between each task, worker requirements of tasks, and even sharing a worker between consecutive stations are introduced.

To the best of our knowledge, this operational problem has not been studied yet in the assembly line design literature. However, one should also consider to look at at parallel machine scheduling literature. Workers can be thought as parallel machines in a workstation. Furthermore, workers have different qualifications for defined tasks. Here, machine eligibility approach is appropriate. Moreover, tasks may have precedence relation. Because of the size of the product, walking time in between operations is considerable forcing the problem to be treated as sequence dependent setup times could be considered. Worker requirements are thought as multi-worker tasks. Hence, the underlying problem in terms of scheduling literature is defined as, "workforce assignment with precedence and machine eligibility constraints, sequence dependent setup times and multi-worker tasks", given line balancing results and model sequencing.

Herrman et al. (1997) proposed heuristics for unrelated parallel machine scheduling with precedence constraints. Liu and Wu proposed an evolutionary algorithm for minimizing the number of tardy jobs on identical parallel machines. Gualtieri et al. (2009) presented heuristic algorithms on identical parallel machine scheduling environment to minimize the makespan. Rabadi et al. (2006) proposed heuristics for the unrelated parallel machine scheduling problem by considering setup times. Hu et al. (2010) developed a heuristic algorithm to minimize makespan for the block erection in a shipyard by considering precedence constraints and machine eligibility constraints in parallel machine environment. The proposed algorithm was tested by using the real life data from the shipyard industry. Gacias et al. (2010) proposed exact method and heuristic method to solve parallel machine scheduling with precedence relations and setup times between the jobs. Kim and Posner (2010) suggested a list scheduling heuristic method for makespan minimization for parallel machines with s-type precedence constraints. Guo and Liu (2010) presented a heuristic algorithm based on local search on each machine with machine eligibility constraints to minimize total weighted tardiness in parallel machine environment. Kim et al. (2003) dealt with search heuristics for unrelated parallel machine environment with setup times with the objective of total weighted tardiness. Finally, Senniappan (2006) provided workload-balancing methodology while minimizing total completion time on non-identical parallel machine scheduling with sequence dependent setups. He developed a genetic algorithm and some simple heuristics to get efficient results on scheduling. Also, it is helpful to look at the study on workforce planning in synchronous production systems by Vairaktarakis et al. (2002). In this study, workforce planning problem was formulated and solved. Moreover, Camm et al. (2008) proposed an integer programming and heuristic methods to minimize workforce size on scheduling parallel assembly workstations. The literature review on the parallel machine scheduling is summarized in Table 1. Our study is added as the last row in the table.

In the scope of this thesis, by following the flow of operational planning in mixed model assembly lines as given in Figure 1, the workforce scheduling problem as short term planning is considered when the task assignment of all models to all workstations and model sequences are given. Table 1 locates this study among at the studies from parallel machine scheduling literature.

Table 1 Comparison of properties of our study and other studies in the scheduling literature

	Problem Characteristics					Data	Objective	Solution Methodology
	M/C type	**Precedence**	**Eligibility**	**Setup**	**Multi Worker**			
Guo and Liu (2010)	Unrelated	No precedence	Exists	No setup	No	They have generated their own data	Minimize weighted total tardiness	Local search based heuristic algorithm
Gualtieri et al. (2009)	Identical	No precedence	No Eligibility	No setup	No	They have generated their own data	Minimize makespan	Constructive heuristic algorithms
Liu and Wu (2003)	Identical	No precedence	No Eligibility	No setup	No	They have generated their own data	Minimize the number of tardy jobs	Evolutionary algortihm
Rabadi et al. (2006)	Unrelated	No precedence	No Eligibility	Sequence dependent	No	They have generated their own data	Minimize makespan	Meta-Raps
Hu et al.(2010)	Identical	Exists	Exist	No setup	No	Real life data	Minimize makespan	Special heuristic algorithm
Our Study	**Unrelated**	**Exists**	**Exists**	**Exists**	**Exists**	**Generated, real**	**Minimize # of workers/ Minimize makespan**	**Heuristic Algorithms**

CHAPTER II

In this chapter problem definition and model formulation are explained in detail. First problem is defined in Section 3.1 by considering the literature review in Chapter 2. Then model formulations are presented in Section 3.2. In Section 3.3 lower bounds related to the problem are developed.

2. PROBLEM DEFINITON & MODEL FORMULATION

As mentioned before, assembly line balancing is the primary line design decision to be made for the manufacturing firms that perform mass production. After solving this long term decision making problem, model sequencing to smoothen workload among various models on mixed assembly line is conducted based on the assignment results of the balancing problem. After all these steps are performed, that is all tasks are assigned to workstations and the sequence of all the models is determined. Then workforce scheduling problem arises as illustrated in Figure 1. We are dealing with this last stage in this study.

The defined problem in this thesis is motivated by the real life problem occurred in production line of MAN Türkiye A.Ş. which produces busses, where product families include travel buses, public transportation buses and middle distance buses (NAG). The products in any of the product families have many sub models with different variations, approximately twenty different bus types in total. The production of these twenty different products is a good example for mixed model assembly line problems defined in the literature. In the company, five cost centers are defined. The production system of the company is assembly flow line with all together 62 active workstations. The cycle time for each station is fixed and the assembly line is synchronized. The operations that are assigned to the workstations have to be completed within the given cycle time. Because of the large dimension of the workpieces, more than one worker or worker teams are allowed to work simultaneously at different locations of the bus. Moreover, the workforce management is difficult and complex in mixed assembly lines under multi-worker situation. Here, the problem studied in the scope of this thesis for MAN Türkiye A.Ş. is not exactly pure balancing problem in mixed model assembly lines. MAN Türkiye A.Ş. has determined all its tasks assignments for each defined workstations. However, as stated before, it manages its production line with the manner of mixed model assembly lines. It means that at the beginning of each day, production list has various types of products that may require different tasks at different workstations. Moreover, because of the large size of workpieces those are produced on the line, in a workstation, more than one workers work simultaneously in workplaces (zones). Figure 2 shows how the work performed on the assembly line and Figure 3 represents loads of worker teams during production of workpiece. Therefore, the problem is transformed from assembly line balancing problem into a scheduling problem solved for every period (cycle) for each workstation with properties of precedence relations between tasks, qualifications of workers for each tasks, multi-worker tasks and walking time of workers. The performance criteria of the problem are to minimize number of actively used workers in resulting schedule, and second to minimize the makespan value of this resulting schedule.

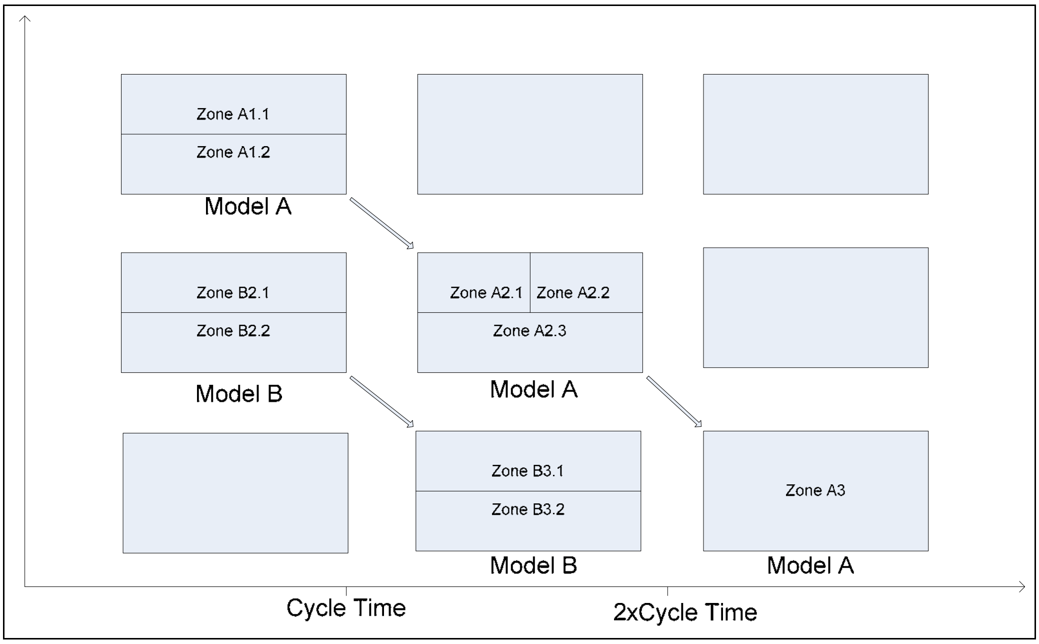

Figure 2 Illustration of the assembly line

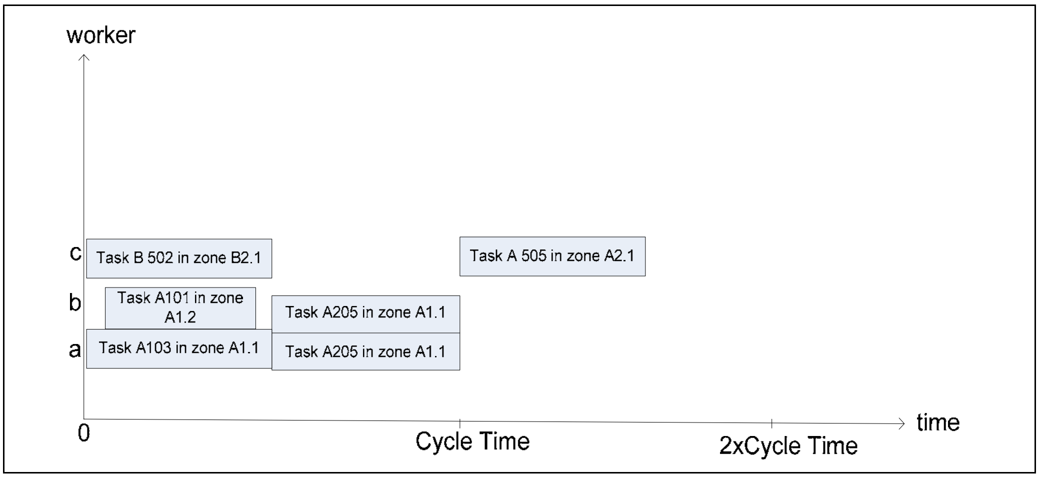

Figure 3 Worker teams during production of workpiece

2.1 PROBLEM DEFINITION

We define the problem undertaken in two stages. At first stage, there are a number of tasks that have precedence relations, walking times, qualification of workers and multi worker tasks to be scheduled without exceeding given cycle time with the use of minimum number of workers. Here, we do not assign tasks to workstations, but to worker (team)s. At second stage, we try to balance workload of actively used workers determined at the first stage subject to the same assignment constraints.

Assumptions of the problem are as follows:

A-1 Paced line with a given fixed cycle time. Production line contains no buffers between the fixed number of workstations.

A-2 Task assignments for all tasks to the workstations are known. All tasks required for a product are already assigned to the workstations.

A-3 Serial line without parallel elements.

A-4 Deterministic task times.

A-5 A task cannot be split among two or more workstations and worker teams. Each task starts in a workstation and completed in that workstation with the same set of workers in the given cycle.

2.2 MATHEMATICAL FORMULATION

Below, mathematical formulations seek the minimum number of workers and balanced workloads of each worker. The relationship between the mathematical formulations is shown in Figure 2.There are two different mathematical models for each of the stages defined in the previous section. In the next sub-sections these mathematical models are defined clearly.

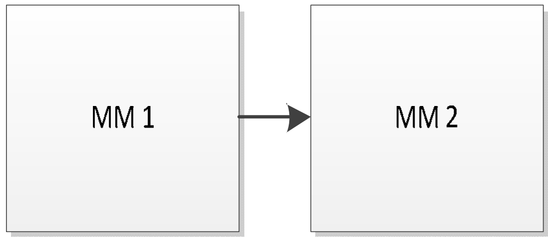

Figure 4 Relationship between mathematical models

Here, periods are used to define the cycles in the assembly line.

Index sets:

R= {1, 2,…, N}:real tasks

D= {1, 2,…D}:dummy tasks (note that dummy tasks are used to prevent sub tours in assignment of tasks to workers)

M= {1, 2,…, M}: multi-worker tasks

K = {1, 2,…, K}: workers

J= {1, 2,…,J}: workstations

P= {1, 2…,P}: periods(cycles)

Parameters:

$TIME_i$=task time for task i

$$PRE_{ih} = \begin{cases} 1, \text{ if task } i \text{ immediately performed before task } h \\ 0, \text{ otherwise} \end{cases}$$

CT=cycle time

$$QUAL_{ki} = \begin{cases} 1, \text{ if worker } k \text{ is qualified for task } i \\ 0, \text{ otherwise} \end{cases}$$

$$ATSP_{ijp} = \begin{cases} 1, \text{ if task } i \text{ is performed at workstation } j \text{ in period } p \\ 0, \text{ otherwise} \end{cases}$$

WT_{ih} =walking duration between task i and task h

V= sufficiently large number

Decision variables:

$$TASG_{kip} = \begin{cases} 1, \text{ if worker } k \text{ does task } i \text{ in period } p \\ 0, \text{ otherwise} \end{cases}$$

$$USED_{kp} = \begin{cases} 1, \text{ if worker } k \text{ is ever used in period } p \\ 0, \text{ otherwise} \end{cases}$$

$$IPS_{ihkp} = \begin{cases} 1, \text{ if task } i \text{ is assigned immediately before task } h \text{ to worker } k \text{ in period } p \\ 0, \text{ otherwise} \end{cases}$$

B_{ip}= start time of task i in period p

2.2.1 Mathematical Model 1 (MM1)

The below mathematical model which is used to minimize the number of used workers in each period.

MM1:

$$\text{Minimize} \quad \sum_{p \in P} \sum_{k \in K} USED_{kp} \qquad (1.0)$$

$$\sum_{i \in R \cup M} TIME_i .TASG_{kip} + \sum_{i \in R \cup M} \sum_{h \in R \cup M \setminus \{i\}} WT_{ih} .IPS_{ihkp} \leq CT.USED_{kp} \quad \forall k \in K, \forall p \in P \quad (1.1)$$

$$\sum_{k \in K} QUAL_{ki} .TASG_{kip} = \sum_{j \in J} ATSP_{ijp} \qquad \forall p \in P, \forall i \in R \qquad (1.2)$$

$$\sum_{k \in K} QUAL_{ki} .TASG_{kip} = 1 \qquad \forall p \in P, \forall i \in D \qquad (1.3)$$

$$B_{hp} \geq B_{ip} + TIME_i + \sum_{k \in K} IPS_{ihkp} .WT_{ih}$$
$$\forall h \in R \cup M, \forall i \in R \cup M \setminus \{h\} \ni PRE_{ih} = 1, \forall p \in P \qquad (1.4)$$

$$B_{hp} + V(1 - \sum_{k \in K} IPS_{ihkp}) \geq B_{ip} + TIME_i + WT_{ih}$$
$$\forall h \in R \cup M, \forall i \in R \cup M \setminus \{h\}, \forall p \in P \qquad (1.5)$$

$$B_{ip} \leq CT - TIME_i \qquad \forall i \in R \cup M \cup D, \forall p \in P \qquad (1.6)$$

$$IPS_{ihkp} \leq TASG_{kip} \qquad \forall h \in R \cup M, \forall i \in R \cup M \cup D \setminus \{h\}, \forall p \in P, \forall k \in K \quad (1.7)$$

$$IPS_{ihkp} \leq TASG_{khp} \qquad \forall h \in R \cup M, \forall i \in R \cup M \cup D \setminus \{h\}, \forall p \in P, \forall k \in K \quad (1.8)$$

$$\sum_{i \in R \cup M \cup D \setminus \{h\}} IPS_{ihkp} = TASG_{khp} \qquad \forall h \in R \cup M \cup D, \forall k \in K, \forall p \in P \quad (1.9)$$

$$\sum_{h \in R \cup M \cup D \setminus \{i\}} IPS_{ihkp} \leq 1 \qquad \forall i \in R \cup M \cup D, \forall k \in K, \forall p \in P \quad (1.10)$$

$$TASG_{kip} = 1 \qquad \forall i \in D, \forall k \in K, \forall p \in P \quad (1.11)$$

$$B_{ip} = 0 \qquad \forall i \in D, \forall p \in P \quad (1.12)$$

$$\sum_{k \in K} TASG_{kip} - \sum_{k \in K} TASG_{khp} = 0 \qquad \forall i \in M, \forall h \in M, \forall p \in P \quad (1.13)$$

$$TASG_{kip} + TASG_{khp} \leq 1 \qquad \forall i \in M, \forall h \in M, \forall k \in K, \forall p \in P \quad (1.14)$$

$$B_{ip} + B_{hp} = 0 \qquad \forall i \in M, \forall h \in M, \forall p \in P \quad (1.15)$$

$$TASG_{kip} \in \{0,1\} \qquad \forall i \in R \cup M \cup D, \forall k \in K, \forall p \in P \quad (1.16)$$

$$IPS_{ihkp} \in \{0,1\} \qquad \forall i \in R \cup M \cup D, \forall h \in R \cup M \cup D, \forall k \in K, \forall p \in P \quad (1.17)$$

$$USED_{kp} \in \{0,1\} \qquad \forall k \in K, \forall p \in P \quad (1.18)$$

$$B_{ip} \geq 0 \qquad \forall i \in R \cup M \cup D, \forall p \in P \quad (1.19)$$

Equation 1.0 is the objective function that minimizes the total number of used workers in periods when the cycle time is given. Constraint 1.1 is the cycle time restriction. That is, if any worker is used, the total work content assigned plus the total walking duration must not exceed the cycle time. Constraint sets 1.2 and 1.3 indicate that each task should be assigned to only one worker in each period for real tasks and dummy tasks respectively. Constraints 1.4 ensure that if there is a precedence relation between task *i* and task *h*, the start time of task *h* is greater than or equal to the finish time of task *i* plus the walking duration between them. If the tasks *i* and *h* has been assigned to the same worker, inequality 1.5 restricts the start time of task *h*. Constraint set 1.6 guarantees that all tasks are completed within the cycle time. Constraint sets 1.7 and 1.8 indicate that tasks do not need to precede each other if they are not assigned to the same worker. Constraint 1.9 lets only one task preceding any task assigned to a worker. Constraint set 1.10 regulates that at least one task should precede a task for each worker. Dummy tasks are assigned for each worker at the beginning of the schedule before workers start to perform real tasks. Therefore, constraints 1.11 and 1.12 are assignment and start time constraints for the dummy tasks for each worker in each workstation. Equation 1.13 guarantees that multi worker tasks should be assigned in same period. 1.14 prevents tasks to be assigned to the same worker and 1.15 makes the start time of multi worker tasks same for each worker. For each period, the rest of the constraints are binary or non-negativity constraints. The MM1 has 1,390,000 binary and 260,000 nonlinear variables for the problem size 30 tasks for each of two models (in total 60 tasks).

