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PLANNING AND PROGRAMMING COMMITTEE
March 18, 2009

SUBJECT: DIESEL MULTIPLE UNIT (DMU) TECHNICAL FEASIBILITY ANALYSIS

ACTION: RECEIVE AND FILE

RECOMMENDATION

Receive and file the final report for the Diesel Multiple Unit (DMU) Technical Feasibility Analysis including an assessment of clean fuel alternatives. Attachment A contains the study's assumptions and methodology and Attachment B contains the Report's Executive Summary. The full Report is available upon request.

ISSUE

At its June 29, 2006 meeting, the Board approved a motion authorizing the initiation of a feasibility analysis of the use of DMU technology (a self-propelled rail car for commuter rail or intercity rail service) on existing rail rights-of-way we own. At its November 29, 2007 meeting, the Board awarded a contract to LTK Engineering Services to conduct the analysis and directed that the Chief Executive Officer include a clean fuel alternative to the feasibility analysis. The analysis has been completed and it is now time for the Board to receive the findings.

BACKGROUND

The purpose of the feasibility analysis was to identify the opportunities and constraints associated with utilizing DMU technology as a component of our rail system on rights-of-way we own in Los Angeles County. Since DMU technology is best suited for commuter or intercity rail service, the study focused on three Metro-owned rail corridors which currently have commuter rail service operated by Metrolink. These corridors are the Ventura County Line, Antelope Valley Line and San Bernardino Line. The Orange County and Riverside Lines, although operating partially within Los Angeles County, were not studied because the rights-of-way are owned by others. Operational, technological, regulatory and infrastructural issues and requirements were examined including:

- Vehicle availability
- Vehicle performance
- Fuel options including clean fuel alternatives, fuel efficiency, and emissions profiles
- Corridor operational capacity
- Fleet maintenance
- Community impacts
- Potential funding sources
- Overall implementation cost
- Likely system operator

We coordinated the feasibility assumptions and analysis with Metrolink. The results have been shared with Metrolink, who concur with the study's findings.

General Conclusions

Our analysis showed that a DMU train is more fuel efficient and emits less polluting emissions, and is cheaper to operate than Metrolink's existing locomotive-haul service. However, due to significant capital start-up costs, including the likely provision of a new Metrolink maintenance facility and new Federal Railroad Administration (FRA)-compliant vehicle development, it is not cost-effective or feasible to implement DMU service on existing Metrolink corridors at this time.

Currently, there are no manufacturers of FRA-compliant DMUs, although several carbuilders have expressed an interest in entering the market. The extensive start-up costs and a minimum 25 or so vehicle order needed, makes it difficult predict the availability of this product. Additionally, in order to meet a rail industry-imposed "12 axle" rule, the minimum length for a DMU train is a three-car consist that could result in unused excess capacity.

Industry and cost constraints limit the feasibility of DMU implementation on Metrolink corridors at this time. In the future, the technology promises to provide us a more evironmentally-efficient, cost-effective passenger service option once the U.S. DMU market is more developed. A comparison table between DMU and Metrolink is included in Attachment C.

Findings

Capacity to Accommodate Daily DMU Trains

By combining DMU overlay service with existing commuter rail service, it is technically possible to provide hourly commuter service on all three corridors; however, operational coordination including positive train control among other improvements would be critical to avoid conflicts with existing rail operations.

Required Infrastructure Improvements

Infrastructure improvements to the three corridors, including double tracking, sidings in various locations, and station modifications such as the addition of a second platform at three stations (Northridge, Van Nuys and Glendale Stations), are required in order to avoid impacting existing service. With the infrastructure improvements, 46 weekday DMU runs could be accommodated on the three corridors. These infrastructure improvements would also significantly improve existing baseline commuter service.

Community Impacts

Community impacts were measured by key destinations/significant features, noise or other sensitive adjacent land uses, station parking deficit and number of at-grade crossings. Based on these measures, the analysis showed that DMU service on the Ventura County Line would provide the greatest benefit and have the least impact to adjacent communities.