Alternatively, one may suggest other objective functions. One of the possibilities is to minimize the maximum number of workers used in all periods. Then, the following modification can be made.

MM1-A:

Minimize U

$$U \geq \sum_{k \in K} USED_{kp} \qquad \forall p \in P$$

(1.1)-(1.19)

where U is the maximum number of workers used in all periods.

Another alternative is that want to minimize the total number of different individual workers used in the planning horizon. One should define the following decision variable to count respectively.

$$\text{USE}_\text{k} = \begin{cases} 1, \text{if worker k is ever used over the time horizon} \\ 0, \text{otherwise} \end{cases}$$

the following modification can be made on MM1.

MM1-B:

Minimize $\sum_{k \in K} USE_k$

$$\sum_{p \in P} USED_{kp} \leq P.USE_k \qquad \forall k \in K$$

(1.1)-(1.19)

2.2.2 Mathematical Model 2 (MM 2)

By using MM1, number of workers to be used in each period is set under the given constraints. MM2 takes the MM1 results as input and balances the workload of each worker by minimizing the maximum workload. First, new decision variables Com_{ip} that is completion time of task i in period p and $Cmax$ that is maximum completion time value of all assigned tasks are introduced.

MM2:

Minimize $C\max$

$$ \tag{1.0} $$

$$\sum_{k\in K} QUAL_{ki}.TASG_{kip} = \sum_{j\in J} ATSP_{ijp} \qquad \forall p\in P, \forall i\in R \tag{1.1}$$

$$\sum_{k\in K} QUAL_{ki}.TASG_{kip} = 1 \qquad \forall p\in P, \forall i\in D \tag{1.2}$$

$$B_{hp} \geq B_{ip} + TIME_i + \sum_{k\in K} IPS_{ihkp}.WT_{ih}$$

$$\forall h\in R\cup M, \forall i\in R\cup M \setminus \{h\} \ni PRE_{ih} = 1, \forall p\in P \tag{1.3}$$

$$B_{hp} + V(1-\sum_{k\in K} IPS_{ihkp}) \geq B_{ip} + TIME_i + WT_{ih}$$

$$\forall h\in R\cup M, \forall i\in R\cup M \setminus \{h\}, \forall p\in P \tag{1.4}$$

$$Com_{ip} \geq B_{ip} + TIME_i \qquad \forall i\in R\cup M\cup D, \forall p\in P \tag{1.5}$$

$$C\max \geq Com_{ip} \qquad \forall i\in R\cup M\cup D, \forall p\in P \tag{1.6}$$

$$IPS_{ihkp} \leq TASG_{kip} \qquad \forall h\in R\cup M, \forall i\in R\cup M\cup D \setminus \{h\}, \forall p\in P, \forall k\in K \tag{1.7}$$

$$IPS_{ihkp} \leq TASG_{khp} \qquad \forall h\in R\cup M, \forall i\in R\cup M\cup D \setminus \{h\}, \forall p\in P, \forall k\in K \tag{1.8}$$

$$\sum_{i\in R\cup M\cup D\setminus\{h\}} IPS_{ihkp} = TASG_{khp} \quad \forall h\in R\cup M\cup D, \forall k\in K, \forall p\in P \tag{1.9}$$

$$\sum_{h\in R\cup M\cup D\setminus\{i\}} IPS_{ihkp} \leq 1 \qquad \forall i\in R\cup M\cup D, \forall k\in K, \forall p\in P \tag{1.10}$$

$$TASG_{kip} = 1 \qquad \forall i\in D, \forall k\in K, \forall p\in P \tag{1.11}$$

$$B_{ip} = 0 \qquad \forall i\in D, \forall p\in P \tag{1.12}$$

$$\sum_{k\in K} TASG_{kip} - \sum_{k\in K} TASG_{khp} = 0 \qquad \forall i\in M, \forall h\in M, \forall p\in P \tag{1.13}$$

$$TASG_{kip} + TASG_{khp} \leq 1 \qquad \forall i\in M, \forall h\in M, \forall k\in K, \forall p\in P \tag{1.14}$$

$$B_{ip} + B_{hp} = 0 \qquad \forall i \in M, \forall h \in M, \forall p \in P \qquad (1.15)$$

$$TASG_{kip} \in \{0,1\} \qquad \forall i \in R \cup M \cup D, \forall k \in K, \forall p \in P \qquad (1.16)$$

$$IPS_{ihkp} \in \{0,1\} \qquad \forall i \in R \cup M \cup D, \forall h \in R \cup M \cup D, \forall k \in K, \forall p \in P \qquad (1.17)$$

$$C\max \geq 0 \qquad (1.18)$$

$$Com_{ip} \geq 0 \qquad \forall i \in R \cup M \cup D, \forall p \in P \qquad (1.19)$$

$$B_{ip} \geq 0 \qquad \forall i \in R \cup M \cup D, \forall p \in P \qquad (1.20)$$

Equation 1.0 is the objective function that minimizes the maximum completion time (Makespan). Constraint sets 1.1 and 1.2 indicate that each task should be assigned to only one worker in each period for real tasks and dummy tasks respectively. Constraints 1.3 ensure that if there is a precedence relation between task *i* and task *h*, the start time of task *h* is later than or equal to or greater than the finish time of task *i* plus the walking duration in between. If the tasks *i* and *h* has been assigned to the same worker, inequality 1.4 restricts the start time of task *h*. Constraint sets 1.5 and 1.6 guarantee finishing of all tasks within the completion time. Constraint sets 1.7 and 1.8 indicate that tasks do not need to precede each other if they are not assigned to the same worker. Constraint 1.9 lets only one task preceding any a task assigned to a worker. Constraint set 1.10 regulates that at least one task should precede a task for each worker. Dummy tasks are assigned for each worker at the beginning of the schedule before workers start to perform real tasks. Therefore, constraints 1.11 and 1.12 are assignment and start time constraints for the dummy tasks for each worker in each workstation. Equation 1.13 guarantees that multi manned tasks should be assigned in same period. 1.14 prevents tasks to be assigned to the same worker and 1.15 makes the start time of multi manned tasks same of each worker. For each period, the rest of the constraints are binary or non-negativity constraints.

As expected from the combinatorial nature and NP-Hardness of the problem, getting exact solutions are impossible in reasonable computational times. Hence, we resort to a heuristic method presented in the following chapter for generating acceptable solutions for the operational real life problem in a reasonable time.

2.3 LOWER BOUNDS

Although our mathematical formulations represent the problems stated, getting acceptable solutions in a reasonable time is not possible for large sized problems. This makes commenting on good performance of our heuristic approaches for large sized problems be almost impossible. Therefore, lower bounding methods are developed in the following subsections.

2.3.1 Lower Bound 1 (LB1)

It is constructed for MM1 problem as modification of best known lower bound for simple assembly line balancing problem. It is calculated by dividing sum of total processing time by the given cycle time value. Modification is done on total processing time by considering multi worker tasks and walking times between each task. The steps of LB1 are presented below:

Step 1: Determine the number of multi worker tasks and get sum of all task times multiplied with the number of workers required. For example, let there are 5 tasks to be scheduled with processing times 10, 12, 5, 8, 9, respectively. Let the first task be the only multi worker task that requires 2 workers, then the sum of all tasks becomes 54.

Step 2: Add the minimum walking times from task to i to any other task j ($MINWALK_i = \min_j \left\{ WALK_{ij} \right\}$) to Step 1 results.

Step 3: Divide the value found in Step 2 by the cycle time and round the result up.

The following formula summarizes the above steps and gives LB1.

Let REQ_i=number of worker requirements of task i.

$$\text{LB1} = \left\lceil \frac{\sum_{i \in N \cup M} TIME_i . REQ_i + \sum_{i \in N \cup M} MINWALK_i}{CT} \right\rceil$$

2.3.2 Lower Bound 2 (LB2)

It is constructed for the problem of MM2 modifying the best known lower bound that is calculated by dividing the sum of total processing time to given number of used worker at a workstation. Modification is done on total processing time by considering multi worker tasks and walking times between each task. Therefore, steps of LB2 are presented as below:

Step 1: Determine the number of multi worker tasks and get sum of all task times including multi worker tasks.

Step 2: Add the minimum walking times from task to *i* to any other task *j* ($MINWALK_i = \min_j \{WALK_{ij}\}$) to Step 1 results

Step 3: Divide the value found in Step 2 by the cycle time and round the result up.

$$LB2 = \left\lceil \frac{\sum_{i \in R} TIME_i . REQ_i + \sum_{i \in R} MINWALK_i}{\text{Number of used workers}} \right\rceil$$

In scope of this thesis, 320 different problem instances are solved for 2 workstations and 3 periods. (160 of them provided problem size 10 and 20). 157 of them give optimal solutions for the defined problem MM1, 152 of them give optimal solutions for the problem MM2. Values that are shown in Table-2 are presented for performances of lower bounds on optimal found solutions. Detailed analysis is given in computational results chapter.

Table 2 Relation between problem size and optimal solutions

Size of the Problem	MM1		MM2	
	#Opt Success	#Opt =#LB1	#Opt Success	#Opt =#LB2
10	77	64	72	57
20	80	53	80	61

CHAPTER III

In this chapter, a solution methodology for the defined problem is presented. In Section 4.1, construction algorithm (phase 1) is expressed in detail. In Section 4.2, makespan minimization (phase 2) is presented in detail.

3. SOLUTION METHODOLOGY

As mentioned in Chapter 2, the single model assembly line balancing problem is NP-Hard (Scholl, 1999). The studied problem includes workforce assignment in parallel multi worker mixed model assembly lines with precedence constraints, qualification of workers, sequence dependent walking times (setup times) between the tasks and worker requirements of each task. Therefore, the studied problem is much more complex and it is a member of NP-Hard problems class. In the meantime, our problem reduces to various parallel machine scheduling problems known to be NP-Hard (Garey and Jhonson, 1979).

It is not possible to get optimal results in a reasonable time for large sized problem instances by using the exact solution methods. Therefore, a heuristic algorithm is developed to obtain feasible solutions for large sized problem instances. We have investigated how far we can get an optimal solution by feeding our formulation into a general solver. We have used GAMS 22.6 with Cplex solver with a computer with 4GHz CPU and 8GB memory. We run 80 instances for each size. The results showing the relation between problem sizes and the number of optimal solutions found is given in Table-3.

Table 3 Relation between problem size and number of optimal solutions found

Size of the Problem	*#OPT Success*
10	77
20	All 80 instances
40	With 3600 sec time limitation, none of them optimal

The Figure 5 presents the relationship for each phases of heuristic algorithm. As seen, it firstly minimizes the number of actively used workers (Phase 1). Results of Phase 1 are used as an input for makespan minimization (Phase 2). Makespan minimization includes rescheduling (Phase 2-1) and transferring tasks (Phase 2-2). Phase 2's results are input for Phase 2-1 and input for Phase 2-2 comes from output of Phase 2-1. These heuristic algorithm phases explained below.

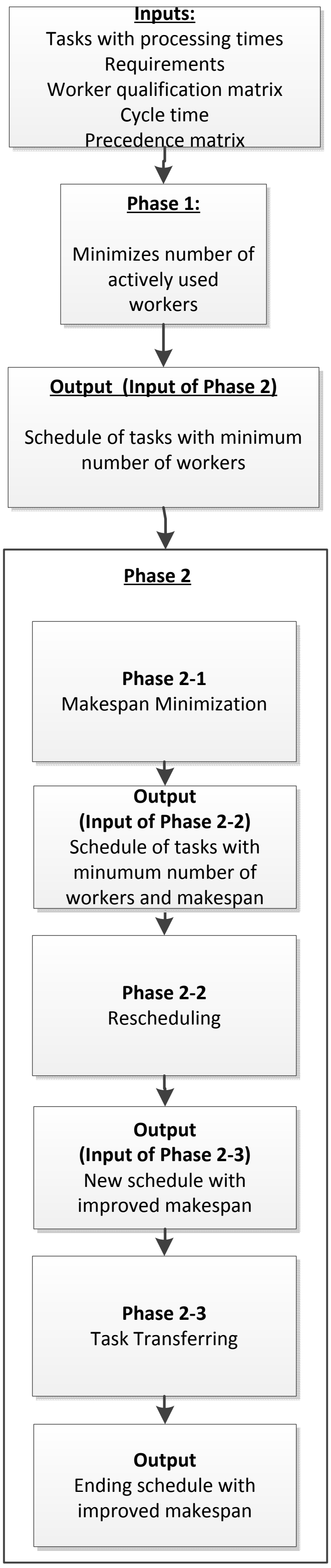

Figure 5 Relationship between phases of heuristic algorithm

3.1 CONSTRUCTION ALGORITHM (PHASE 1)

Inputs: Tasks to be scheduled with processing times, requirements information, workers with qualification matrix for each task, cycle time, precedence matrix for each task.

Outputs: Schedule of all unscheduled tasks to minimum number of workers.

Initialization: Initialization for processing times, requirements of tasks to be scheduled, cycle time, workers, precedence matrix, qualification matrix for all tasks for workers.

Step 1: Form candidate tasks list [CT] including eligible tasks at the current position.

Step 2: Apply the following operations for obtaining [CT]

Step 2.1: For each task in CT, calculate $FOLLOWALK_i$ value by using the following equation:

$$FOLLOWALK_i = TIME_i + \sum_{j \in F_i} TIME_j + \min_{h \in F_i} \{WT_{ih}\},$$

where F_i is the set of tasks following task *i*.

Step 2.2: Obtain [CT] by sorting CT according to $FOLLOWALK_i$ values in descending order.

Step 3: Select the first task is from [CT].

Step 4: Assign the selected task to the worker who is able to perform this task in the current cycle and has the maximum workload.

Step 5: Repeat Step 1 to Step 4 until all tasks are scheduled in a given cycle time.

This phase uses a priority rule that includes ordering tasks based on values which include tasks' positional weight values and walking times.

Example:

Inputs for Construction Algorithm (Phase 1) are presented below. Figure 6 shows the precedence relations between tasks on precedence diagram.

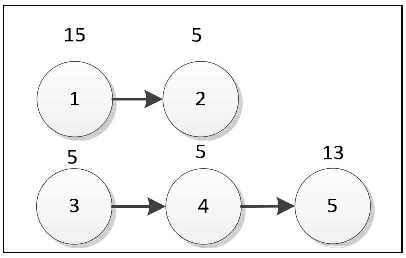

Figure 6 Precedence diagram of the example

Qualifications of workers are given in Table 4. For example, worker 1 is qualified to accomplish task 1, since the associated cell value is 1.

Table 4 Worker-task qualification

Worker/Task	Task 1	Task 2	Task 3	Task 4	Task 5
Worker 1	1	1	1	0	1
Worker 2	0	1	1	1	1
Worker 3	1	1	0	1	1
Worker 4	1	1	1	1	0

Table 5 presents the walking times between tasks.

Table 5 Walking times between tasks

Task/Task	Task 1	Task 2	Task 3	Task 4	Task 5
Task 1	0	1	1	1	0
Task 2	1	0	0	1	0
Task 3	0	1	0	3	1
Task 4	1	1	3	0	1
Task 5	0	1	1	1	0

The number of worker requirements is shown in Table 6. For example, to complete task 1, 2 workers are required.

Table 6 Worker requirements of each task

Task	# Required Worker
Task 1	2
Task 2	1
Task 3	1
Task 4	1
Task 5	1

Cycle Time : 45

To give an idea about phase-1 first two iterations are shown below.

Iteration 1:

Step 1: CT={1, 3}

Step 2:

Step 2.1: $FOLLOWALK_1 = 15 + 5 + 0 = 20$

$FOLLOWALK_3 = 5 + 5 + 13+0 = 23$

Step 2.2: [CT]={3,1}

Step 3: Select task 3 as from [CT].

Step 4: Assign task 3 to worker 1 that is able to perform task 3 and the most loaded worker.

Iteration 2:

Step 1: CT={1, 4}

Step 2:

Step 2.1: $FOLLOWALK_1 = 15 + 5 + 0 = 20$

$FOLLOWALK_4 = 5 + 13+0 = 18$

Step 2.2: [CT]= {1,4}

Step 3: Select task 1 from [CT].

Step 4: Because task 1 requires 2 workers to be accomplished, assign task 1 to worker 1 and worker 3 who are able to perform task 1 and the most loaded workers.

If continue in this way, the end result will be as shown in the diagram in Figure 7. At the beginning, there are four different workers with different qualifications. In the solution found only two of them are actively used.

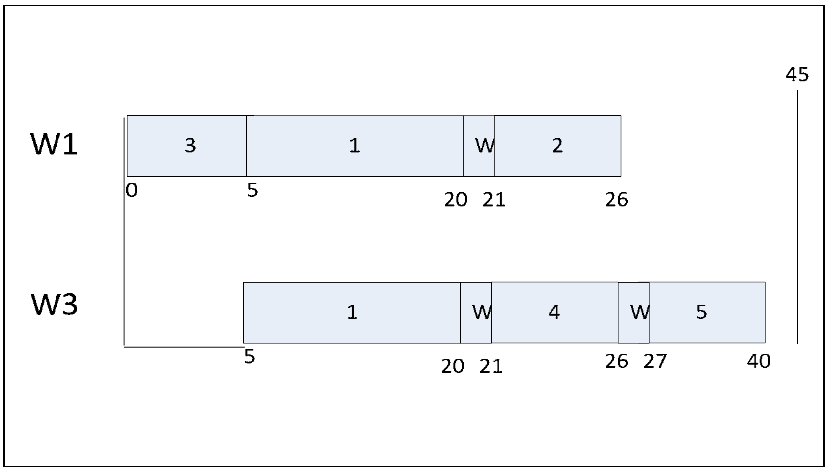

Figure 7 Resulting schedule of construction algorithm (Phase 1)

3.2 MAKESPAN MINIMIZATION (PHASE 2)

Here, makespan minimization is presented in three stages as Construction of Makespan Minimization (Phase 2-1), Rescheduling (Phase 2-2), Task Transferring (Phase 2-3).

3.2.1 Construction of Makespan Minimization (Phase 2-1)

Inputs: Output of the Phase 1 (Number of used workers with each worker's id).

Outputs: A new schedule found by applying the following algorithm.

Initialization: Initialization for processing times, requirements of tasks to be scheduled, workers, precedence matrix, worker-task qualification matrix for all tasks for workers.

Step 1: Form candidate tasks (CT) list for tasks that are ready to be scheduled by using precedence relations between tasks.

Step 2: Sort CT and obtain [CT] as follows.

> Step 2.1: For all tasks in CT, set FOLLOWALK= $TIME_i$ +Total Task Times of Followers +min{WT_{ih}} and obtain [CT]
>
> Step 2.2: Sort [CT] in descending order.

This phase uses a priority rule that includes ordering tasks based on Largest Processing Time (LPT) but not only orders processing times , it orders sum of processing times of all follower tasks of task *i* and walking times as well

Step 3: The first task is selected from the [CT].

Step 4: The selected task is scheduled to a worker who is able to perform the task and the least loaded.

Step 5: Repeat Step 1 to Step 4 until all tasks are scheduled in a given cycle time.

Example:

Inputs for makespan minimization (precedence diagram, walking times, and processing times) are same as previous phase. Also the number of actively used workers comes from output of previous step as 2 workers (worker 1 and worker 3). To give an idea about phase-2, first two iterations are shown below.

Iteration 1:

Step 1: CT= {1, 3}

Step 2:

Step 2.1: $FOLLOWALK_1 = 15 + 5 + 0 = 20$

$FOLLOWALK_3 = 5 + 5 + 13 = 23$

Step 2.2: [CT]= {3,1}

Step 3: Select task 3 from [CT].

Step 4: Assign task 3 to worker 1 that is able to perform the task and the least loaded worker.

Iteration 2:

Step 1: CT= {1, 4}

Step 2:

Step 2.1: $FOLLOWALK_1 = 15 + 5 + 0 = 20$

$FOLLOWALK_4 = 5 + 13+0 = 18$

Step 2.2: [CT]= {1, 4}

Step 3: Select task 1 from [CT].

Step 4: Because task 1 requires 2 workers to be accomplished, assign task 1 to worker 1 and worker 3 who are able to perform the task and the least loaded workers.

Assignment of tasks to worker 1 and 3 is given in Figure 8. In this solution, the makespan value is 39.

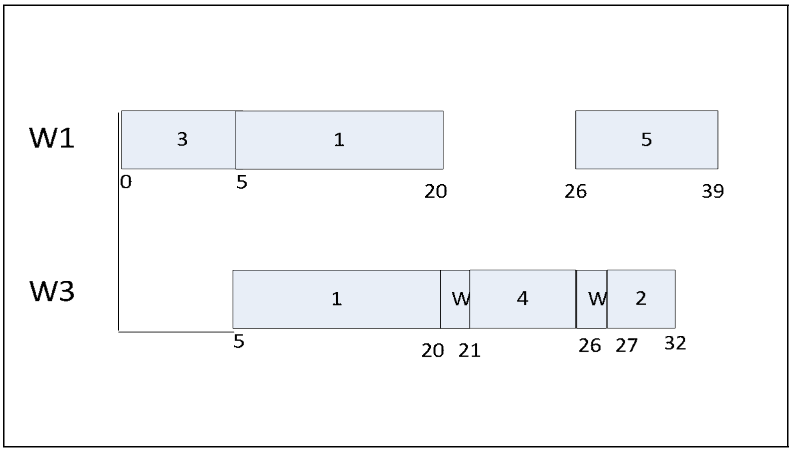

Figure 8 Resulting schedule of minimization of makespan

3.2.2 Rescheduling (Phase 2-2)

Inputs: Schedule of Phase 2.

Outputs: A new schedule found by aiming to minimize the makespan value in the input schedule. Makespan is the total time required to process all tasks. This time is the maximum completion time over all tasks.

Step 0: Consider the schedule of Phase 2.

Step 1: Find the worker *k* that creates Cmax.

Step 2: Select the last task *i* of that worker;

> -Find ready time (RT) that is the earliest time that this task could be scheduled from the schedule of the Phase 2.
>
> -From starting the ready time of this task find the best position by considering walking times between the tasks to be scheduled.
>
> -If there is no gain (workload of this worker after rescheduling does not change) select the task that is in the last position of worker with lesser workload.
>
> -If there is a gain, assign the task and reschedule (find new completion times) tasks that are performed by this worker and also reschedule the successors of the task based on the shift amount.

Step 3: Repeat these procedures until there is no more gain in rescheduling the workers.

Example:

Consider the schedule of a worker that creates the makespan value shown in Figure 9. Note that there is no precedence relationship between tasks t1, t2 and t3, and there is not walking time between t1 and t2, but between t1 and t3, as well as t2 and t3 walking times exist. In Rescheduling, it is expected to reduce makespan value by omitting walking times.

Step 1 and Step 2: Figure 9 presents the most loaded worker 1 (W1) that creates makespan with value of 41.

Step 3: Task t1 which is the last task of W1 is selected.

Ready time (RT) of t1 is 0. Because, there is no immediate predecessors of t1. Then starting from the first position of the schedule of W1, gain is calculated for all positions available on worker. In Figure 10, t1 is located in position 2. After this insert, the current workload becomes 40. Because, there is no walking time between t1 and t2.

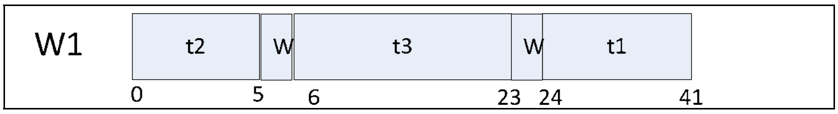

Figure 9 Schedule of the most loaded worker in resulting solution of Phase 2

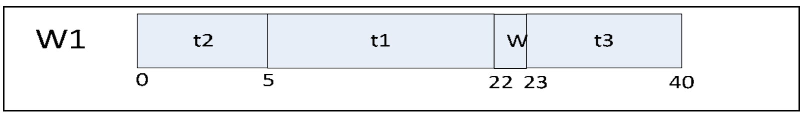

Figure 10 Result of the rescheduling phase applied to the Phase 2 solution

3.2.3 Task Transfer (Phase 2-3)

Here, the aim is to decrease makespan value by transferring a task from the most loaded worker to least loaded worker on the resulting schedule of Phase 2-1.

Inputs: Schedule of Phase-2-1

Outputs: A new schedule found by aiming to decreasing Cmax

Step 0: Consider the schedule of Phase 2-1.

Step 1: Find the worker with maximum workload

Step 2: Select the last task of worker with maximum workload

Step 3:

-If there is no gain (workload of this worker after rescheduling does not change) select the task that is in the last position of worker with lesser workload.

-If there is a gain, assign the task and reschedule (Find new completion times) tasks that are performed by this worker and also reschedule the successors of the task based on the shift amount.

Step 4: Repeat these procedures until there is no more gain in transferring tasks between the workers.

Example:

The schedule in Figure 11 shows all task assignments to all workers. There are 6 tasks to be scheduled; t2 and t4 are immediate predecessors of t3, t6 respectively. The other remaining tasks neither have predecessor nor successor. The precedence diagram is shown in Figure 12. And it is known that between t1 and t5 there is no walking time.

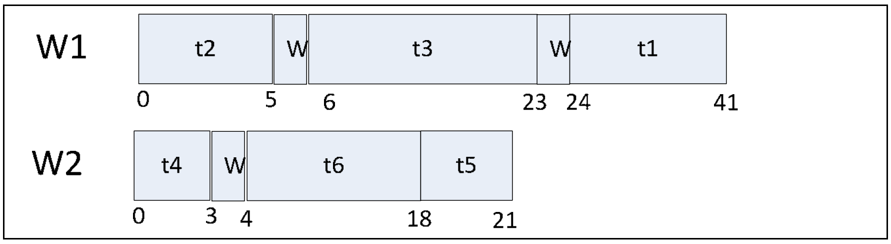

Figure 11 Tasks assignment before rescheduling

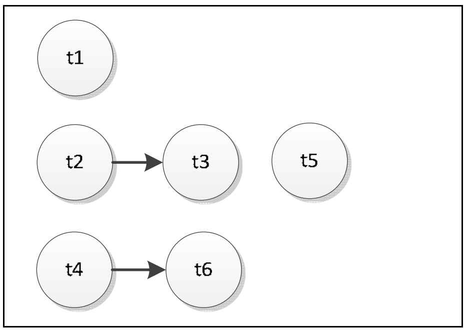

Figure 12 Precedence diagram for the example

Transferring t1 from worker 1 to worker 2 makes makespan value 38 as shown in Figure 13. Therefore, rescheduling algorithm provides decrease in makespan value.

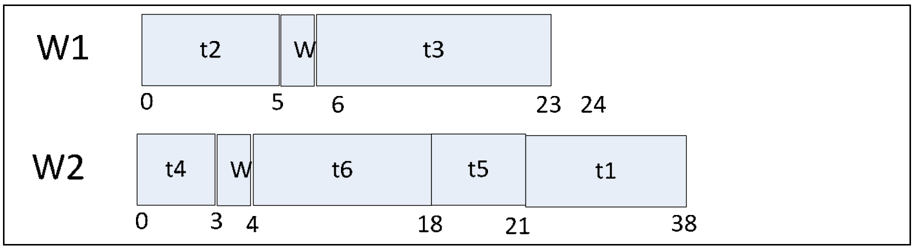

Figure 13 Task assignment after rescheduling

CHAPTER IV

In this chapter, our experimental study is explained. Test problems are constructed with real life data, since there are not any benchmarking problems in the literature.

4. EXPERIMENTAL STUDY

4.1 PROBLEM GENERATION AND EXPERIMENTAL DESIGN

For our problem, there is no test problem found in the literature. We have generated test problems by the following way:

- Model Sequence: 2 different types of product model for 3 periods (cycles) are selected.
- Number of Tasks (I): For the given model sequence, the number of tasks for each model in each period, are selected as 5, 10 and 20, 30 (10, 20, 40, 60 tasks in total).
- Processing times of tasks ($TIME_i$): Uniform distributed integer numbers are used in ranges of 5-15, 8-15, 5-20 and 8-20. These ranges are selected by analyzing the real life processing times. Ranges 5-15 and 8-15 represent low mean low variance and low mean high variance. 5-20 and 8-20 are high mean high variance and high mean low variance.
- Multi-worker tasks: For each period, 20% of all tasks are selected as multi-worker tasks by taking real life multi worker task ratio into consideration.
- Qualification Matrix (QUAL): 80% of tasks have been performed by all workers and 80% of workers perform all tasks.
- Precedence Matrix (PRE): Flexibility Ratio (F-ratio) developed by Dar-El (1973) is used to construct a precedence matrix. The complementary density measure F-ratio measures the precedence relations between tasks as represented below:

$F - ratio = \frac{2 \times B}{I(I-1)}$ where B is the number of 0's in the upper triangular matrix

The F-ratios used are %60 and %40.

- Walking Times (WT): Generated by a uniform distribution ranges by taking real life walking times from MAN Türkiye A.Ş. into consideration.
- Cycle Time (CT): 50 and 80 minutes are selected as cycle times.
- Maximum Number of Workers: 6 workers are used for the number of tasks 5, 10 and 9 workers are used for the number of tasks 20, 30 initially.

For each processing time range, 20 random instances are generated. For low mean processing time ranges, flexibility ratio is taken as 40% and CT is used as 50 minutes. For high mean processing time ranges, flexibility ratio is taken as 60% and CT is used as 80 minutes. Therefore, for each problem size, 80 instances are generated. Since there are 4 different sizes, 320 problem instances are generated in total and two solutions are obtained for each instance using two problems defined (MM1 and MM2).

4.2 RESULTS

Table-3 presents the number of optimal solution found by MM1, number of infeasible solutions if there is any. Moreover, number of cases that our heuristic solution catches the optimal solution found are reported. For the problem size 10, 3 instances out of 80 instances are infeasible. However, in remaining 77 instances, Phase 1 heuristic approach gives the optimal. For the problem size 20, for all the 80 instances, the results of Phase 1 are same as the optimal.

Table 7 Mathematical model MM1 and heuristic algorithm (Phase 1) results

	MM1 Results			*Heuristic (Phase 1) Results*		
Size of the Problem	*#OPT Success*	*#Infeasible (MM1)*	*#Feasible (MM1)*	*#OPT (Phase 1)*	*#Infeasible (Phase1)*	*#Feasible (Phase1)*
10	77	3	77	77	0	77
20	80	0	80	80	0	80
40	0	0	80	0	0	80
60	0	26	54	0	0	80

It should be noted that for MM1, 3600 seconds of time limitation is used. It is observed that getting feasible solutions in a reasonable time is not possible. However, for all instances for the problem size 40, feasible solutions are obtained. For the problem size 60, MM1 yields feasible solutions for only 54 instances while remaining 26 instances are infeasible.

Table 8 represents the results of MM2 mathematical formulation that is used for minimization of makespan value and the performance of Phase 2, 2-1, 2-2 heuristic approaches.

According to Table 8, for problem size 10, 3 instances were infeasible: MM2 yields optimal solution in 77 instances in a given time interval. We were able to find 72 optimal solutions by our heuristic approach. For the problem size 20, 80 instances have optimal solutions, but results of only 61 instances optimally solved by using the heuristic.

Table 8 MM2 and heuristic algorithm (Phase 2, 2-1, 2-2) results

	MM2			*Heuristic (Phase 2)*		
Problem Size	*#OPT Success*	*#Infeasible (MM2)*	*#Feasible Success (MM2)*	*#OPT (Phase 2)*	*#Infeasible (Phase 2)*	*#Feasible (Phase2)*
10	77	0	77	72	0	72
20	80	0	80	61	0	61
40	0	0	80	0	0	80
60	0	26	54	0	0	54

In 3600 second time limitation, there are not any optimal solutions reported by MM2. However, there are feasible solutions.

Table 9 and Table 10 present the comparison of heuristic approaches' performances respectively. To evaluate the performance, Average Gap is calculated. Formulation of Gap1 is as follows for the problem MM1:

$$\text{Gap1: } \frac{UB1 - LB1}{LB1}.$$

where UB1 is the result of Phase 1, and LB1 comes from Chapter 5.

Max: Maximum difference of UB1-LB1.

Min: Minimum difference of UB1-LB1.

Formulation of Gap2 is as follows for the problem MM2:

$$\text{Gap2} = \frac{UB2 - LB2}{LB2}$$

where UB2 is the result of Phase 2, 2-1, 2-2 and LB2 comes from Chapter 5.

Max2= Maximum of the difference UB2-LB2.

Min 2= Minimum of difference of UB2-LB2.

Table 9 Performance evaluation of Phase 1 and MM1

Size of the Problem	#Feasible Success	Phase 1			MM1		
		Average Gap	Max	Min	Average Gap	Max	Min
40	80	32.43%	8	2	37.21%	9	4

Table 10 Performance evaluation of Phase 2, 2-1, 2-2 and MM2

Size of the Problem	#Feasible Success	Phase 2, 2-1, 2-2			MM2		
		Average Gap	Max	Min	Average Gap	Max	Min
40	80	18.21%	24	4	19.30%	27	6
60	54	26.10%	31	5	27.90%	33	3

Average Gap values given in Tables 9 and 10 might be seen high. The reason is that the difference in number of workers at low level result in high Gap values. For example, when optimal number of workers is 2 and lower bound is 1 for the same instance, Gap is 100%. Such instances cause the Gap to be high.

Table 11 shows the CPU time performance evaluation on the optimal solutions for the problem MM1. For the problem size 10, the average CPU time is 0.036 when the maximum one is 0.07 by using MM1. As Phase 1 is used average CPU time of 0.011 when the maximum CPU time is 0.028. And for the problem size 20, the average CPU time is calculated as 0.12 when the maximum one is 0.47 by using MM1. But, in Phase 1, the average CPU time is 0.016 while the maximum CPU time is 0.35. Then it can be said that, Phase 1 reaches optimal solutions in shorter times than MM1 reaches.