DMU Vehicle Trainsets

The DMU vehicle is a self-propelled rail car. This feature makes it an ideal technology to use as one or two car trains on low ridership routes or off-peak trips. However, Metrolink and the freight railroads have adopted a "12 axle" rule for all trains, to ensure reliable "shunting" (activation) of the track circuits for safer train detection on the system. As a result, the minimum consist for a DMU train is three cars. To provide 46 weekday DMU runs, a fleet of 30 vehicles (10 trainsets of three cars each with a total capacity of 2,300 seated riders) will be required.

Fleet Size and Ridership

Providing hourly service results in operating a total of 46 weekday trains on all three lines. The study estimated 60 riders per three-car train, equalling an average weekday ridership of 2,800 passengers. It is noted that a three-car DMU train can provide 230 seats, resulting in an excess capacity of 74%. A three-car locomotive-haul train, which provides 420 seats, results in an excess capacity of 86%. In either scenario, the 12 axle, three-car train requirement forces the utilization of two unneeded cars on each train.

Federal Railroad Administration (FRA)-Compliant Vehicles

The study corridors are subject to FRA rules and regulations. Currently, there are no manufacturers of FRA-compliant DMUs, although several carbuilders have expressed an interest in entering this market. Start-up costs for a new FRA-compliant DMU will be extensive, with design and tooling expenses likely being included in the new vehicle cost.

Propulsion Alternatives

"Clean diesel" (ultra low sulfur diesel (ULSD) used in combination with exhaust after-treatments) was determined to be the optimum fuel for the DMU fleet. This is the technology Metrolink is using in a trial in one of their diesel locomotives. Simulations indicated that the DMU train using ULSD would have the same kinematic performance as a locomotive-haul train also using ULSD, but be about 29% more fuel-efficient, and generate less harmful emissions. The other fuel alternatives examined are less energy, emissions and/or cost efficient, or are still in development stages. Electrical Multiple Unit technology (EMU) was analyzed, but the total capital cost to implement an EMU fleet was significantly

higher (by at least $102 million) than the clean diesel DMU, and thus not considered in further detail.

Environmental Friendliness
Assuming equivalent conditions, computer simulations of both a DMU train and a locomotive-hauled train (both using ULSD) indicated that the DMU train is more fuel efficient and generally has a preferred emissions profile. Fuel consumption was about 29% less, and, with the exception of carbon monoxide, the DMU train produced between 12% and 51% less polluting emissions.

Maintenance
Maintenance requirements for DMU vehicles are significantly different than those for locomotive-haul passenger vehicles. DMU vehicles are self-contained, and can run as single cars, whereas Metrolink's passenger vehicles rely on locomotives for power. Maintaining DMU vehicles will require either construction (including land acquisition) of a new maintenance facility, or modifications to Metrolink's Central Maintenance Facility (CMF) and to that agency's planned Eastern Maintenance Facility (EMF). It will be difficult to locate a new facility in an operationally strategic location, given the lack of large vacant industrial land in the greater Los Angeles area. Although minimal capacity exists to maintain 30 additional vehicles at the CMF/EMF, whether DMU or locomotive-haul, operational conflicts are likely to occur. Additionally, this would necessitate using the CMF for round-the-clock operations, potentially raising quality-of-life issues for the surrounding neighborhoods.

Cost
The study determined that Metrolink would be the most viable operator of the DMU overlay service. Based on this premise, Metrolink's costs and requirements were used as the basis for estimating operating costs. Metrolink's management has reviewed these estimates.

- Capital Cost
  The total capital cost to provide a DMU fleet with a new maintenance facility was estimated to be $330 million. Using the existing facilities of the CMF and the planned EMF, total capital cost was estimated to be $295 million. While initial estimates indicate that remodeling the existing maintenance facilities would be less expensive, it is likely that serious operational constraints related to operating and maintaining two diverse technology fleets in the same facility would need to be mitigated.

- Operating Cost
  The crew size and other agency costs would be the same for both DMU and Metrolink's existing service. DMU vehicles are about 29% more fuel efficient and are less expensive to maintain (self-contained vehicle, different rebuild cycles, etc.) than for locomotive-hauled trains. Total operating costs of a three-car DMU train would be $76.51 per train-mile, whereas the operating costs for a three-car Metrolink train are $80.75 per train-mile, resulting in a 5% operating cost savings using DMU service.