Table 11 CPU times of Phase 1, 2-1, 2-2 and MM1 on optimal solutions

Size of the Problem	#OPT Success	MM1		Phase 1	
		Average CPU	Maximum CPU	Average CPU	Maximum CPU
10	77	0.036	0.07	0.011	0.028
20	80	0.12	0.47	0.016	0.35

Table 12 shows the CPU time performance evaluation on the optimal found solutions for the problem MM2. For the problem size 10, the average CPU time is 0.027 when the maximum one is 0.063 by using MM2. As Phase 2 is used average

CPU time of 0.009 when the maximum CPU time is 0.015. And for the problem size 20, the average CPU time is calculated as 0.08 when the maximum one is 0.45 by using MM2. But, in Phase 2, the average CPU time is 0.013 while the maximum CPU time is 0.37. Then it can be said that, Phase 2 reaches optimal solutions in shorter times than MM2 reaches.

Table 12 CPU Times of Phase 2, 2-1, 2-2 and MM2 on optimal solutions

Size of the Problem	#OPT Success	MM2		Phase 2, 2-1, 2-2	
		Average CPU	Maximum CPU	Average CPU	Maximum CPU
10	72	0.027	0.063	0.009	0.015
20	61	0.080	0.450	0.013	0.370

CHAPTER V

In this Chapter, a case study at MAN Türkiye A.Ş. is performed. In Section 6.1 general information about MAN Türkiye A.Ş. and the problem environment are described. In Section 6.2, a small-sized real life problem instance of MAN is explained in detail.

5. CASE STUDY AT MAN TÜRKİYE A.Ş.

As stated before, this thesis study is motivated by the problem occurred in MAN Türkiye A.Ş. Therefore, a small sized case study that represents the problem seen in MAN Türkiye A.Ş. with its all properties is solved.

5.1 PROBLEM ENVIRONMENT

MAN Türkiye A.Ş. has been established in 1966. In 1985, truck and motor production plants were opened in Ankara. Since 1995, MAN Türkiye A.Ş. has been producing large sized products such as busses where product families include travel buses, public transportation buses and middle distance buses (NAG). The main products in the product family have many submodels with different options, which reach to approximately twenty different bus types. In the company, there are five cost centers with 110 workstations but in the scope of this study 62 of them are considered. Relationship of these cost centers can be seen in Figure 11.

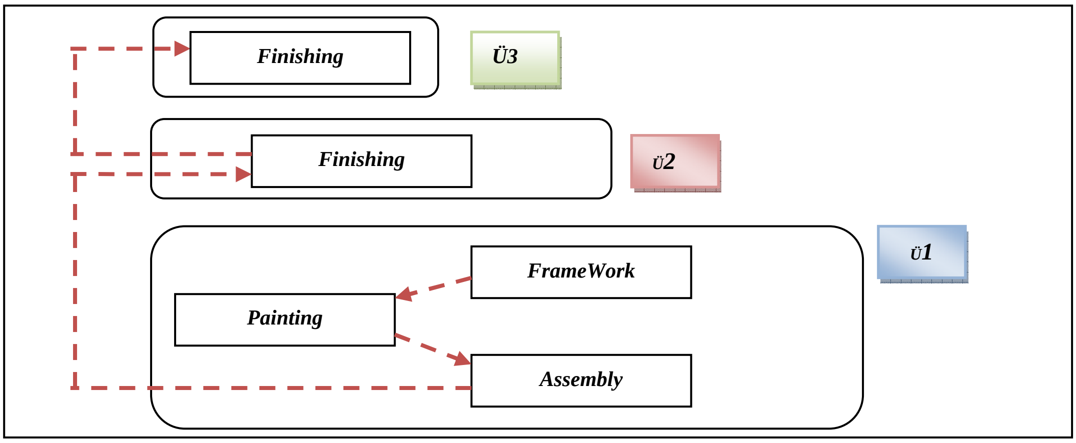

Figure 14 Cost centers of MAN Türkiye A.Ş.

For each main model, there are nearly hundred of processes to be performed and each process is included a number of tasks. Thus, each main product has nearly four thousands of tasks to be accomplished by workers on the production line. Also, a task has a number of jobs. The relationship between process, tasks and jobs can be seen in Figure 12. Here, in this study the term tasks are used.

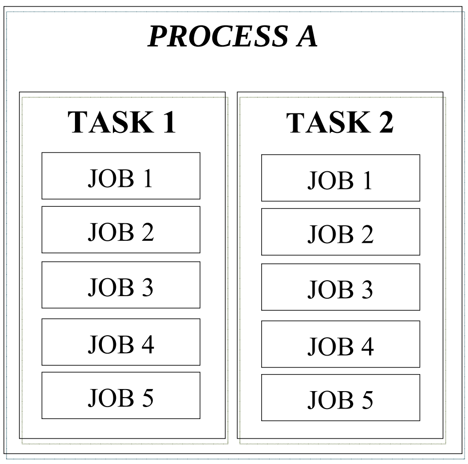

Figure 15 Relationship between process, task and job

MAN Türkiye A.Ş. manages its production line with the manner of mixed model assembly lines. It means that at the beginning of each day, production list is formed for various types of products that may require different tasks at different workstations. The predefined tasks are performed by the workers at these stations and final products are completed after the last station. The cycle time for each station is fixed. These operations that are assigned to the workstations have to be completed in the given cycle time. Because of the large dimensions of the product, more than one workers or worker teams work simultaneously at different locations (zones) of the bus. The zones that are defined by MAN Türkiye A.Ş. can be seen in Appendix A in detail. Moreover, there are precedence relations between these predefined tasks, each task cannot be performed by each worker and again due to large dimension of the products some tasks require more than one worker to be completed. In all these complications, MAN Türkiye A.Ş. cannot perform the workforce. As the reader would understand, production of different types of products on a single assembly line of MAN Türkiye A.Ş. yields huge range on workloads of workers. Furthermore, the number of tasks is very large, performing assembly line balancing (Figure 1) is almost impossible due to the combinatorial nature of the problem. The model sequence that includes number of products model with its production sequence for a given planning horizon is known. Therefore, to prevent the work over loads of workers on the assembly line and to get efficient solution in a reasonable time, the solution methodology (first minimization of number of actively used workers, then minimization of makespan per period in planning horizon) mentioned in Chapter 4 is used. Thus, it is not exactly pure assembly line balancing problem in mixed model environment. MAN Türkiye A.Ş. has all its tasks assignments for each defined workstations. Therefore, the problem returns from static assembly line balancing problem to a scheduling problem solved for every period (cycle) for each workstation. Figure 13 presents the workpiece flow in MAN Türkiye A.Ş's assembly line.

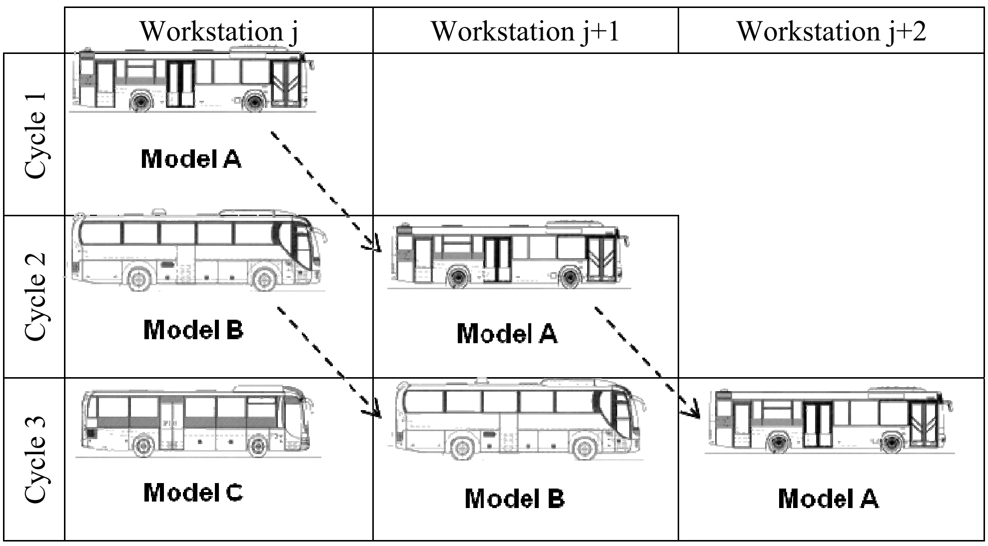

Figure 16 Workpiece flow in the line

It should be noted that this study is partially supported by Ministry of Science, Industry and Technology in the scope of SAN-TEZ project with project number 00695.2010-2. Every progress in this thesis is related with this SAN-TEZ project steps. The problem stated in Chapter 3 is formed by symptoms seen on the production line of MAN Türkiye A.Ş.

In the scope of SAN-TEZ project, macro and micro system analysis were made, the problem was defined. At the same time data gathering was performed. It can be said that data gathering part is the most tiring due to absence of most of the data or wrong data. Because the data are gathered by concrete forms called as standard operation form (SOF). Then, these concrete forms are transformed to a soft copy that provides easiness in data management. Reader can reach a sample of SOF and other used forms during the project in Appendix B. For example, there were not any precedence relations information up to this project. Most of the precedence relations for the products were obtained during the project. As a result of this situation, their representation of workerloads called as *yamazumi* by the firm does not represents the real workloads of workers. Thus, it was resulted in wrong planning operations. Besides precedence relations, data on processing times, walking times, and requirements of workers and qualifications of workers were gathered during this project. At last as a concrete result of this SAN-TEZ project, a decision support system was developed.

5.2 REAL LIFE PROBLEM INSTANCE

In this section, the proposed heuristic algorithm has been applied to the real life problem of MAN Türkiye A.Ş. Here, there are 27 tasks with cycle time 3600 seconds. Currently, 6 workers perform the tasks in a given cycle time.

Associated precedence diagram with processing times in seconds of 27 tasks are represented in Figure 11. Qualifications of workers and walking times between each task can be seen from Appendix C.

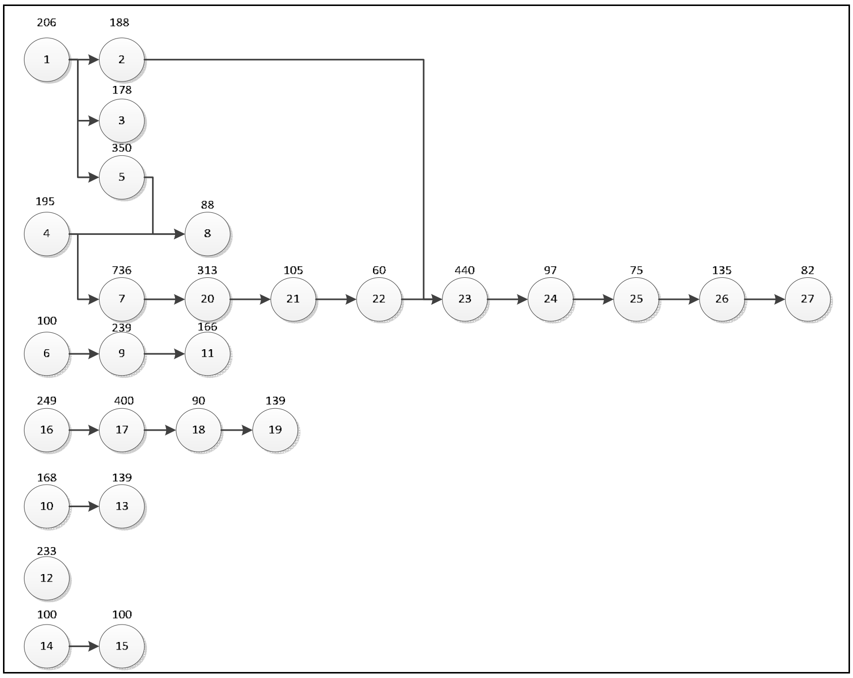

Figure 17 Precedence relations between 27 tasks

Construction Algorithm (Phase 1):

Here, the aim is to minimize the number of actively used 6 workers in production area. Construction sets the maximum priority for task *i* that has the maximum value of sum of processing time, minimum walking time and total processing times of successors. Therefore, at first the task 4 with FOLLOWALK = 1019 is assigned to worker 1 who is able to perform task 4 with start time 0 and finish time 195. Other assignments can be seen in Figure 12.

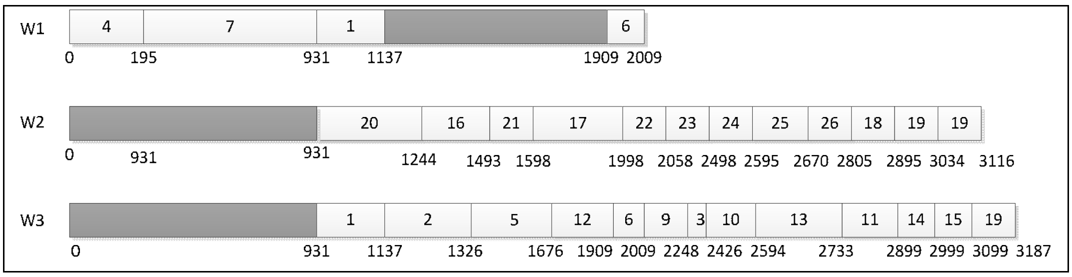

Figure 18 Resulting schedule of minimization of actively used workers (MM1)

As a result of Phase 1, the number of 6 actively used workers is decreased to 3 actively used workers.

It should be stated that our Construction Algorithm does not consider to minimize makespan value of the schedule. Its main concern is to minimize number of actively used workers without exceeding given cycle time.

Minimization of Makespan (Phase 2)

Here, as an input, numbers of workers found in the Construction Algorithm together with their qualifications are used. Aim is to get balanced workload of the workers by minimizing the makespan value. Again, we use the same priority rule that is the summation of processing time of the associated task, walking time and the sum of all successors processing times. Then, task 4 is the first task to be scheduled with FOLLOWALK =1019 to worker 1. The resulting schedule is presented in Figure 13. Makespan value is 3116.

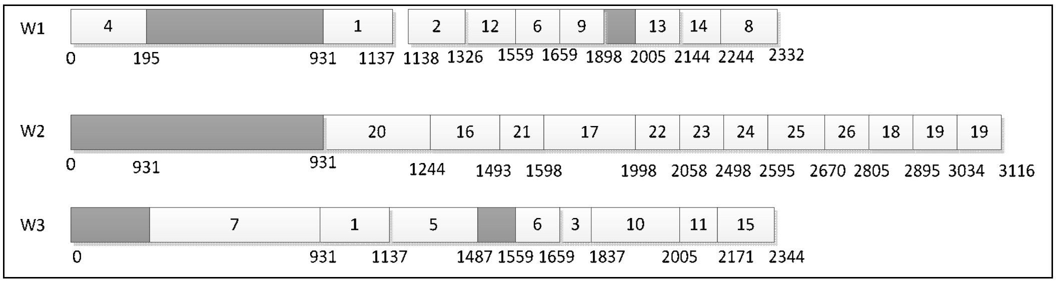

Figure 19 Resulting schedule of minimization of makespan (Phase 2, 2-1, 2-2)

It should be noted that the current schedule of the firm has 6 actively used workers. However, by using proposed algorithm only 3 workers are used and associated makespan value that will be used as cycle time is reduced to 3116.

Besides this small case study with 27 tasks, 3 different real life problems with larger sizes (more than 1,000 tasks for each) are solved by the proposed algorithm. These 3 different problems and performance measures (GAP 1 and GAP 2 calculated in chapter 4) are presented in Table 13.

Table 13 Results for real life problem instances

Problem	# of tasks	# of Workers in Current Application (MM1)	Makespan Value in Current Application (MM2)	Phase 1 (number of workers)		Phase 2, 2-1, 2-2 (makespan)	
				Solution	LB 1	Solution	LB 2
Problem 1	1032	78	75	78	74	65	61
Problem 2	997	78	74	77	70	65	58
Problem 3	1000	78	70	78	72	65	60

*Problem 1's inputs (half of it) are given in Appendix D.

When the number of workers is compared, there is not much improvement using construction algorithm compared to the current values. Only one less worker is the improvement we get for problem 2. When makespan is considered, the improvement is significant. All the makespan values are found by the minimization of makespan algorithm as with a given cycle time 65. This means using the current amount of workers in the field, it is possible to catch the cycle time with better allocation of tasks to workers. In the current application, the tasks are not properly distributed to workers, and this results in makespan values which are much more than the cycle time. As a result, cycle time becomes more than 65 in the application which reduces production ratio.

Since these 3 problems are large-sized, all the input data cannot be supplied. But only for problem 1, an interested reader can find the input data in Appendix D.

CHAPTER VI

6. CONCLUSION AND DISCUSSIONS

In this thesis, we study workforce scheduling in parallel multi worker multi sided mixed model assembly line balancing problem. Our first aim is to find the minimum number of actively used workers by considering precedence relations, walking times between tasks, multi worker tasks, qualification of workers without exceeding the given cycle time. The second aim is to obtain balanced schedule of number of workers that is result of first aim by considering again precedence relations, walking times between tasks, multi worker tasks, qualification of workers. Most of the study was performed at MAN Türkiye A.Ş.

To the best of our knowledge, there is not any work in the literature directly applicable to the situation. Two mixed integer linear mathematical formulations are developed. However, due to the combinatorial nature of the problem, the mathematical formulations do not give even any feasible solution in a reasonable time. Therefore, priority based heuristic approaches are developed. To test those algorithms, lower bounds by modifying existing lower bounds are constructed. To make performance analysis on our heuristic, new test problems are generated based on the data of MAN Türkiye A.Ş. Then, comparison results for the test problems are presented. As well as a case study at MAN Türkiye A.Ş. presented. Three realistic problem instances are generated by using real life data from the company. These instances are actually in moderate size compared to the overall problem. Using our two phase heuristic algorithm, significant improvements in makespan (therefore in realized cycle time and production ratio) are observed, but workforce amount does not improve much. With better qualification of workers, workforce planning is also expected to improve. In overall, our two phase algorithm brings significant benefits to the company.

As further research directions, new problem characteristics can be included. One possibility is to consider more detailed qualifications information. In this study, qualification of workers is thought as workers are capable or not. However, degrees of qualifications such 1 (means expert at the task), 0.5 (means worker cannot perform the task alone) and 0 (means cannot capable of doing the task) can be considered. Range in degree of qualification can provide different performance measures.

For another further research direction, problem can be considered with pre-assigned tasks. Workers' available times will be different in this context. This approach will bring a smaller sized problem with less tasks to be allocated, but requires extra effort to model this new situation. Although taking available times results in extra effort for the model, it might provide to give a quick response in adding new tasks to be performed by the planning horizon.

As another further research direction, the problems given in Figure-1 can be solved by integrated approach. It means that the result of workforce scheduling problem can be an input for model sequencing and assembly line balancing problems.

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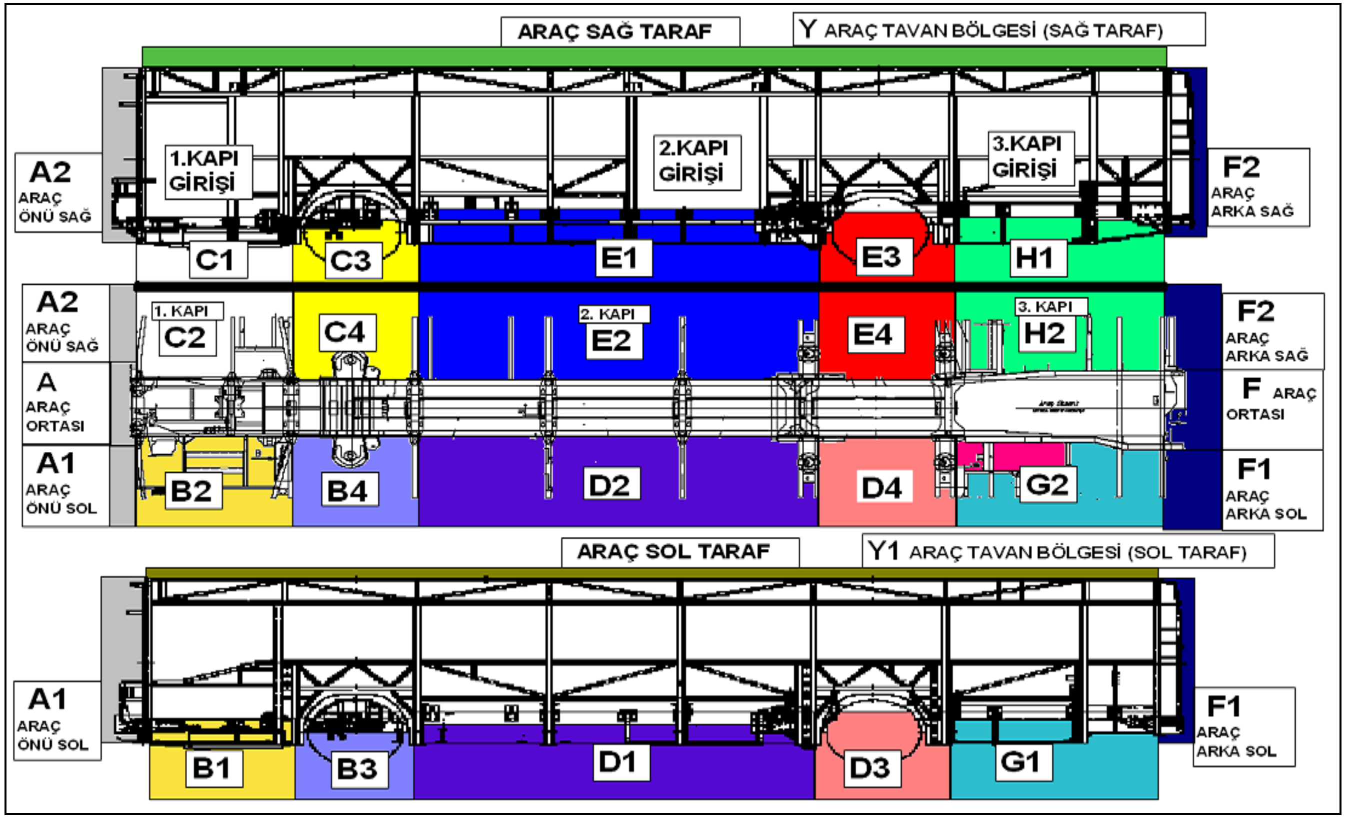
APPENDICES

APPENDIX A-Workplaces (Zones) of Workpiece at MAN Türkiye A.Ş.



APPENDIX B-Sample Forms Used in Man Türkiye A.Ş.

Sample Standard Operation Form (SOF)

MAN — **Standart Operasyon Formu**

Hazırlayan: A ÇETİNYÜREK | Tarih: 18/2/2011

Bölüm: Ön Hazırlık | İstasyon: D11 | Takım NO: 6/2 | Araç Tipi: R07

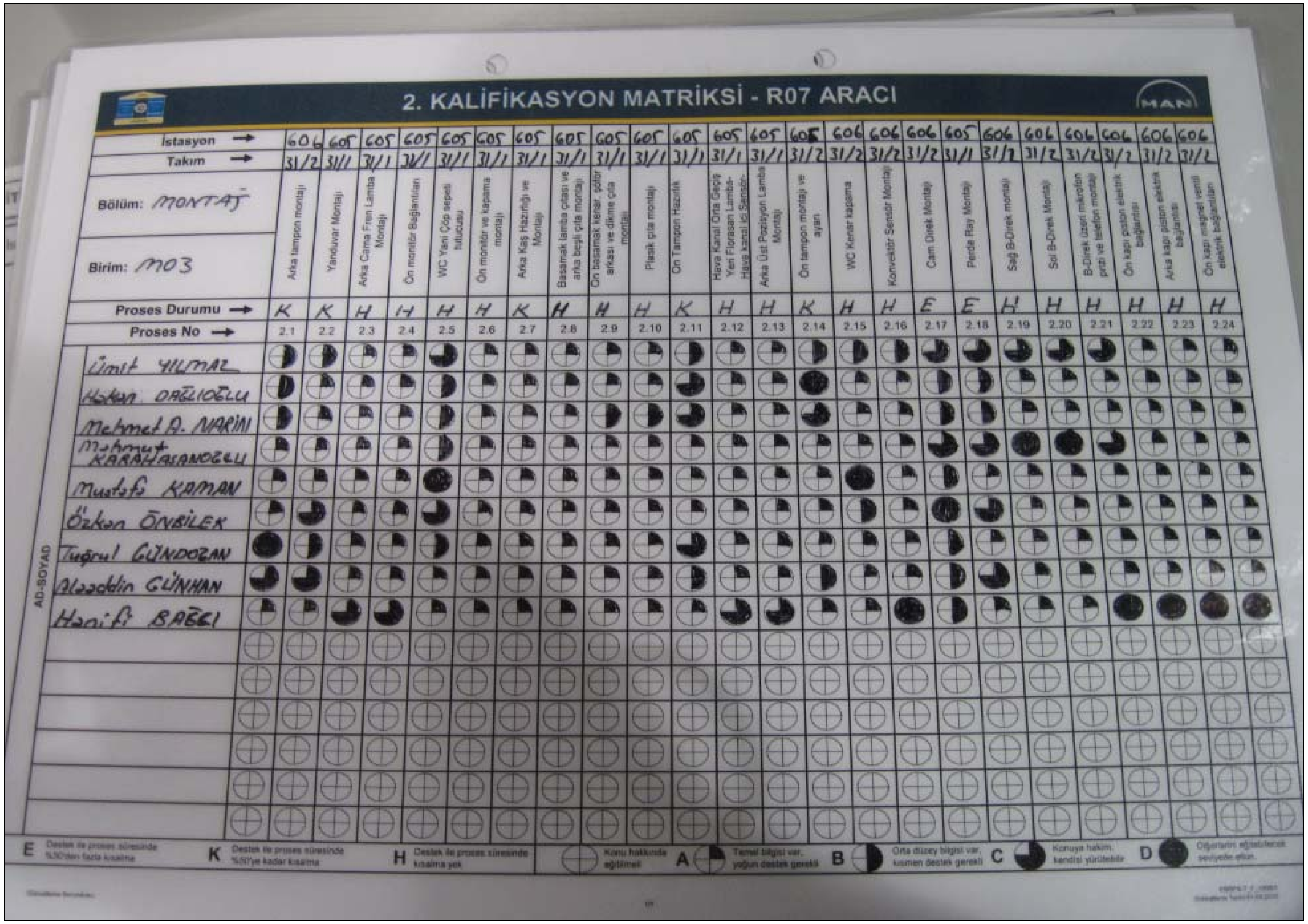
Prosesler: ELÇEK KİLİT VE ABİYES MONTAJI

Takt: 65+5 | Çevrim Süresi: 69 30

SOF No: Bari Doğan (ÇEVRİM 1)

Sıra No	İSF No	İş Tanımı	Opsiyon	Takım Hazırlık	Parça Alma	Parça Hazırlık	Araç Hazırlık	Yürüme	Alıştırma	İşlem	Ayar	Kontrol	Bekleme	Diğer	Toplam	Kişi Sayısı	Diğer SOF No
		Kum atma								02 00							
1	1	Malzemelerin alınması ve kurt ağzı kilitlerin yerine oturtulması								1.30							
2	2	Sağ 2. kapak kurt ağzı kilitlerin sıkılması								5 00							
	3	" " " izolasyonların takılması	Kış paketi							10 00							
	4	" " " elçek ve dişli plakalarının montaj edilmesi	WC'siz							01 00							
3	5	" " " elçeklerin montaj edilmesi	WC'li							01 00							
4	6	" " " Tel ve Elçeklerin montajı yapılması								06 00							
5	7	" " " Elektrik tesisatının toplanması								05 00							
6	8	" " " kilit açma ayarlarının yapılması								06 00							
7	9	" " " Abiyelerinin montajı								02 00							
	10	WC kapağı sacının montajı	Kış paketi, s[illegible]							01 00							
8	11	Sağ 3. kapak kilitlerinin sabitlenip sıkılması								02 00							
	12	" " " izolasyonların takılması	Kış paketi							05 00							
9	13	" " " elçeğin oturtulması								01 00							
10	14	" " " Tel ve Elçeklerinin montajı yapılması								04 00							
11	15	" " " Elektrik tesisatının toplanması								02 00							
12	16	" " " istop açma yeri montajı								02 00							
13	17	" " " kilit açma yeri montajı								05 00							
14	18	Sol 1. Bagaj kapağı kurt ağzı kilitleri montajı								05 00							
	19	" " " " izolasyon takılması	Kış paketi							10 00							
15	20	" " " elçeğin takılması								02 00							
16	21	" " " Tel ve Elçek tutucusunun bağlanması								05 00							
17	22	" " " Elektrik tesisatının toplanması								02 00							
18	23	" " " kilit açma ayarlarının yapılması								08 00							
19	24	" " " Abiyelerin takılması ve kontrol yap.								05 00							
			Toplam:							69 30							
DESTEK İŞ*																	
			Genel Toplam							69 30							

Sample Qualification Form



Sample Task Requirement Form

PROSESLER

Proses İsmi: HİDROLİK YAĞ BORULARI MONTAJI

Sıra No	İş İsmi	Araç Tipi	Opsiyon	Parça Numaraları	Montaj Resmi No	Kısıtlar	Öncelik sonralık	Araçta yapıldığı bölge	Kaç kişi ile yapılıyor	İstasyon Numarası	Birim Yöneticisi	Operatör
1	Boy borusunun bağlanması	A78						E2	1	D01	Murat Tosun	
2	Arka aks üstü boruların bağlanması	"						"	"	"	"	
3	Ön aks arkası boruların bağlanması	"						"	"	"	"	
4	Ön aks üstü boruların bağlanması	"						B4	"	"	"	
5	Ön aks sağ kısa boruların bağlanması	"						B2	"	"	"	
6	Yağ hortumunun bağlanması	"						B2	"	"	"	
7	Kelepçe atılması	"						B2	"	"	"	
8	Ana borunun kütüğe bağlanması	"						B2	"	"	"	
9	Şoför altı tutucuya kelepçe atılması	"						B2	"	"	"	
10	Kütük altı rekorların sıkılması	"						B2	"	"	"	
11												
12												
13												
14												
15												

Sample Data Form Used in the Scope of the Project

CODE	WORK STATION	BUS MODEL	PROCESS CODE	PROCESS	TASK CODE	TASK	PREDECESSOR	ZONE	WORKER REQUIREMENT	PROCESSING TIME
P1ISF1	G01	R07	P1	BAGAJ İÇİ ÖN DAVLUMBAZ FİLE MONTAJI	ISF1	File Montaj Deliklerinin Markalanması		D2 BAĞAJ	1	3,07
P1ISF2	G01	R07	P1	BAGAJ İÇİ ÖN DAVLUMBAZ FİLE MONTAJI	ISF2	File Montaj Deliklerinin Delinmesi		D2 BAĞAJ	1	1,40
P1ISF3	G01	R07	P1	BAGAJ İÇİ ÖN DAVLUMBAZ FİLE MONTAJI	ISF3	Filenin Yerine Vidalanması		D2 BAĞAJ	1	3,60
P2ISF1	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF1	Büyük Üçgen Tahta Hazırlığı		ARAÇ DIŞI	1	3,08
P2ISF2	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF2	Küçük Üçgen Tahta Hazırlığı		ARAÇ DIŞI	1	3,58
P2ISF3	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF3	Büyük Ve Wc Arkası Tahta Hazırlığı		ARAÇ DIŞI	1	4,62
P2ISF4	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF4	Büyük Üçgen Tahta Montajı	1	C2	1	7,00
P2ISF5	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF5	Küçük Üçgen Tahta Montajı	2	C2	1	6,33
P2ISF6	G01	R07	P2	BÜYÜK ÜÇGEN TAHTA HAZIRLIĞI	ISF6	Büyük Ve Wc Arkası Tahta Montajı	3	C2	1	4,43
P3ISF1	G01	R07	P3	DAVLUMBAZ ÇITA HAZIRLIĞI	ISF1	Sağ Davlumbaz Çıtasının Yapılması		E2 (BAGAJ)	1	2,63
P3ISF2	G01	R07	P3	DAVLUMBAZ ÇITA HAZIRLIĞI	ISF2	Sol Davlumbaz Çıtasının Yapılması		D2 (BAGAJ)	1	2,58
P4ISF1	G01	R07	P4	ESP KAPAMA MONTAJI	ISF1	Esp Kapama Montajının Yapılması		E2 (BAGAJ)	1	2,27
P4ISF2	G01	R07	P4	ESP KAPAMA MONTAJI	ISF2	Para Dolabı Montajı		E2 (BAGAJ)	1	4,37

APPENDIX C- Inputs of Case Study at MAN Türkiye A.Ş.

Qualification of Workers

WORKER \ TASK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Walking Times Between Tasks

TASK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX D – Input Data of Problem 1