Potential Non-Traditional Funding Sources

Potential non-traditional public funding sources were researched for DMU implementation. The consultant concluded that at this time, the most lucrative source would be advertising (print media or video/digital media) and vehicle/station naming rights, and identified successful multi-million dollar contracts signed by other transit agencies. However, the stations to be served by the proposed DMU trains are Metrolink stations owned by the various cities in which they are located, not within our jurisdiction. Further, we have been as yet unsuccessful in generating interest in non-traditional advertising opportunities of any significant dollar value, with the exception of wallscapes and billboards.

Optional Operations

As options to DMU overlay service on all three corridors, we considered alternative strategies such as using Metrolink's locomotive-haul vehicles for the overlay service and/or introducing DMU service within only one corridor.

(1) Locomotive-haul overlay service:

While this option would require less capital investment, there are other aspects to consider:

- Metrolink would need to increase its spare capacity to provide the hourly service proposed in the Report;
- The infrastructure improvements would still need to be made; and
- Maintenance facility modifications and/or expansion would be required.

Assuming the same level of off-peak overlay service, the purchase of a like number of vehicles and similar maintenance requirements, we found that on a cost per-new-rider basis, it would be about 10% cheaper ($95,000 per rider versus $105,000 per rider, with the difference being attributed to vehicle costs) in capital costs to add more Metrolink midday service than to introduce a new commuter rail technology. However, as stated previously, it would be 5% cheaper to operate DMU trains than to operate Metrolink's locomotive-haul trains.

(2) Limited DMU overlay service:

The lower level of service necessary for only one line, or a portion of one line, would require fewer trains and thus justify purchasing many fewer DMU vehicles. Given the current state of the DMU vehicle market, purchasing a small order of DMUs (minimum three-car train) would be prohibitively expensive. It is estimated that the design and tooling costs prorated to each car would likely at least double the initial cost of the vehicle, from perhaps $5 million per car to $13 million. Adding the cost of infrastructure improvements and potential maintenance facility expansion makes the proposal cost-prohibitive.

Other Agency Interest

Both San Bernardino Associated Governments (SANBAG) and Riverside County Transportation Commission (RCTC) have investigated the potential use of DMU technology. SANBAG has identified DMU in their current Alternatives Analysis for passenger rail service on the proposed Redlands Corridor project. RCTC considered DMU technology for Metrolink's passenger service on the proposed Perris Valley Line, but has elected to proceed utilizing locomotive-haul equipment.

Denver, Colorado, is presently soliciting bids for both FRA-compliant DMUs and EMUs to run on four new corridors. This is sure to stimulate interest in the DMU market.

NEXT STEPS

The report will be formally transmitted to Metrolink for future consideration. We will continue to monitor the progress of DMU vehicle manufacturers and propulsion systems, the development of improved rail signal technologies and the FRA's design compliance regulations. Further, we will continue to consider DMU technology as part of the alternatives analyses in our corridor studies.

ATTACHMENT(S)

A. DMU Analysis Assumptions and Methodology
B. DMU Technical Feasibility Analysis Executive Summary
C. DMU and Metrolink Comparison Table

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Diesel Multiple Unit (DMU) Analysis Assumptions and Methodology

Study assumptions made for this analysis include:

- DMU service must not negatively impact existing rail operations, including Metrolink, Amtrak and freight lines
- Service to be at least hourly off-peak
- Service to be considered during peak hours only if no impact to existing commuter operations

Study methodology included analysis of the following subjects:

- Review of existing studies and existing operating agreements:
  Eight studies of varying relevance were reviewed. No legal prohibitions or conflicts were identified in existing agreements.
- Technical definition of three study corridors, and corridor operational capacity study:
  Computer models of the three lines were built to establish a baseline. Supplemental service, termed "DMU overlay service" opportunities were identified and infrastructure changes were modeled for optimum fleet utilization.
- Ridership forecast:
  Off-peak ridership was forecast by using Metrolink's Strategic Assessment Study peak-period ridership projections in a comparative analysis with San Francisco area's Caltrain off-peak ridership, which amounts to about 25% of their peak ridership.
- DMU market survey:
  FRA rule-compliant DMUs would be required, in order to share tracks with Metrolink's and the freight railroads' FRA-compliant vehicles. FRA non-compliant vehicles are widely available, but currently no compliant vehicles are manufactured.
- DMU propulsion investigation:
  A comparative analysis of DMU and locomotive-haul trains was undertaken, in part to measure fuel-efficiency and engine emissions. Alternative fuels were explored, including ultra-low sulfur diesel, biodiesel, ethanol, natural gas, hybrid drives and fuel cell technology, measuring energy efficiency against their likely ability to meet EPA emissions standards.
- DMU fleet maintenance plan:
  Two options for DMU maintenance were identified; a new shop facility or modifications of Metrolink's Central Maintenance Facility (CMF) used in combination with their planned Eastern Maintenance Facility (EMF).
- Community opportunities and constraints:
  Evaluation criteria were established to measure potential positive opportunities and negative constraints (impacts) within each corridor area.
- Cost Estimation:
  Three separate alternatives were costed:
  - DMU and new maintenance facility
  - DMU and use of CMF and EMF

- Electrical Multiple Units (EMU) and new maintenance facility

Vehicle assumption: 10 three-car trains necessary to provide hourly service due to Metrolink's and freight railroad's 12 axle requirement.

Maintenance shop assumption: New facility or use of CMF/EMF

Infrastructure improvements assumption: Seven improvements which would increase network capacity and permit better utilization of DMU fleet.

Diesel Multiple Unit (DMU)
Technical Feasibility Analysis

EXECUTIVE SUMMARY

Table of Contents

EXECUTIVE SUMMARY

Purpose of the DMU Technical Feasibility Study

The purpose of this study was to determine if Diesel Multiple Unit (DMU) trains (diesel, self-propelled railcars capable of coupling with other like cars to run as a single train) could be used to provide additional passenger rail service to Los Angeles County residents by either supplementing the existing Southern California Regional Rail Authority (SCRRA) Metrolink locomotive-haul peak hour service, and/or providing new off-peak service on the LA County, Metro-owned portion of three Metrolink corridors; viz., Ventura County, Antelope Valley and San Bernardino. We termed this "DMU overlay service". We examined the viability of this concept from a variety of perspectives, including:

- ☐ DMU vehicle availability
- ☐ DMU performance
- ☐ DMU fuel options, including clean fuel alternatives, fuel efficiency, and emissions profile
- ☐ Corridor operational capacity to accept DMU overlay service
- ☐ Corridor infrastructure improvements needed to support the overlay service
- ☐ DMU fleet maintenance requirements
- ☐ Community impacts
- ☐ Potential funding sources
- ☐ Overall implementation cost
- ☐ Cost effectiveness of the concept as compared to the addition of Metrolink locomotive-hauled rolling stock

A number of assumptions were made for conducting this study. These include the following:

- ☐ The "DMU overlay service" resultant from the study effort must not negatively impact any existing service (Metrolink, Amtrak, freight)
- ☐ The DMU service would be used to provide at least hourly off-peak service
- ☐ Supplemental DMU overlay service during peak hours would be considered *only* if there would be no impact to the existing commuter service
- ☐ Routes not terminating at Union Station could be considered

Study Methodology and Summary-Level Results

The approach to the work was designed to accommodate each of the above noted perspectives. Briefly, the study areas included the following:

Review of Existing Studies

Eight previous studies with varying relevance to the DMU technical feasibility analysis were reviewed. Information of value to the study, gleaned from these reports, included:

- ☐ There are several areas along the target alignments where signal and/or track improvements could significantly enhance operational capacity
- ☐ Union Station's capacity to accommodate additional service, especially during rush hours, could pose a problem.

- ☐ Certain costs were identified which were accommodated in our costing model
- ☐ Certain ridership forecasts were found to be relevant

Technical Definition of the Three Study Corridors

The scope of the DMU overlay analysis was limited to those portions of the three Metro-owned Metrolink corridors located within Los Angeles County. A technical definition of each corridor, from both an operations and infrastructure perspective, was necessary in order to build computer models of the network for both a diesel propulsion analysis and an operations simulation. To this end, we identified each corridor's infrastructure (distances, grades, curves, signal blocks, stations, etc.) and operations network (schedules of all Metrolink, Amtrak and freight traffic). These parameters were input to the various computer simulations we constructed.