Processing Times

#	Code	Time
1	P1ISF1	3,07
2	P1ISF2	1,40
3	P1ISF3	3,60
4	P2ISF1	3,08
5	P2ISF2	3,58
6	P2ISF3	4,62
7	P2ISF4	7,00
8	P2ISF5	6,33
9	P2ISF6	4,43
10	P3ISF1	2,63
11	P3ISF2	2,58
12	P4ISF1	2,27
13	P4ISF2	4,37
14	P5ISF1	6,00
15	P5ISF2	6,50
16	P6ISF1	1,33
17	P6ISF2	6,13
18	P6ISF3	1,98
19	P7ISF1	7,42
20	P7ISF2	1,18
21	P7ISF3	1,38
22	P7ISF4	1,88
23	P7ISF5	2,12
24	P7ISF6	1,78
25	P7ISF7	2,12
26	P7ISF8	2,32
27	P7ISF9	1,52
28	P7ISF10	3,60
29	P7ISF11	2,77
30	P7ISF12	8,67
31	P7ISF13	4,60
32	P7ISF14	3,30
33	P7ISF15	4,47
34	P7ISF16	1,53
35	P7ISF17	2,52
36	P7ISF18	5,90
37	P8ISF1	3,30
38	P8ISF2	3,90
39	P8ISF3	4,40
40	P9ISF1	1,68
41	P9ISF2	4,40
42	P10ISF1	4,70
43	P10ISF2	1,73
44	P11ISF1	3,30
45	P11ISF2	2,17
46	P11ISF3	3,78
47	P11ISF4	2,08
48	P11ISF5	1,25
49	P11ISF6	2,05
50	P11ISF7	1,80
51	P11ISF8	3,93
52	P11ISF9	2,53
53	P11ISF10	1,60
54	P11ISF11	4,32
55	P11ISF12	10,50
56	P12ISF1	1,43
57	P12ISF2	2,08
58	P12ISF3	3,47
59	P13ISF1	2,30
60	P13ISF2	0,50
61	P13ISF3	0,50
62	P13ISF4	22,85
63	P14ISF1	8,27
64	P14ISF2	7,20
65	P14ISF3	2,75
66	P14ISF4	4,90
67	P14ISF5	2,92
68	P14ISF6	4,82
69	P14ISF7	7,43
70	P14ISF8	4,30
71	P14ISF9	1,67
72	P14ISF10	2,87
73	P14ISF11	5,63
74	P14ISF12	3,57
75	P14ISF19	3,13
76	P14ISF20	3,80
77	P14ISF21	1,83
78	P14ISF22	6,02
79	P14ISF23	1,37
80	P14ISF24	2,93
81	P14ISF24	3,83
82	P14ISF25	1,38
83	P14ISF25	1,08
84	P14ISF26	2,80
85	P14ISF27	4,52
86	P14ISF28	5,08
87	P14ISF29	12,93
88	P14ISF	0,50
89	P15ISF2	6,98
90	P15ISF3	2,78
91	P15ISF4	4,90
92	P15ISF5	2,92
93	P15ISF13	0,72
94	P15ISF14	1,37
95	P15ISF15	0,70
96	P15ISF16	2,23
97	P15ISF17	2,20
98	P15ISF18	1,07
99	P15ISF23	1,03
100	P15ISF26	2,18
101	P15ISF27	4,10
102	P15ISF28	2,23
103	P15ISF30	3,70
104	P15ISF31	1,03
105	P16ISF1	7,10
106	P17ISF1	17,02
107	P17ISF2	6,13
108	P18ISF1	1,25
109	P18ISF2	2,62
110	P18ISF3	3,90
111	P18ISF4	1,98
112	P18ISF5	1,55
113	P18ISF6	15,75
114	P19ISF1	6,98
115	P19ISF2	1,00
116	P19ISF3	1,12
117	P19ISF4	3,52
118	P19ISF5	0,62
119	P19ISF6	6,07
120	P20ISF1	0,50
121	P21ISF1	1,18
122	P21ISF1	1,20
123	P21ISF2	0,50
124	P21ISF2	2,25
125	P21ISF3	1,55
126	P21ISF3	1,00
127	P21ISF4	3,47
128	P21ISF4	1,20
129	P21ISF5	4,13
130	P21ISF5	2,77
131	P21ISF7	1,57
132	P21ISF7	1,57
133	P21ISF8	2,95
134	P21ISF9	2,65
135	P21ISF10	2,07
136	P21ISF10	2,07
137	P21ISF11	1,73
138	P21ISF11	2,35
139	P21ISF12	1,45
140	P21ISF12	0,73
141	P21ISF13	4,92
142	P21ISF13	2,35
143	P22ISF1	0,67
144	P22ISF1	0,67
145	P22ISF2	12,70
146	P22ISF3	7,30
147	P22ISF3	2,35
148	P22ISF3	2,35
149	P22ISF3	7,07
150	P22ISF3	1,17
151	P22ISF4	1,23
152	P22ISF4	1,47
153	P22ISF4	3,08
154	P22ISF4	0,50
155	P22ISF5	0,50
156	P22ISF6	2,40
157	P22ISF6	4,07
158	P22ISF6	4,83
159	P22ISF6	3,35
160	P22ISF7	5,67
161	P22ISF7	5,95
162	P22ISF7	1,95
163	P22ISF8	4,20
164	P22ISF8	3,68
165	P22ISF9	6,08
166	P22ISF9	7,83
167	P22ISF9	1,80
168	P22ISF10	2,23
169	P22ISF10	2,60
170	P22ISF11	6,43
171	P22ISF12	8,33
172	P22ISF13	1,53
173	P22ISF14	2,83
174	P22ISF15	0,80
175	P22ISF16	0,43
176	P22ISF17	0,87
177	P22ISF18	4,37
178	P22ISF18	3,10
179	P22ISF18	3,10
180	P22ISF19	5,90
181	P22ISF20	3,70
182	P22ISF20	3,67
183	P22ISF20	3,67
184	P22ISF20	3,67
185	P22ISF20	1,03
186	P22ISF21	5,33
187	P22ISF21	4,03
188	P22ISF21	4,03
189	P22ISF21	2,70
190	P22ISF22	4,72
191	P22ISF22	3,02
192	P22ISF23	1,92
193	P22ISF23	4,00
194	P22ISF24	5,20
195	P22ISF25	8,40
196	P22ISF26	5,88
197	P22ISF27	3,08
198	P22ISF28	4,72
199	P22ISF28	4,72
200	P22ISF28	2,92

#	Code	Time
201	P22ISF29	0,50
202	P22ISF30	1,18
203	P22ISF30	2,53
204	P22ISF31	1,53
205	P22ISF33	3,88
206	P22ISF34	7,15
207	P22ISF35	8,37
208	P22ISF36	7,15
209	P22ISF37	8,37
210	P22ISF38	7,12
211	P22ISF39	12,20
212	P22ISF40	4,60
213	P22ISF41	3,55
214	P22ISF	11,77
215	P23ISF1	1,85
216	P23ISF2	1,98
217	P24ISF1	4,75
218	P25ISF1	3,30
219	P25ISF2	1,65
220	P25ISF3	7,98
221	P25ISF4	6,35
222	P25ISF5	0,50
223	P26ISF1	8,62
224	P26ISF2	3,08
225	P27ISF1	3,07
226	P27ISF2	4,08
227	P27ISF3	12,08
228	P28ISF1	3,80
229	P29ISF1	10,85
230	P29ISF2	0,50
231	P30ISF1	1,85
232	P30ISF2	1,53
233	P30ISF3	1,00
234	P30ISF4	3,27
235	P31ISF2	1,88
236	P31ISF3	6,10
237	P31ISF4	6,90
238	P32ISF1	0,50
239	P32ISF2	7,53
240	P32ISF	3,77
241	P32ISF	2,00
242	P33ISF1	1,60
243	P33ISF2	5,40
244	P33ISF3	2,18
245	P33ISF4	7,57
246	P33ISF5	7,85
247	P33ISF6	6,07
248	P33ISF7	11,23
249	P33ISF8	3,93
250	P33ISF9	2,50

#	Code	Time
251	P33ISF-2.5	0,50
252	P34ISF1	2,65
253	P34ISF2	5,00
254	P34ISF3	1,68
255	P34ISF4	2,88
256	P34ISF5	5,75
257	P34ISF6	5,75
258	P34ISF7	15,80
259	P34ISF8	0,55
260	P34ISF9	1,97
261	P34ISF10	2,75
262	P34ISF11	11,12
263	P34ISF	0,50
264	P35ISF4	5,78
265	P35ISF5	7,12
266	P35ISF6	8,00
267	P36ISF2	4,55
268	P37ISF1	4,78
269	P37ISF2	2,00
270	P37ISF3	3,57
271	P37ISF4	3,50
272	P37ISF5	5,30
273	P37ISF6	5,55
274	P37ISF7	3,82
275	P37ISF8	0,50
276	P37ISF9	9,27
277	P37ISF10	7,03
278	P37ISF11	2,73
279	P38ISF8	14,57
280	P39ISF2	7,67
281	P39ISF2	8,70
282	P39ISF3	3,87
283	P39ISF3	9,42
284	P39ISF4	5,50
285	P39ISF5	5,58
286	P39ISF6	4,00
287	P39ISF7	12,58
288	P39ISF8	9,55
289	P39ISF9	3,83
290	P39ISF10	3,70
291	P39ISF11	5,55
292	P39ISF12	2,72
293	P39ISF13	9,33
294	P39ISF14	4,12
295	P39ISF15	0,50
296	P39ISF16	3,92
297	P40ISF1	3,88
298	P40ISF2	4,37
299	P40ISF3	6,52
300	P40ISF4	5,18

#	Code	Time
301	P40ISF5	5,93
302	P40ISF6	4,65
303	P40ISF7	3,42
304	P40ISF8	2,05
305	P40ISF9	5,02
306	P40ISF10	5,05
307	P40ISF11	10,90
308	P41ISF1	5,87
309	P41ISF2	5,62
310	P41ISF3	3,83
311	P41ISF4	5,00
312	P41ISF5	6,00
313	P41ISF6	5,17
314	P42ISF1	7,38
315	P42ISF2	4,42
316	P42ISF2	5,07
317	P42ISF3	3,00
318	P42ISF4	3,12
319	P42ISF4	5,88
320	P42ISF5	3,58
321	P42ISF6	4,33
322	P42ISF7	3,68
323	P42ISF8	4,00
324	P43ISF9	4,28
325	P43ISF10	8,88
326	P43ISF10	7,67
327	P43ISF11	6,43
328	P43ISF11	6,48
329	P44ISF1	5,55
330	P44ISF2	11,93
331	P44ISF3	3,33
332	P44ISF4	4,88
333	P44ISF5	13,00
334	P44ISF6	29,63
335	P45ISF1	5,85
336	P45ISF2	8,75
337	P45ISF3	3,42
338	P45ISF4	9,90
339	P46ISF1	6,33
340	P46ISF2	2,42
341	P46ISF3	0,50
342	P46ISF4	1,42
343	P46ISF5	2,83
344	P46ISF6	5,52
345	P46ISF7	0,25
346	P46ISF8	0,50
347	P46ISF9	5,02
348	P46ISF10	1,92
349	P46ISF11	3,00
350	P46ISF12	2,78

#	Code	Time
351	P47ISF1	16,00
352	P47ISF1	10,18
353	P47ISF2	18,02
354	P47ISF2	16,08
355	P47ISF3	14,88
356	P47ISF4	15,35
357	P48ISF1	7,60
358	P49ISF1	6,00
359	P50ISF1	2,10
360	P50ISF2	0,50
361	P50ISF3	2,72
362	P50ISF4	1,80
363	P50ISF5	2,77
364	P50ISF6	4,35
365	P50ISF7	3,60
366	P50ISF8	0,50
367	P50ISF9	1,68
368	P50ISF10	0,50
369	P50ISF11	5,48
370	P50ISFOT	0,50
371	P50ISFOT	0,50
372	P50ISFOT	0,50
373	P50ISFOT	0,50
374	P50ISFOT	0,50
375	P50ISFOT	0,50
376	P51ISF6	2,10
377	P52ISF1	6,15
378	P52ISF2	6,57
379	P53ISF1	2,33
380	P53ISF2	8,82
381	P53ISF3	6,38
382	P53ISF4	7,07
383	P53ISF5	7,50
384	P54ISF1	7,78
385	P54ISF2	4,33
386	P54ISF3	3,57
387	P54ISF4	4,17
388	P54ISF5	5,60
389	P55ISF1	5,47
390	P55ISF2	3,23
391	P55ISF3	3,75
392	P55ISF4	3,63
393	P55ISF5	7,02
394	P55ISF5	3,72
395	P55ISF6	12,53
396	P55ISF7	1,12
397	P55ISF8	1,82
398	P55ISF9	1,20
399	P55ISF10	3,35
400	P55ISF11	0,50

#	Code	Time
401	P55ISFOT	6,23
402	P56ISF1	3,97
403	P56ISF2	2,00
404	P56ISF3	7,63
405	P56ISF4	4,07
406	P57ISF1	0,83
407	P57ISF2	1,33
408	P57ISF3	7,33
409	P58ISF1	10,45
410	P58ISF2	2,50
411	P58ISF3	3,50
412	P58ISF4	5,13
413	P58ISF5	3,17
414	P58ISF6	2,50
415	P58ISF7	1,33
416	P58ISF8	8,83
417	P58ISF9	11,73
418	P59ISF1	8,22
419	P60ISF1	4,42
420	P60ISF2	3,12
421	P60ISF3	6,12
422	P60ISF4	5,97
423	P60ISF5	4,47
424	P60ISF6	3,57
425	P60ISF7	3,75
426	P60ISF8	2,40
427	P60ISF9	4,40
428	P60ISF10	3,45
429	P60ISF11	6,33
430	P60ISF11	4,75
431	P60ISF12	4,85
432	P60ISF12	7,23
433	P60ISF13	5,78
434	P60ISF13	2,13
435	P60ISF14	1,05
436	P60ISF15	1,33
437	P60ISF15	2,38
438	P60ISF16	2,67
439	P60ISF18	2,50
440	P60ISF19	2,03
441	P60ISF20	2,33
442	P60ISF21	13,60
443	P60ISF22	13,60
444	P60ISF23	5,20
445	P60ISF23	5,20
446	P60ISF24	2,27
447	P60ISF25	3,43
448	P60ISF26	3,43
449	P60ISF27	4,58
450	P60ISF27	4,58

#	Code	Time
451	P60ISF28	2,37
452	P60ISF29	2,37
453	P60ISF30	0,93
454	P60ISF31	3,00
455	P60ISF31	0,70
456	P60ISF32	2,00
457	P60ISF33	3,83
458	P61ISF1	7,20
459	P61ISF2	3,67
460	P61ISF3	3,03
461	P61ISF4	3,50
462	P62ISF1	4,62
463	P62ISF2	2,28
464	P62ISF3	9,25
465	P62ISF4	3,80
466	P63ISF1	2,72
467	P63ISF2	9,53
468	P63ISF3	3,87
469	P63ISF4	4,42
470	P63ISF5	6,00
471	P63ISF6	4,98
472	P63ISF7	5,17
473	P63ISF8	5,20
474	P63ISF9	2,52
475	P63ISF10	1,43
476	P63ISF11	0,97
477	P63ISF12	1,62
478	P63ISF13	5,77
479	P63ISF14	12,70
480	P63ISF15	5,52
481	P63ISF16	1,38
482	P63ISFOT	9,18
483	P63ISFOT	10,03
484	P64ISF1	7,38
485	P64ISF2	5,82
486	P64ISF3	3,20
487	P64ISF4	2,82
488	P64ISF5	2,02
489	P64ISF6	13,38
490	P64ISF7	12,42
491	P64ISF8	2,43
492	P64ISF9	4,67
493	P64ISF10	2,53
494	P64ISF11	1,40
495	P64ISF12	5,93
496	P64ISF13	4,22
497	P65ISF1	17,83
498	P65ISF2	1,70
499	P65ISF3	3,85
500	P65ISF4	2,97

Precedence Relations

#	Code	Predecessor	#	Code	Predecessor	#	Code	Predecessor
1	P1ISF1		51	P11ISF8		101	P15ISF27	P15ISF24
2	P1ISF2		52	P11ISF9		102	P15ISF28	P15ISF25
3	P1ISF3		53	P11ISF10		103	P15ISF30	
4	P2ISF1		54	P11ISF11		104	P15ISF31	P15ISF30 - 26 - 27 - 28
5	P2ISF2		55	P11ISF12		105	P16ISF1	P16ISF
6	P2ISF3		56	P12ISF1		106	P17ISF1	P17ISF
7	P2ISF4	P2ISF1	57	P12ISF2	P12ISF1	107	P17ISF2	P17ISF
8	P2ISF5	P2ISF2	58	P12ISF3	P12ISF2	108	P18ISF1	
9	P2ISF6	P2ISF3	59	P13ISF1		109	P18ISF2	
10	P3ISF1		60	P13ISF2		110	P18ISF3	
11	P3ISF2		61	P13ISF3		111	P18ISF4	P18ISF3
12	P4ISF1		62	P13ISF4		112	P18ISF5	P18ISF4
13	P4ISF		63	P14ISF1		113	P18ISF6	P18ISF1,2,3,4,5
14	P5ISF1		64	P14ISF2	P14ISF1	114	P19ISF1	
15	P5ISF2	P5ISF1	65	P14ISF3	P14ISF2	115	P19ISF2	P19ISF1
16	P6ISF1		66	P14ISF4	P14ISF2	116	P19ISF3	P19ISF1
17	P6ISF2	P6ISF1	67	P14ISF5	P14ISF2	117	P19ISF4	P19ISF1
18	P6ISF3	P6ISF2	68	P14ISF6	P14ISF3	118	P19ISF5	P19ISF1
19	P7ISF1		69	P14ISF7	P14ISF4	119	P19ISF6	P19ISF1
20	P7ISF2	P7ISF1	70	P14ISF8	P14ISF5	120	P20ISF1	
21	P7ISF3	P7ISF2	71	P14ISF9	P14ISF6 - 7 - 8	121	P21ISF1	
22	P7ISF4	P7ISF3	72	P14ISF10	P14ISF6	122	P21ISF1	
23	P7ISF5	P7ISF4	73	P14ISF11	P14ISF7	123	P21ISF2	P21ISF1
24	P7ISF6	P7ISF5	74	P14ISF12	P14ISF8	124	P21ISF2	P21ISF1
25	P7ISF7	P7ISF6	75	P14ISF19	P14ISF16	125	P21ISF3	P21ISF2
26	P7ISF8	P7ISF7	76	P14ISF20	P14ISF17	126	P21ISF3	P21ISF2
27	P7ISF9	P7ISF8	77	P14ISF21	P14ISF18	127	P21ISF4	P21ISF3
28	P7ISF10	P7ISF9	78	P14ISF22		128	P21ISF4	P21ISF3
29	P7ISF11	P7ISF10	79	P14ISF23	P14ISF19 - 22	129	P21ISF5	P21ISF4
30	P7ISF12	P7ISF11	80	P14ISF24	P14ISF20 - 22	130	P21ISF5	P21ISF4
31	P7ISF13	P7ISF12	81	P14ISF24	P14ISF20 - 22	131	P21ISF7	P21ISF5
32	P7ISF14	P7ISF13	82	P14ISF25	P14ISF21 - 22	132	P21ISF7	P21ISF5
33	P7ISF15	P7ISF14	83	P14ISF25	P14ISF21 - 22	133	P21ISF8	P21ISF7
34	P7ISF16	P7ISF15	84	P14ISF26	P14ISF23	134	P21ISF9	P21ISF7
35	P7ISF17	P7ISF16	85	P14ISF27	P14ISF24	135	P21ISF10	P21ISF7
36	P7ISF18	P7ISF17	86	P14ISF28	P14ISF25	136	P21ISF10	P21ISF7
37	P8ISF1		87	P14ISF29	P14ISF26 - 27 - 28	137	P21ISF11	
38	P8ISF2	P8ISF1	88	P14ISF		138	P21ISF11	
39	P8ISF3	P8ISF2	89	P15ISF2	P15ISF1	139	P21ISF12	
40	P9ISF1		90	P15ISF3	P15ISF2	140	P21ISF12	
41	P9ISF2	P9ISF1	91	P15ISF4	P15ISF2	141	P21ISF13	P21ISF12
42	P10ISF1		92	P15ISF5	P15ISF2	142	P21ISF13	P21ISF12
43	P10ISF2	P10ISF1	93	P15ISF13	P15ISF10	143	P22ISF1	
44	P11ISF1		94	P15ISF14	P15ISF11	144	P22ISF1	
45	P11ISF2		95	P15ISF15	P15ISF12	145	P22ISF2	P22ISF1
46	P11ISF3		96	P15ISF16	P15ISF13	146	P22ISF3	P22ISF2
47	P11ISF4		97	P15ISF17	P15ISF14	147	P22ISF3	P22ISF2
48	P11ISF5		98	P15ISF18	P15ISF15	148	P22ISF3	P22ISF2
49	P11ISF6		99	P15ISF23	P15ISF19 - 22	149	P22ISF3	P22ISF2
50	P11ISF7		100	P15ISF26	P15ISF23	150	P22ISF3	P22ISF2