One significant outcome of the technical definition task was the understanding that the freight operators and Metrolink have both adopted a "12 axle" rule for all trains; that is, there can be no trains with less than 12 axles permitted on the system. The reason for this is to ensure reliable "shunting" of the track circuits used to detect both block occupancy (signal system) and train proximity (grade crossing warning devices). The 12 axle rule affects the DMU overlay concept in a negative way: it necessitates that the minimum length for a DMU train is three cars (12 axles). This precludes the advantage of using the self-contained DMUs as one or two car trains on low ridership routes.

DMU Market Survey

The three study corridors are part of the "General Railway System of Transportation", and, as such, are subject to the Federal Railroad Administration (FRA) rules and regulations. The FRA has strict rules governing the design and construction of rail vehicles to be operated on the General Railway System. It was concluded that FRA rule-compliant ("compliant") DMUs are required for the intended service. If the alternative vehicle technology, non-compliant DMUs, were to be used, it would be necessary to physically separate these DMUs in time from the FRA compliant freight and passenger traffic. Given the high volume and around the clock use by both passenger and freight traffic on these corridors, this would be neither practical nor desired.

An important part of the DMU Technical Feasibility Analysis was to determine the availability of compliant DMUs in the marketplace. At the time the study commenced, there was only one manufacturer in the United States, Colorado Rail Manufacturing (CRM, formerly, Colorado Railcar). However, CRM has suffered financial losses, and ceased operations on December 31, 2008. We have identified several manufacturers including Bombardier, CAF, Nippon Sharyo, Rotem and Siemens, who may be interested in designing and manufacturing compliant DMUs, if the order size were to be large enough; say, more than 25 cars. (Enough to reduce the non-recurring or mobilization costs to less than $1 million per car.)

DMU Propulsion Investigation

One aspect of this study was to compare DMU and locomotive-haul trains from several technical perspectives, such as fuel-efficiency and engine emissions. In this regard, we conducted a comparative analysis (via computer simulation) of DMU and locomotive-haul operation over the same route, with conditions as similar as we could make them (one locomotive and three passenger cars vs. three DMU-type cars). Our simulations indicate that the equivalent DMU train using "clean diesel" would have the same kinematic performance as a

locomotive-haul train, but be about 29% more fuel-efficient, and generate less harmful emissions.

We also investigated the use of alternative fuels, including ultra-low sulfur diesel, biodiesel, ethanol, natural gas, hybrid drives and fuel cell technology for possible use in the DMU fleet. We contrasted the energy efficiency of these fuels against their likely ability to meet Tiers 3 and 4 emission standards of the EPA, one of which will be in effect depending on when the DMUs are ordered. Finally, we evaluated the concept of electrification and the use of Electrical Multiple Units (EMU). However, due to the extremely high infrastructure costs, including acquisition of additional right-of-way for the overhead infrastructure and required environmental clearances, that option was not further considered as an alternative.

The optimum approach was determined to be "clean diesel"; that is, ultra low sulfur diesel used in combination with exhaust after-treatments (filtration and catalytic conversion).

Review of Existing Operating Agreements

A review of all existing operating agreements was undertaken to ensure that there were no legal prohibitions to Metro operating a DMU commuter service on any of the target corridors within LA County. No conflicts were found.

Corridor Operational Capacity Study

Consistent with the purpose of this study, it was necessary to build a computer model of the network operations to establish a baseline and identify any operations "voids" where DMU service could be implemented. Rail Traffic Controller (RTC) was the software used for the simulation effort as this is the same software used by Metrolink for scheduling purposes. Following establishment (and verification) of a baseline model (which includes existing Metrolink, Amtrak and various freight train traffic), and the addition of DMU trains to the extent practical and useful, the model was run and examined to determine if any infrastructure changes could be made to enhance operational capacity and diminish the impact of the additional DMU service. The seven infrastructure changes listed below were then defined at a level of detail for which a rough order of magnitude (ROM) cost estimate could be generated. Finally, the changes were implemented in the model and the simulation re-run and refined to the point of optimum utilization of the DMU fleet. General results were as follows:

- ☐ Time slots were found for 46 daily DMU trains in the network. These include the following:
  - — 16 DMU trains between Los Angeles Union Station (LAUS) and Chatsworth
  - — 6 DMU trains between Burbank Bob Hope Airport and Chatsworth
  - — 16 DMU trains between LAUS and Via Princessa
  - — 8 DMU trains between LAUS and Claremont
- ☐ Seven infrastructure changes were identified and added to the model. These changes increased network capacity.
  - — Chatsworth Station layover track
  - — Second main track from Van Nuys to Chatsworth
  - — Second platform at Van Nuys Station
  - — Via Princessa Station layover track
  - — Second main track from Newhall to Saugus
  - — Second platform at Glendale Station
  - — Claremont Station layover

- After the infrastructure changes were added to the network model, it was determined that the addition of the 46 DMU trains not only reduced the impact to baseline service levels to very minimal disruption, but baseline performance for Metrolink and Amtrak actually improved in most areas.

DMU Fleet Maintenance Plan

DMUs are significantly different from locomotive-haul rolling stock. DMUs have the ability to run as single cars, and are thus self-contained. Locomotive-haul passenger vehicles rely on the locomotive for propulsion and "head-end power" to drive the auxiliary features, such as air conditioning. As a consequence, the life cycle maintenance requirements for a DMU differ from those requirements for either locomotives or passenger coaches. Nine trains, plus one spare, are required to provide 46 daily DMU train runs. Three-car trains would be used to comply with the 12 axle rule. Maintenance service capacity for 30 DMUs would need to be provided. In order to maintain a DMU fleet, two options were identified:

(1) A new shop facility; or

(2) Modification to the present Metrolink Central Maintenance Facility (CMF) used in combination with the planned Eastern Maintenance Facility (EMF)

Our study indicated that a new facility, capable of maintaining 30 DMUs, could be built for a ROM figure of $55 million, including real estate acquisition estimated at $20 million. Alternatively, the CMF could be modified to maintain DMUs, in combination with the EMF, for a ROM figure of $20 million (no additional real estate needed). Use of the CMF/EMF facilities for maintaining the DMU fleet could be problematic. Although the capacity for an additional 30 cars (marginally) exists, there are bound to be operational and maintenance conflicts which would not occur were a separate shop for DMU maintenance to be constructed. Additionally, using the CMF for DMU fleet maintenance would necessitate the need for round-the-clock operations, which could raise quality-of-life issues (noise, light and exhaust pollution) in the surrounding environs. A more in-depth industrial engineering study would be required before the appropriate maintenance alternative could be identified.

Community Opportunities and Constraints for Overlay DMU Service

The addition of a DMU overlay service to the existing rail network, which includes Metrolink, Amtrak and freight railroads, could have community impacts, both positive and negative. On the positive side, many alignment locations would welcome the transportation alternative provided by a DMU overlay service. On the negative side, the addition of DMU service could have some undesirable effects, such as increased traffic, noise, etc. Our study included identification of those geographic locations which could be impacted, positively or negatively, by the addition of DMU overlay service, and the rough number of affected locations in each corridor. In this regard, we took the following approach:

- For each of the candidate corridors, we examined a mile-wide "strip" along the alignment and considered this as a potential "impact zone"
- Each potential impact zone was divided into a number of segments. Each segment generally included two or three stations. The average segment is from five to ten miles in length, which would make each impact zone five to ten square miles in area.
- Those location types identified as possibly being affected by the DMU overlay service, either positively or negatively, include:

Positive impacts; opportunities for utilization of DMU overlay service:

- Commercial centers
- Cultural and historic centers
- Public assembly sites
- Transportation centers
- Communities and neighborhoods
- Planned major developments and/or planned land use changes

Negative impacts; facilities and location types which may require impact mitigation measures include:

- Medical facilities
- Parks and recreation areas
- Residential communities
- Schools

The segment rating system established for positive impacts was based upon the number of locations within each segment. The segment rating system established for negative impacts was based on the percentage of sensitive land use area within each segment. This ultimately resulted in the finding that, from the standpoint of community opportunities and constraints (least impacts and highest benefits), the Ventura County Line ranked highest for the implementation of a DMU overlay service.