#	Code	Predecessor
151	P22ISF4	P22ISF3
152	P22ISF4	P22ISF3
153	P22ISF4	P22ISF3
154	P22ISF4	P22ISF3
155	P22ISF5	P22ISF3
156	P22ISF6	P22ISF5
157	P22ISF6	P22ISF5
158	P22ISF6	P22ISF5
159	P22ISF6	P22ISF5
160	P22ISF7	P22ISF6
161	P22ISF7	P22ISF6
162	P22ISF7	P22ISF6
163	P22ISF8	P22ISF7
164	P22ISF8	P22ISF7
165	P22ISF9	P22ISF8
166	P22ISF9	P22ISF8
167	P22ISF9	P22ISF8
168	P22ISF10	P22ISF8
169	P22ISF10	P22ISF8
170	P22ISF11	P22ISF10
171	P22ISF12	P22ISF11
172	P22ISF13	P22ISF12
173	P22ISF14	P22ISF13
174	P22ISF15	P22ISF14
175	P22ISF16	P22ISF14
176	P22ISF17	P22ISF4
177	P22ISF18	P22ISF16-17
178	P22ISF18	P22ISF16-17
179	P22ISF18	P22ISF16-17
180	P22ISF19	P22ISF18
181	P22ISF20	P22ISF18
182	P22ISF20	P22ISF18
183	P22ISF20	P22ISF18
184	P22ISF20	P22ISF18
185	P22ISF20	P22ISF18

#	Code	Predecessor
201	P22ISF29	P22ISF27-28
202	P22ISF30	P22ISF28
203	P22ISF30	P22ISF28
204	P22ISF31	P22ISF14-27
205	P22ISF33	
206	P22ISF34	P22ISF32
207	P22ISF35	P22ISF32
208	P22ISF36	P22ISF34
209	P22ISF37	P22ISF35
210	P22ISF38	P22ISF36
211	P22ISF39	P22ISF37
212	P22ISF40	P22ISF38
213	P22ISF41	P22ISF39
214	P22ISF	
215	P23ISF1	
216	P23ISF2	
217	P24ISF1	
218	P25ISF1	
219	P25ISF2	
220	P25ISF3	
221	P25ISF4	
222	P25ISF5	
223	P26ISF1	
224	P26ISF2	
225	P27ISF1	
226	P27ISF2	
227	P27ISF3	
228	P28ISF1	
229	P29ISF1	
230	P29ISF2	
231	P30ISF1	
232	P30ISF2	P30ISF1
233	P30ISF3	P30ISF2
234	P30ISF4	P30ISF3
235	P31ISF2	P31ISF1

#	Code	Predecessor
251	P33ISF-2.5	
252	P34ISF1	
253	P34ISF2	
254	P34ISF3	P34ISF1-2
255	P34ISF4	P34ISF1-2-3
256	P34ISF5	P34ISF1-2-3
257	P34ISF6	P34ISF1-2-3-4-5
258	P34ISF7	P34ISF6
259	P34ISF8	P34ISF7
260	P34ISF9	P34ISF7-8
261	P34ISF10	P34ISF7-8
262	P34ISF11	P34ISF1-2-3-4-5-6-7-8-9-10
263	P34ISF	
264	P35ISF4	P35ISF0
265	P35ISF5	P35ISF4
266	P35ISF6	P35ISF5
267	P36ISF2	
268	P37ISF1	
269	P37ISF2	P37ISF1
270	P37ISF3	P37ISF2
271	P37ISF4	P37ISF3
272	P37ISF5	P37ISF4
273	P37ISF6	P37ISF5
274	P37ISF7	P37ISF6
275	P37ISF8	P37ISF7
276	P37ISF9	P37ISF8
277	P37ISF10	P37ISF9
278	P37ISF11	P37ISF10
279	P38ISF8	
280	P39ISF2	P39ISF1
281	P39ISF2	P39ISF1
282	P39ISF3	P39ISF2
283	P39ISF3	P39ISF2
284	P39ISF4	P39ISF3
285	P39ISF5	P39ISF4

186	P22ISF21	P22ISF20	236	P31ISF3	P31ISF2	286	P39ISF6	P39ISF5
187	P22ISF21	P22ISF20	237	P31ISF4	P31ISF3	287	P39ISF7	P39ISF6
188	P22ISF21	P22ISF20	238	P32ISF1		288	P39ISF8	P39ISF7
189	P22ISF21	P22ISF20	239	P32ISF2		289	P39ISF9	P39ISF3
190	P22ISF22	P22ISF21	240	P32ISF		290	P39ISF10	P39ISF9
191	P22ISF22	P22ISF21	241	P32ISF		291	P39ISF11	P39ISF10
192	P22ISF23	P22ISF22	242	P33ISF1		292	P39ISF12	P39ISF3
193	P22ISF23	P22ISF22	243	P33ISF2	P33ISF1	293	P39ISF13	P39ISF12
194	P22ISF24	P22ISF23	244	P33ISF3	P33ISF2	294	P39ISF14	P39ISF13
195	P22ISF25	P22ISF24	245	P33ISF4	P33ISF3	295	P39ISF15	P39ISF13
196	P22ISF26	P22ISF25	246	P33ISF5	P33ISF4	296	P39ISF16	P39ISF14-15
197	P22ISF27	P22ISF26	247	P33ISF6	P33ISF5	297	P40ISF1	
198	P22ISF28	P22ISF21	248	P33ISF7	P33ISF6	298	P40ISF2	
199	P22ISF28	P22ISF21	249	P33ISF8	P33ISF7	299	P40ISF3	P40ISF1-2
200	P22ISF28	P22ISF21	250	P33ISF9	P33ISF8	300	P40ISF4	P40ISF1-2-3

#	Code	Predecessor
301	P40ISF5	P40ISF1-2-3
302	P40ISF6	P40ISF1-2-3-4-5
303	P40ISF7	P40ISF6
304	P40ISF8	P40ISF7
305	P40ISF9	P40ISF7-8
306	P40ISF10	P40ISF7-8
307	P40ISF11	P40ISF1-2-3-4-5-6-7-8-9-10
308	P41ISF1	P41ISF0
309	P41ISF2	P41ISF0
310	P41ISF3	
311	P41ISF4	
312	P41ISF5	P41ISF0
313	P41ISF6	
314	P42ISF1	P42ISF0
315	P42ISF2	P42ISF1
316	P42ISF2	P42ISF1
317	P42ISF3	P42ISF2
318	P42ISF4	P42ISF3
319	P42ISF4	P42ISF3
320	P42ISF5	P42ISF2-4
321	P42ISF6	P42ISF5
322	P42ISF7	P42ISF6
323	P42ISF8	P42ISF6-7
324	P43ISF9	
325	P43ISF10	
326	P43ISF10	
327	P43ISF11	
328	P43ISF11	
329	P44ISF1	P44ISF0
330	P44ISF2	P44ISF0
331	P44ISF3	P44ISF0
332	P44ISF4	P44ISF1,2,3
333	P44ISF5	P44ISF4
334	P44ISF6	P44ISF5
335	P45ISF1	P45ISF0

#	Code	Predecessor
351	P47ISF1	P47ISF0
352	P47ISF1	P47ISF0
353	P47ISF2	P47ISF1
354	P47ISF2	P47ISF1
355	P47ISF3	P47ISF1
356	P47ISF4	P47ISF1
357	P48ISF1	
358	P49ISF1	P49ISF0
359	P50ISF1	
360	P50ISF2	P50ISF1
361	P50ISF3	
362	P50ISF4	
363	P50ISF5	P50ISF2-3
364	P50ISF6	P50ISF5
365	P50ISF7	P50ISF6
366	P50ISF8	P50ISF6
367	P50ISF9	P50ISF6
368	P50ISF10	P50ISF7
369	P50ISF11	P50ISF8
370	P50ISFOT	
371	P50ISFOT	
372	P50ISFOT	
373	P50ISFOT	
374	P50ISFOT	
375	P50ISFOT	
376	P51ISF6	P51ISF5
377	P52ISF1	P52ISF0
378	P52ISF2	P52ISF0
379	P53ISF1	P53ISF0
380	P53ISF2	P53ISF1
381	P53ISF3	P53ISF2
382	P53ISF4	P53ISF3
383	P53ISF5	P53ISF0
384	P54ISF1	P54ISF0
385	P54ISF2	P54ISF0

#	Code	Predecessor
401	P55ISFOT	
402	P56ISF1	P56ISF0
403	P56ISF2	P56ISF1
404	P56ISF3	P56ISF2
405	P56ISF4	P56ISF3
406	P57ISF1	P57ISF0
407	P57ISF2	P57ISF1
408	P57ISF3	P57ISF2
409	P58ISF1	P58ISF0
410	P58ISF2	P58ISF0
411	P58ISF3	P58ISF0
412	P58ISF4	P58ISF0
413	P58ISF5	P58ISF0
414	P58ISF6	P58ISF0
415	P58ISF7	P58ISF0
416	P58ISF8	P58ISF0
417	P58ISF9	P58ISF0
418	P59ISF1	
419	P60ISF1	
420	P60ISF2	
421	P60ISF3	
422	P60ISF4	
423	P60ISF5	P60ISF1
424	P60ISF6	
425	P60ISF7	
426	P60ISF8	
427	P60ISF9	
428	P60ISF10	
429	P60ISF11	
430	P60ISF11	
431	P60ISF12	
432	P60ISF12	
433	P60ISF13	
434	P60ISF13	
435	P60ISF14	

336	P45ISF2	P45ISF1
337	P45ISF3	P45ISF2
338	P45ISF4	P45ISF3
339	P46ISF1	
340	P46ISF2	P46ISF1
341	P46ISF3	P46ISF2
342	P46ISF4	P46ISF3
343	P46ISF5	P46ISF4
344	P46ISF6	P46ISF5
345	P46ISF7	
346	P46ISF8	P46ISF7
347	P46ISF9	P46ISF8
348	P46ISF10	P46ISF9
349	P46ISF11	P46ISF10
350	P46ISF12	P46ISF11

386	P54ISF3	
387	P54ISF4	
388	P54ISF5	
389	P55ISF1	P55ISF0
390	P55ISF2	P55ISF1
391	P55ISF3	P55ISF0
392	P55ISF4	P55ISF3
393	P55ISF5	P55ISF2,4
394	P55ISF5	P55ISF2,4
395	P55ISF6	P55ISF2,4,5
396	P55ISF7	P55ISF0
397	P55ISF8	P55ISF7
398	P55ISF9	P55ISF0
399	P55ISF10	P55ISF8,9
400	P55ISF11	P55ISF0

436	P60ISF15	
437	P60ISF15	P60ISF1
438	P60ISF16	
439	P60ISF18	
440	P60ISF19	
441	P60ISF20	
442	P60ISF21	
443	P60ISF22	
444	P60ISF23	
445	P60ISF23	
446	P60ISF24	
447	P60ISF25	
448	P60ISF26	
449	P60ISF27	
450	P60ISF27	

#	Code	Predecessor
451	P60ISF28	
452	P60ISF29	
453	P60ISF30	
454	P60ISF31	
455	P60ISF31	
456	P60ISF32	
457	P60ISF	
458	P61ISF1	
459	P61ISF2	
460	P61ISF3	
461	P61ISF4	
462	P62ISF1	
463	P62ISF2	
464	P62ISF3	
465	P62ISF4	
466	P63ISF1	P63ISF0
467	P63ISF2	P63ISF1
468	P63ISF3	P63ISF2
469	P63ISF4	P63ISF3
470	P63ISF5	P63ISF4
471	P63ISF6	P63ISF5
472	P63ISF7	P63ISF6
473	P63ISF8	P63ISF0
474	P63ISF9	P63ISF8
475	P63ISF10	P63ISF7,9
476	P63ISF11	P63ISF10
477	P63ISF12	P63ISF11
478	P63ISF13	P63ISF11
479	P63ISF14	P63ISF12
480	P63ISF15	P63ISF12
481	P63ISF16	P63ISF15
482	P63ISFOT	
483	P63ISFOT	
484	P64ISF1	
485	P64ISF2	
486	P64ISF3	
487	P64ISF4	
488	P64ISF5	
489	P64ISF6	
490	P64ISF7	
491	P64ISF8	
492	P64ISF9	
493	P64ISF10	
494	P64ISF11	
495	P64ISF12	
496	P64ISF13	
497	P65ISF1	
498	P65ISF2	
499	P65ISF3	
500	P65ISF4	

Qualifications of Workers

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		HASAN ÖZDEMİR	MEHMET DEMİREL	ALAATTİN CİNGÖZ	UĞUR SARIYARLIOĞLU	MUSTAFA ÖZ	ŞENOL YILMAZ	AYHAN ÜNAL	AHMET METİN	YASİN ÖZÖNAL	CAFER ÇİÇEK	YAKUP YILMAZ	SEDAT BAYRAM	HÜSEYİN OZAN	A. SITKI YILDIRIM	HAYDAR GÜLTEKİN	HASAN KOÇ	CAHİT ERDEN	BAYRAM ARSLAN	M.SEDAT KEMİKSİZ	NURULLAH YAVUZ	HASAN TÜRK	AHMET DEMİRCİ	ERTUĞRUL YALINKILIÇ	MUSTAFA DEDEOĞLU	MİKAİL TARLABÖLEN	AHMET İNCEKARA	RECEP ÖZMEN	SATILMIŞ KARABİBER	HARUN CAN	MURAT KOÇAK	BAHRİ ÖNAL	SADULLAH TÜRKEN	MEHMET MERT	NAİL BABAOĞLAN	MUSTAFA ÇELEBİ	MUHARREM ADIGÜZEL
1	P1ISF1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	P1ISF2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	P1ISF3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	P2ISF1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	P2ISF2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	P2ISF3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	P2ISF4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	P2ISF5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	P2ISF6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	P3ISF1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	P3ISF2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	P4ISF1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	P4ISF2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	P5ISF1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	P5ISF2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	P6ISF1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	P6ISF2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	P6ISF3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	P7ISF1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	P7ISF2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	P7ISF3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	P7ISF4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	P7ISF5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	P7ISF6	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	P7ISF7	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	P7ISF8	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	P7ISF9	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	P7ISF10	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	P7ISF11	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	P7ISF12	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
31	P7ISF13	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	P7ISF14	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	P7ISF15	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	P7ISF16	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	P7ISF17	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	P7ISF18	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	P8ISF1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	P8ISF2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	P8ISF3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	P9ISF1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	P9ISF2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	P10ISF1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	P10ISF2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	P11ISF1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	P11ISF2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	P11ISF3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	P11ISF4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	P11ISF5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	P11ISF6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	P11ISF7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	P11ISF8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	P11ISF9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	P11ISF10	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	P11ISF11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	P11ISF12	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	P12ISF1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	P12ISF2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	P12ISF3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	P13ISF1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	P13ISF2	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	P13ISF3	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	P13ISF4	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	P14ISF1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	P14ISF2	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	P14ISF3	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	P14ISF4	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	P14ISF5	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	P14ISF6	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	P14ISF7	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	P14ISF8	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
71	P14ISF9	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	P14ISF10	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	P14ISF11	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	P14ISF12	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	P14ISF19	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	P14ISF20	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	P14ISF21	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	P14ISF22	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	P14ISF23	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	P14ISF24	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	P14ISF24	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	P14ISF25	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	P14ISF25	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	P14ISF26	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	P14ISF27	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	P14ISF28	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	P14ISF29	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	P14ISF	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	P15ISF2	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	P15ISF3	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91	P15ISF4	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	P15ISF5	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	P15ISF13	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	P15ISF14	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	P15ISF15	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	P15ISF16	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	P15ISF17	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	P15ISF18	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	P15ISF23	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	P15ISF26	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	P15ISF27	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102	P15ISF28	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103	P15ISF30	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	P15ISF31	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	P16ISF1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106	P17ISF1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107	P17ISF2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108	P18ISF1	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109	P18ISF2	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	P18ISF3	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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111	P18ISF4	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112	P18ISF5	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113	P18ISF6	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114	P19ISF1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	P19ISF2	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	P19ISF3	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117	P19ISF4	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118	P19ISF5	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119	P19ISF6	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	P20ISF1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	P21ISF1	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122	P21ISF1	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
123	P21ISF2	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
124	P21ISF2	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	P21ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	P21ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127	P21ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128	P21ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129	P21ISF5	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	P21ISF5	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	P21ISF7	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132	P21ISF7	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133	P21ISF8	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134	P21ISF9	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135	P21ISF10	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	P21ISF10	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137	P21ISF11	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138	P21ISF11	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139	P21ISF12	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	P21ISF12	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	P21ISF13	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142	P21ISF13	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
143	P22ISF1	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	P22ISF1	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	P22ISF2	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	P22ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147	P22ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148	P22ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149	P22ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	P22ISF3	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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151	P22ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152	P22ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153	P22ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154	P22ISF4	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	P22ISF5	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	P22ISF6	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157	P22ISF6	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158	P22ISF6	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159	P22ISF6	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	P22ISF7	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	P22ISF7	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162	P22ISF7	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163	P22ISF8	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164	P22ISF8	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	P22ISF9	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	P22ISF9	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167	P22ISF9	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	P22ISF10	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169	P22ISF10	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	P22ISF11	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	P22ISF12	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172	P22ISF13	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173	P22ISF14	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174	P22ISF15	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	P22ISF16	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	P22ISF17	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
177	P22ISF18	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
178	P22ISF18	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	P22ISF18	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	P22ISF19	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	P22ISF20	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
182	P22ISF20	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
183	P22ISF20	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
184	P22ISF20	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185	P22ISF20	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	P22ISF21	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
187	P22ISF21	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
188	P22ISF21	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
189	P22ISF21	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	P22ISF22	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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191	P22ISF22	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192	P22ISF23	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
193	P22ISF23	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
194	P22ISF24	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	P22ISF25	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	P22ISF26	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
197	P22ISF27	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198	P22ISF28	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199	P22ISF28	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	P22ISF28	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	P22ISF29	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	P22ISF30	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
203	P22ISF30	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
204	P22ISF31	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	P22ISF33	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	P22ISF34	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
207	P22ISF35	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
208	P22ISF36	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
209	P22ISF37	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	P22ISF38	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211	P22ISF39	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212	P22ISF40	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
213	P22ISF41	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
214	P22ISF	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	P23ISF1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
216	P23ISF2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
217	P24ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
218	P25ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
219	P25ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	P25ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221	P25ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
222	P25ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
223	P26ISF1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224	P26ISF2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225	P27ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
226	P27ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
227	P27ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
228	P28ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
229	P29ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	P29ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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231	P30ISF1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
232	P30ISF2	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
233	P30ISF3	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
234	P30ISF4	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
235	P31ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
236	P31ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
237	P31ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
238	P32ISF1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
239	P32ISF2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	P32ISF	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
241	P32ISF	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
242	P33ISF1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
243	P33ISF2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
244	P33ISF3	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	P33ISF4	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
246	P33ISF5	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
247	P33ISF6	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
248	P33ISF7	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
249	P33ISF8	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	P33ISF9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
251	P33ISF-2.5	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
252	P34ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
253	P34ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
254	P34ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
255	P34ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
256	P34ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
257	P34ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
258	P34ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
259	P34ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
260	P34ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
261	P34ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
262	P34ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
263	P34ISF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
264	P35ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
265	P35ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
266	P35ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
267	P36ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
268	P37ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
269	P37ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
270	P37ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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271	P37ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
272	P37ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
273	P37ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
274	P37ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275	P37ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	P37ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
277	P37ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
278	P37ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
279	P38ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	P39ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
281	P39ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
282	P39ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
283	P39ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
284	P39ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
285	P39ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
286	P39ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
287	P39ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
288	P39ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
289	P39ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
290	P39ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
291	P39ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
292	P39ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
293	P39ISF13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
294	P39ISF14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
295	P39ISF15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
296	P39ISF16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
297	P40ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
298	P40ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
299	P40ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
300	P40ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
301	P40ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
302	P40ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
303	P40ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
304	P40ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
305	P40ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
306	P40ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
307	P40ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
308	P41ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
309	P41ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
310	P41ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0