Costing Methodology | Capital Costs

Three separate capital cost alternatives were evaluated:

(1) DMU | New maintenance facility
(2) DMU | CMF + EMF
(3) Electrical Multiple Unit (EMU) | New maintenance facility

The key costing elements which were used to develop estimates in 2008 dollars for the three alternatives are described below:

Vehicles

The cost to purchase a 20 car DMU fleet and a 10 car TMU (Trailer Multiple Unit) fleet. The TMU is similar to the DMU, but has no diesel power for either propulsion or auxiliaries. This fleet cost has been roughly identified as $150 million.

Maintenance Facility (Shop)

The cost to provide maintenance facilities for the above fleet was broken down into two options:

- ☐ A new facility to be used exclusively for the DMUs. This cost is approximately $35 million, not including ROM real estate costs of $20 million.
- ☐ Use of the existing CMF and EMF to maintain the fleet. This cost is approximately $20 million.

Infrastructure Improvements

The cost to implement seven specific corridor infrastructure changes which will increase network capacity and permit better utilization of the DMU fleet was determined to be $125 million.

EMU Fleet

Costs associated with an alternative EMU (Electrical Multiple Unit) fleet were assembled as well.

Fleet Purchase:	$103 million
Catenary & Substations:	$170 million
Shop:	$ 35 million

The total capital cost to provide an EMU fleet would be roughly $453 million, significantly more than the cost of a DMU overlay ($330 million). As a result, EMU service was not further considered as an alternative in this study.

A summary of the costs for each alternative is found in the following table:

Capital Construction and Engineering Costs

Cost Components (2008 Dollars)	Alternative 1 DMU | New MF	Alternative 2 DMU | CMF & EMF	Alternative 3 EMU | New MF
Vehicle Fleet (& catenary for EMU)	$150,000,000	$150,000,000	$273,000,000
Infrastructure Changes	$125,000,000	$125,000,000	$125,000,000
Maintenance Facility	$ 35,000,000	$ 20,000,000	$ 35,000,000
Land Acquisition	$ 20,000,000	--	20,000,000
TOTAL	**$330,000,000**	**$295,000,000**	**$453,000,000**

Costing Methodology | Operating Costs

Operating costs for a DMU overlay service were estimated on the basis of Metrolink's costs, and were compared to locomotive-haul costs on a per-mile basis. DMU operating costs were found to be approximately 5% lower than locomotive-haul costs. The per-mile operating costs have three components; viz., agency costs (operations, insurance, overhead, etc.), fuel, and maintenance.

Metrolink's costs for these components, in 2008 dollars, are as follows:

Agency costs:		$62.96 per train-mile
Fuel costs:		$8.57 per train-mile
Maintenance costs:		$9.22 per train-mile
	Total	$80.75 per train mile

Projected DMU costs for these components, in 2008 dollars, are as follows:

Agency costs:		$62.96 per train-mile
Fuel costs:		$6.17 per train-mile
Maintenance costs:		$7.38 per train-mile
	Total	$76.51 per train mile

It is noted that a DMU train can provide 230 seats. With ridership projected at 60 riders per train, this result in an excess capacity of 74%.

Potential Funding Approaches

The scope of this sub-task was to look for funding opportunities outside of the traditional sources used by Metro for the DMU overlay fleet. The most lucrative revenue source from the DMU overlay service could be advertising (print media or video/digital media) and vehicle/station naming rights, which in some circumstances might potentially generate $1 million in revenues.

However, Metrolink's stations are owned by the cities within which the stations are located, and any advertising opportunities would need to be negotiated with the station owners.

Summary of Major Findings

Major study findings included the following:

- ☐ The 12 axle rule necessitates that a minimum of three DMUs be included on each train, even though in many time slots, it would be more cost effective to operate only 1 or 2 car trains.
- ☐ With the seven major infrastructure improvements noted in the study, the three corridors have the capacity to accommodate 46 additional daily DMU trains. These infrastructure improvements also improved baseline Metrolink performance.
- ☐ FRA-compliant DMUs will be required.
- ☐ A three-car DMU train is more fuel-efficient and has a (generally) more environmentally friendly emissions profile than a three-car locomotive-haul train.
- ☐ "Clean diesel" is the optimum fuel choice for a DMU.
- ☐ The Ventura County Line would experience the least impacts and gain the highest positive benefits from a DMU overlay service.
- ☐ A minimum fleet of 30 DMUs would be required to meet the objectives of the DMU overlay service.
- ☐ Ridership forecast estimated to be 60 riders per train in 2010, equaling an average weekday ridership of 2,800 passengers.
- ☐ Because of better fuel efficiency and cheaper life cycle maintenance costs, it would be 5% less to operate DMUs in the overlay service described herein than to use Metrolink's locomotive-haul fleets for the overlay service. The difference in cost would be dramatic, if an alternative to the 12-axle rule were to be found.
- ☐ Some "transit" service (service which operates without a stop at Union Station), as opposed to "commuter" service (service in and out of Union Station) is possible, i.e., between Burbank Bob Hope Airport and Chatsworth.
- ☐ Two possibilities exist for DMU maintenance: Constructing an entirely new facility, or modifying the existing Metrolink CMF and planned EMF to accommodate a DMU overlay fleet.

Conclusions

DMU technology offers a number of benefits to the County's Metrolink service region. The major benefits which the utilization of DMUs could offer include:

- ☐ The ability to provide a more cost-effective vehicle technology solution for small trains than using an equivalent locomotive-haul consist, both from a capital and an operations cost perspective
- ☐ The ability to run single car trains, matching demand with capacity
- ☐ More energy-efficient operation than for equivalent locomotive-haul trains
- ☐ A more environmentally-friendly emissions and noise profile than for equivalent locomotive-haul trains

However, while this study has demonstrated the feasibility of implementing DMU technology on Metro's rights of way, the real benefits of utilizing DMUs for commuter service are constrained by the 12 axle rule and the need to utilize FRA-compliant equipment. These current constraints make it difficult to suggest DMU as a cost-effective strategy for implementing overlay service on the three Los Angeles County corridors at this time.

ATTACHMENT C

DMU / Metrolink Comparison Table

	DMU	Metrolink	Comments
Capital Costs			
	$330,000,000 (New MF) $295,000,000 (CMF & EMF)	---- $265,000,000 (CMF & EMF)	10% cheaper to implement using Metrolink vehicles
Operating Costs			
Agency Costs (per train-mile)	$62.96	$62.96	
Fuel Costs (per train-mile)	$6.17	$8.57	
Maintenance Costs (per train-mile)	$7.38	$9.22	
TOTAL	$76.51 per train mile	$80.75 per train mile	5% cheaper to operate DMU
Fleet Size and Ridership			
Total Seat Passengers	230	420	
Estimated DMU Riders	60[(a)]	----	
Seat Usage	26%	14%	
Excess Capacity	74%	86%	
Cost per new rider	$105,000	$95,000	10% cheaper to add more Metrolink midday service
Fuel Economy [(b)]			
Fuel Consumption	-29% (81 gallons)	113 gallons	
Emissions [(b) (c)]			
Carbon Monoxide (CO)		-38%	
Particulate Matter (PM10)	-26%		
Nitrous Oxide and Non-Methane Hydrocarbons (NOx + NMHC)	-51%		
Carbon Dioxide (CO_2)	-12%		

(a) Assuming an estimated 60 riders per DMU and a total of 46 DMU trains on the three corridors per day, average weekday ridership would total about 2,800 passengers.

(b) Results of simulation run from Los Angeles Union Station (LAUS) - Chatsworth - LAUS, both engines using ULSD.

(c) Emissions calculations for both engines were measured based on compliance with EPA's maximum allowable emissions for Tier 3 requirements. Current regulations (until 2011) allow Metrolink's locomotives to meet the less stringent Tier 2 requirements.