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311	P41ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
312	P41ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
313	P41ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
314	P42ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
315	P42ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
316	P42ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
317	P42ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
318	P42ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
319	P42ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
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321	P42ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
322	P42ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
323	P42ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
324	P43ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
325	P43ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
326	P43ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
327	P43ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
328	P43ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
329	P44ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
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332	P44ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
333	P44ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
334	P44ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
335	P45ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
336	P45ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
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342	P46ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
343	P46ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
344	P46ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
345	P46ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
346	P46ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
347	P46ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
348	P46ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
349	P46ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
350	P46ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0

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351	P47ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
352	P47ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
353	P47ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
354	P47ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
355	P47ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
356	P47ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0
357	P48ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
358	P49ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
359	P50ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
360	P50ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
361	P50ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
362	P50ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
363	P50ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
364	P50ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
365	P50ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
366	P50ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
367	P50ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
368	P50ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
369	P50ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
370	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
371	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
372	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
373	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
374	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
375	P50ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
376	P51ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
377	P52ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
378	P52ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
379	P53ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
380	P53ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
381	P53ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
382	P53ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
383	P53ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
384	P54ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
385	P54ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
386	P54ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
387	P54ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
388	P54ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
389	P55ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
390	P55ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

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391	P55ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
392	P55ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
393	P55ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
394	P55ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
395	P55ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
396	P55ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
397	P55ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
398	P55ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
399	P55ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
400	P55ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
401	P55ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
402	P56ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
403	P56ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
404	P56ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
405	P56ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
406	P57ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
407	P57ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
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413	P58ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
414	P58ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
415	P58ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
416	P58ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
417	P58ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
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427	P60ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
428	P60ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
429	P60ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
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431	P60ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
432	P60ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
433	P60ISF13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
434	P60ISF13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
435	P60ISF14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
436	P60ISF15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
437	P60ISF15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
438	P60ISF16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
439	P60ISF18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
440	P60ISF19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
441	P60ISF20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
442	P60ISF21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
443	P60ISF22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
444	P60ISF23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
445	P60ISF23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
446	P60ISF24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
447	P60ISF25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
448	P60ISF26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
449	P60ISF27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
450	P60ISF27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
451	P60ISF28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
452	P60ISF29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
453	P60ISF30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
454	P60ISF31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
455	P60ISF31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
456	P60ISF32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
457	P60ISF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
458	P61ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
459	P61ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
460	P61ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
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470	P63ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

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471	P63ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
472	P63ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
473	P63ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
474	P63ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
475	P63ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
476	P63ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
477	P63ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
478	P63ISF13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
479	P63ISF14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
480	P63ISF15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
481	P63ISF16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
482	P63ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
483	P63ISFOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
484	P64ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
485	P64ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
486	P64ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
487	P64ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
488	P64ISF5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
489	P64ISF6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
490	P64ISF7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
491	P64ISF8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
492	P64ISF9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
493	P64ISF10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
494	P64ISF11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
495	P64ISF12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
496	P64ISF13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
497	P65ISF1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
498	P65ISF2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
499	P65ISF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
500	P65ISF4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Worker Requirements of Tasks

#	Code	Req.
1	P1ISF1	2
2	P1ISF2	1
3	P1ISF3	1
4	P2ISF1	1
5	P2ISF2	1
6	P2ISF3	1
7	P2ISF4	2
8	P2ISF5	1
9	P2ISF6	2
10	P3ISF1	1
11	P3ISF2	1
12	P4ISF1	1
13	P4ISF	1
14	P5ISF1	1
15	P5ISF2	1
16	P6ISF1	1
17	P6ISF2	1
18	P6ISF3	1
19	P7ISF1	1
20	P7ISF2	1
21	P7ISF3	1
22	P7ISF4	1
23	P7ISF5	1
24	P7ISF6	1
25	P7ISF7	1
26	P7ISF8	1
27	P7ISF9	1
28	P7ISF10	1
29	P7ISF11	1
30	P7ISF12	1
31	P7ISF13	1
32	P7ISF14	1
33	P7ISF15	1
34	P7ISF16	1
35	P7ISF17	1
36	P7ISF18	1
37	P8ISF1	1
38	P8ISF2	1
39	P8ISF3	1
40	P9ISF1	1
41	P9ISF2	1
42	P10ISF1	1
43	P10ISF2	1
44	P11ISF1	1
45	P11ISF2	1
46	P11ISF3	1
47	P11ISF4	2
48	P11ISF5	1
49	P11ISF6	1
50	P11ISF7	1

#	Code	Req.
51	P11ISF8	1
52	P11ISF9	1
53	P11ISF10	2
54	P11ISF11	1
55	P11ISF12	1
56	P12ISF1	1
57	P12ISF2	1
58	P12ISF3	1
59	P13ISF1	1
60	P13ISF2	1
61	P13ISF3	1
62	P13ISF4	2
63	P14ISF1	2
64	P14ISF2	1
65	P14ISF3	1
66	P14ISF4	1
67	P14ISF5	1
68	P14ISF6	1
69	P14ISF7	1
70	P14ISF8	1
71	P14ISF9	1
72	P14ISF10	1
73	P14ISF11	1
74	P14ISF12	1
75	P14ISF19	1
76	P14ISF20	1
77	P14ISF21	2
78	P14ISF22	1
79	P14ISF23	1
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84	P14ISF26	1
85	P14ISF27	1
86	P14ISF28	1
87	P14ISF29	1
88	P14ISF	1
89	P15ISF2	2
90	P15ISF3	1
91	P15ISF4	1
92	P15ISF5	1
93	P15ISF13	1
94	P15ISF14	1
95	P15ISF15	1
96	P15ISF16	1
97	P15ISF17	1
98	P15ISF18	1
99	P15ISF23	1
100	P15ISF26	1

#	Code	Req.
101	P15ISF27	1
102	P15ISF28	1
103	P15ISF30	1
104	P15ISF31	1
105	P16ISF1	1
106	P17ISF1	1
107	P17ISF2	1
108	P18ISF1	1
109	P18ISF2	1
110	P18ISF3	1
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112	P18ISF5	1
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117	P19ISF4	1
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142	P21ISF13	1
143	P22ISF1	1
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147	P22ISF3	1
148	P22ISF3	1
149	P22ISF3	1
150	P22ISF3	1

#	Code	Req.
151	P22ISF4	1
152	P22ISF4	1
153	P22ISF4	1
154	P22ISF4	1
155	P22ISF5	1
156	P22ISF6	1
157	P22ISF6	1
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159	P22ISF6	1
160	P22ISF7	1
161	P22ISF7	1
162	P22ISF7	1
163	P22ISF8	1
164	P22ISF8	1
165	P22ISF9	1
166	P22ISF9	1
167	P22ISF9	1
168	P22ISF10	1
169	P22ISF10	1
170	P22ISF11	1
171	P22ISF12	1
172	P22ISF13	1
173	P22ISF14	1
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179	P22ISF18	1
180	P22ISF19	1
181	P22ISF20	1
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185	P22ISF20	1
186	P22ISF21	1
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191	P22ISF22	1
192	P22ISF23	1
193	P22ISF23	1
194	P22ISF24	1
195	P22ISF25	1
196	P22ISF26	1
197	P22ISF27	1
198	P22ISF28	1
199	P22ISF28	1
200	P22ISF28	1

#	Code	Req.
201	P22ISF29	1
202	P22ISF30	1
203	P22ISF30	1
204	P22ISF31	1
205	P22ISF33	1
206	P22ISF34	1
207	P22ISF35	1
208	P22ISF36	1
209	P22ISF37	1
210	P22ISF38	1
211	P22ISF39	1
212	P22ISF40	1
213	P22ISF41	2
214	P22ISF	1
215	P23ISF1	1
216	P23ISF2	1
217	P24ISF1	1
218	P25ISF1	1
219	P25ISF2	1
220	P25ISF3	1
221	P25ISF4	2
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223	P26ISF1	1
224	P26ISF2	1
225	P27ISF1	1
226	P27ISF2	1
227	P27ISF3	1
228	P28ISF1	1
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231	P30ISF1	1
232	P30ISF2	1
233	P30ISF3	1
234	P30ISF4	1
235	P31ISF2	1
236	P31ISF3	1
237	P31ISF4	1
238	P32ISF1	1
239	P32ISF2	1
240	P32ISF	1
241	P32ISF	1
242	P33ISF1	1
243	P33ISF2	1
244	P33ISF3	1
245	P33ISF4	1
246	P33ISF5	1
247	P33ISF6	1
248	P33ISF7	1
249	P33ISF8	1
250	P33ISF9	1

#	Code	Req.
251	P33ISF-2.5	1
252	P34ISF1	2
253	P34ISF2	1
254	P34ISF3	1
255	P34ISF4	1
256	P34ISF5	1
257	P34ISF6	1
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259	P34ISF8	1
260	P34ISF9	1
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262	P34ISF11	1
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267	P36ISF2	1
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269	P37ISF2	1
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271	P37ISF4	1
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274	P37ISF7	1
275	P37ISF8	1
276	P37ISF9	1
277	P37ISF10	1
278	P37ISF11	1
279	P38ISF8	1
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285	P39ISF5	1
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289	P39ISF9	1
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291	P39ISF11	1
292	P39ISF12	1
293	P39ISF13	1
294	P39ISF14	1
295	P39ISF15	1
296	P39ISF16	1
297	P40ISF1	1
298	P40ISF2	1
299	P40ISF3	1
300	P40ISF4	1

#	Code	Req.
301	P40ISF5	1
302	P40ISF6	1
303	P40ISF7	1
304	P40ISF8	1
305	P40ISF9	1
306	P40ISF10	1
307	P40ISF11	1
308	P41ISF1	1
309	P41ISF2	1
310	P41ISF3	1
311	P41ISF4	2
312	P41ISF5	1
313	P41ISF6	1
314	P42ISF1	1
315	P42ISF2	1
316	P42ISF2	1
317	P42ISF3	1
318	P42ISF4	1
319	P42ISF4	1
320	P42ISF5	1
321	P42ISF6	1
322	P42ISF7	1
323	P42ISF8	1
324	P43ISF9	1
325	P43ISF10	1
326	P43ISF10	1
327	P43ISF11	1
328	P43ISF11	1
329	P44ISF1	1
330	P44ISF2	1
331	P44ISF3	1
332	P44ISF4	1
333	P44ISF5	1
334	P44ISF6	2
335	P45ISF1	1
336	P45ISF2	1
337	P45ISF3	1
338	P45ISF4	1
339	P46ISF1	1
340	P46ISF2	1
341	P46ISF3	1
342	P46ISF4	2
343	P46ISF5	1
344	P46ISF6	1
345	P46ISF7	1
346	P46ISF8	1
347	P46ISF9	1
348	P46ISF10	1
349	P46ISF11	1
350	P46ISF12	1

#	Code	Req.
351	P47ISF1	1
352	P47ISF1	1
353	P47ISF2	1
354	P47ISF2	1
355	P47ISF3	1
356	P47ISF4	1
357	P48ISF1	1
358	P49ISF1	1
359	P50ISF1	2
360	P50ISF2	1
361	P50ISF3	1
362	P50ISF4	1
363	P50ISF5	1
364	P50ISF6	1
365	P50ISF7	1
366	P50ISF8	1
367	P50ISF9	1
368	P50ISF10	1
369	P50ISF11	1
370	P50ISFOT	1
371	P50ISFOT	1
372	P50ISFOT	1
373	P50ISFOT	1
374	P50ISFOT	1
375	P50ISFOT	1
376	P51ISF6	1
377	P52ISF1	1
378	P52ISF2	1
379	P53ISF1	1
380	P53ISF2	1
381	P53ISF3	1
382	P53ISF4	1
383	P53ISF5	1
384	P54ISF1	1
385	P54ISF2	1
386	P54ISF3	1
387	P54ISF4	1
388	P54ISF5	1
389	P55ISF1	1
390	P55ISF2	1
391	P55ISF3	1
392	P55ISF4	1
393	P55ISF5	1
394	P55ISF5	1
395	P55ISF6	1
396	P55ISF7	1
397	P55ISF8	1
398	P55ISF9	1
399	P55ISF10	1
400	P55ISF11	1

#	Code	Req.	#	Code	Req.
401	P55ISFOT	1	451	P60ISF28	1
402	P56ISF1	1	452	P60ISF29	1
403	P56ISF2	1	453	P60ISF30	1
404	P56ISF3	1	454	P60ISF31	1
405	P56ISF4	1	455	P60ISF31	1
406	P57ISF1	1	456	P60ISF32	1
407	P57ISF2	1	457	P60ISF	2
408	P57ISF3	1	458	P61ISF1	1
409	P58ISF1	1	459	P61ISF2	1
410	P58ISF2	1	460	P61ISF3	1
411	P58ISF3	1	461	P61ISF4	1
412	P58ISF4	1	462	P62ISF1	1
413	P58ISF5	1	463	P62ISF2	1
414	P58ISF6	2	464	P62ISF3	1
415	P58ISF7	1	465	P62ISF4	1
416	P58ISF8	1	466	P63ISF1	1
417	P58ISF9	1	467	P63ISF2	1
418	P59ISF1	1	468	P63ISF3	2
419	P60ISF1	1	469	P63ISF4	1
420	P60ISF2	1	470	P63ISF5	1
421	P60ISF3	1	471	P63ISF6	1
422	P60ISF4	1	472	P63ISF7	1
423	P60ISF5	1	473	P63ISF8	1
424	P60ISF6	1	474	P63ISF9	1
425	P60ISF7	1	475	P63ISF10	1
426	P60ISF8	1	476	P63ISF11	1
427	P60ISF9	1	477	P63ISF12	1
428	P60ISF10	1	478	P63ISF13	1
429	P60ISF11	1	479	P63ISF14	1
430	P60ISF11	1	480	P63ISF15	1
431	P60ISF12	1	481	P63ISF16	1
432	P60ISF12	1	482	P63ISFOT	1
433	P60ISF13	1	483	P63ISFOT	1
434	P60ISF13	1	484	P64ISF1	1
435	P60ISF14	1	485	P64ISF2	1
436	P60ISF15	1	486	P64ISF3	1
437	P60ISF15	1	487	P64ISF4	1
438	P60ISF16	1	488	P64ISF5	1
439	P60ISF18	1	489	P64ISF6	1
440	P60ISF19	1	490	P64ISF7	1
441	P60ISF20	1	491	P64ISF8	1
442	P60ISF21	1	492	P64ISF9	1
443	P60ISF22	1	493	P64ISF10	1
444	P60ISF23	1	494	P64ISF11	1
445	P60ISF23	1	495	P64ISF12	1
446	P60ISF24	1	496	P64ISF13	1
447	P60ISF25	1	497	P65ISF1	1
448	P60ISF26	1	498	P65ISF2	1
449	P60ISF27	1	499	P65ISF3	1
450	P60ISF27	1	500	P65ISF4	1

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BS	Çankaya University/Industrial Engineering	2009
High School	Zonguldak Atatürk Anadolu High School	2004

WORK EXPERIENCE

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2007 July	MKE Gazi Fişek Fabrikası	Intern Engineering Student

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

1. Karabak F., Güner N.D., Satır B., Kandiller L. and Gürsoy İ. “An Optimization Model for Worker Assignment of a Mixed Model Vehicle Production Assembly Line Under Worker Mobility”, Proceedings of the 41st International Conference on Computers & Industrial Engineering, 483-490, 2011.